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Efficacy of ProTaper rotary instruments in removing filling materials during root canal retreatment

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Abstract

The aim of the this study was to investigate the efficacy of ProTaper rotary instruments compared to hand instrumentation with Hedstrom files, with and without the use of a solvent (eucalyptol) in the retreatment of gutta-percha filled root canals. Roots of forty extracted single-rooted maxillary anterior teeth with straight root canals were utilized in this study. The root canals were prepared using step-back technique and obturated with laterally condensed gutta-percha and sealer cement. The roots randomly divided into four groups with ten specimens each. Removal of gutta-percha was performed using ProTaper and Hedstrom files, both were used with and without the solvent eucalyptol. Both, time taken to reach the working length and time taken to complete removal of gutta-percha were recorded. Statistical analysis of the collected data revealed a highly significant decrease in the working time when ProTaper was used to remove gutta-percha compared with Hedstrom files. A highly significant decrease in the working time was found when eucalyptol was used with ProTaper. No significant difference existed between the treatments using Hedstrom with or without the use of eucalyptol.

Key words: ProTaper, Hedstrom files, root canal retreatment

Introduction

The results of many cross-sectional epidemiological studies reported a high percentage of root filled teeth with radiographic signs of apical periodontitis indicating a substantial need for endodontic retreatment.[1-3] The main causes of endodontic failure making retreatment necessary are thought to be insufficient cleaning and inadequate obturation.[4] Additionally teeth with inadequate obturation, unfilled or untreated root canals, or under extended root fillings may require retreatment before coronal restoration, as failure may occur in the future.[5]

The main goals of retreatment are complete removal of the root canal filling material in order to regain access to the apical foramen thus facilitating sufficient cleaning and shaping of the complete root canal system.[6]

Although numerous materials are described for obturation of root canals, gutta-percha in combination with a sealer is the most frequently used material. Techniques described for gutta-percha removal include the use of rotary instruments, heat carrying instruments and solvents.[7,8] In many cases the combined use of different

techniques may be the most efficient and time saving method.[9]

The development of the Nickel-Titanium (NiTi) manual and rotary instruments has revolutionized endodontics. Once the value of the NiTi for endodontic applications was established, research was directed toward the study of various systems able to reduce the number of files necessary for the working sequence and, at the same time, to lower the risk of separation. This trend has leaded to the introduction to the market many of NiTi rotary instruments that are different in taper and blade design. ProTaper system is one of the latest NiTi rotary products that available know in the market. ProTaper files introduce a new design with progressively increasing tapers with a multiple taper in a single instrument, triangular section, active blades, and a moderately active tip.[10,11]

Recently, the use of different NiTi instruments has been recommended for gutta-percha removal and various studies have reported their effectiveness.[12-15]

The aim of the this study was to investigate the efficacy of ProTaper rotary instruments compared to hand instrumentation with Hedstrom files, with and without the use of a solvent (eucalyptol) in the retreatment of gutta-percha filled root canals.

Materials and methods

Forty extracted single-rooted maxillary anterior teeth with straight root canals were selected for this study. All teeth were scaled with a periodontal scaler to remove soft tissue and calculus and stored in physiologic saline solution prior to testing.

The crown portions of all teeth were removed using diamond disc with straight hand piece and water coolant, this is to eliminate the variables in the access preparation, as well as to standardize the length of the root which should be 15 mm from the apex to the coronal end. Apical patency was ensured with size 10 reamer. Then the pulpal contents were removed using barbed broaches. Working length was defined as 1 mm short of the root tip. A step-back technique was used to prepare the root canals using k-files with circumferential filing action. The root canals were instrumented to No. 35 k-files at the entire working length then the coronal portions were flared by shortening the working length of each progressively larger file by 1 mm and performing circumferential filing. Recapitulation to working length with a No. 35 file and irrigation with 2 ml of 2.5 % sodium hypochlorite was performed before the use of each larger size.

The root canals were dried with paper points and obturated with laterally condensed gutta-percha and ZnOE (Dorifil, Dorident) as the sealer. The access cavities were sealed with Coltosol (Coltene, Switzerland) and the teeth stored in physiologic saline solution at 37 °C for two weeks to allow setting of the sealer. After that, the roots were coded and randomly divided into four groups with ten specimens each. The temporary filling was removed and the root canal was reopened. Removal of gutta-percha was performed using ProTaper and Hedstrom files, both were used with and without the solvent eucalyptol.

The gutta-percha and sealer were removed using the following techniques:

Group 1: ProTaper (Dentsply, Maillefer, Switzerland) rotary instruments and a low speed hand piece (300rpm) were used in a crown-down technique. Only the finishing files (F3-F1) were used for the retreatment. Apical

enlargement was performed to the file F3. Eucalyptol was used as a solvent.

Group 2: ProTaper rotary instruments were used as described above but no solvent was applied.

Group 3: Hedstrom files (Union Broach, NY, USA) sizes 45-20 were used for the retreatment of gutta-percha and sealer. The hand instruments were used in reverse sequence in a crown-down technique. Eucalyptol was applied as a solvent.

Group 4: Hedstrom files were used as described above but without solvent.

Both, time taken to reach the working length and time taken to complete removal of gutta-percha were recorded. Gutta-percha removal was judged complete when the working length was obtained and no more gutta-percha could be removed with the instruments used. All instruments were discarded after use in three root canals. All roots were treated by the same operator.

Statistical analysis was performed using ANOVA ($p < 0.001$) and t-test for the analysis of working time.

Results

Time taken to reach the working length

Working length could be reached in all specimens. The fastest technique to reach the working length was ProTaper with eucalyptol, followed by ProTaper, Hedstrom files with eucalyptol, and Hedstrom files (Table 1, Figure. 1).

Analysis of variance was performed to test the differences in the mean time among the four experimental groups. A statistically significant difference ($p < 0.001$) was found among the four experimental groups (Table 2).

Further analysis using t-test was performed to test the difference between the means of time of each pair of groups. It revealed a highly significant decrease ($p < 0.001$) in the working time when ProTaper was used, compared with Hedstrom files. A highly significant decrease ($p < 0.001$) in the working time was found when eucalyptol was used with ProTaper. No significant difference existed between the treatments using Hedstrom with or without the use of eucalyptol (Table 3).

Time taken to complete removal of gutta-percha

The fastest technique to remove gutta-percha completely again was ProTaper with eucalyptol, followed by ProTaper, Hedstrom files with eucalyptol, and Hedstrom files(Table 4, Figure 2).

Analysis of variance showed a statistically significant difference ($p < 0.001$) among the four experimental groups (Table 5). t-test proved that there was a highly significant decrease ($p < 0.001$) in the working time when ProTaper was used to remove gutta-percha compared with Hedstrom files. A highly significant decrease ($p < 0.001$) in the working time was found when eucalyptol was used with ProTaper. No significant difference existed between the treatments using Hedstrom with or without the use of eucalyptol (Table 6).

Discussion

All root canals in this study were prepared to size 35 with a 0.2 taper. This was assumed to represent rather narrow and often under prepared root canals, which frequently are found in retreatment cases. Probably, preparation to sizes 30 or even 25 may have been more appropriate from clinical prerogative, but this would

have resulted in some of the instruments used for gutta-percha removal cutting not only gutta-percha but also dentine. As a consequence, working time for some instruments could have been longer than when only cutting gutta-percha.

In the present study, eucalyptol was used as a solvent. Although chloroform is known to be more efficient in dissolving gutta-percha,[16-18] it has been reported to be locally toxic in contact with periradicular tissues, to be hepatotoxic and nephrotoxic and has been classified as a carcinogen.[19] Eucalyptol was selected from a variety of different solvents already recommended for endodontic retreatment which also xylol, methyl, chloroform, tetrahydrofuran, halothane and others. Eucalyptol has been reported to be safe and efficient.[20-22] The use of eucalyptol in the present study resulted in shorter working times in both groups where it was used. This difference was statistically significant between the groups when ProTaper was used to remove gutta-percha. These results are in accordance with similar studies reporting on reduced working time when using a solvent.[18,23]

In this study, the use of ProTaper was significantly faster than using Hedstrom files. This is probably due to the fact that the rotational speed have plasticized the gutta-percha more rapidly. The plasticized gutta-percha would also have presented less resistance to removal. This is aided mainly by the instrument design that may result in a combination of softening the gutta-percha by rotation and cutting the gutta-percha. This action was potentiated by the dissolving effect of eucalyptol when used with ProTaper to remove gutta-percha. These findings are consistent with those obtained in comparable studies, Sae-Lim et al. [23] and Ferreira et al. [24] reported that ProFile with and without use of chloroform was faster in gutta-percha removal than hand instrumentation with chloroform. Betti and Bramante [25] found that Quantec SC instruments without a solvent performed significantly faster than hand instruments with a xylol as a solvent. Hulsmann and Bluhm [13] and Somma et al. [15] found significant decrease in the working time using different rotary NiTi instruments for the removal of endodontic filling material. Whereas Imura et al. [26] reported a significantly shorter working time for Hedstrom files than for Quantec SC. Barrieshi-Nusair [27] found a shorter working time for hand instruments when compared with ProFile .04 both used with chloroform as a solvent.

Under the experimental conditions of this study, ProTaper proved to be efficient and time-saving instrument for the removal gutta-percha. The use of eucalyptol as a solvent shortened the time to reach the working length and to remove the gutta-percha.

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Table(1): Descriptive statistics for experimental groups

	N	Mean Time (min.)	Std. Deviation	Minimum	Maximum
group 1	10	1.88	0.10	1.69	2.05
group 2	10	2.42	0.15	2.19	2.67
group 3	10	3.12	0.23	2.81	3.50
group 4	10	3.25	0.25	2.87	3.61

Table (2): ANOVA test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.255	3	4.085	102.222	< 0.001
Within Groups	1.439	36	0.040		
Total	13.693	39			

Table (3): t-test

Comparison groups	T- value	P- value	Significance at level of 0.001
Group 1 Vs. Group 2	9.267	< 0.001	Highly significant
Group 1 Vs. Group 3	14.46	< 0.001	Highly significant
Group 1 Vs. Group 4	16	< 0.001	Highly significant
Group 2 Vs. Group 3	7.53	< 0.001	Highly significant
Group 2 Vs. Group 4	8.93	< 0.001	Highly significant
Group 3 Vs. Group 4	1.16	0.3	Not significant

Table(4): Descriptive statistics for experimental groups

	N	Mean Time (min.)	Std. Deviation	Minimum	Maximum
group 1	10	2.98	0.20	2.67	3.27
group 2	10	3.83	0.21	3.47	4.15
group 3	10	5.08	0.41	4.53	5.69
group 4	10	5.24	0.42	4.70	5.86

Table (5): ANOVA test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	34.54	3	11.51	105.81	< 0.001
Within Groups	3.92	36	0.11		
Total	38.46	39			

Table (6): t-test

Comparison groups	T- value	P- value	Significance at level of 0.001
Group 1 Vs. Group 2	9.05	< 0.001	Highly significant
Group 1 Vs. Group 3	14.51	< 0.001	Highly significant
Group 1 Vs. Group 4	15.18	< 0.001	Highly significant
Group 2 Vs. Group 3	8.56	< 0.001	Highly significant
Group 2 Vs. Group 4	9.38	< 0.001	Highly significant
Group 3 Vs. Group 4	0.86	0.4	Not significant

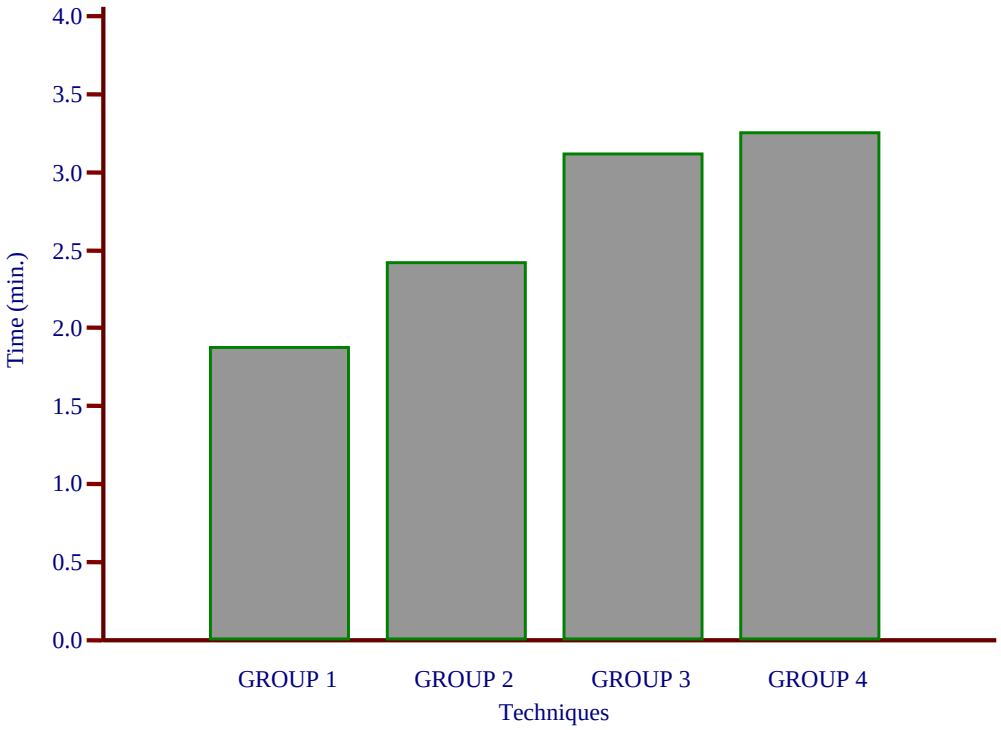

Figure (1): Graph showing mean time taken to reach the working length for the four groups

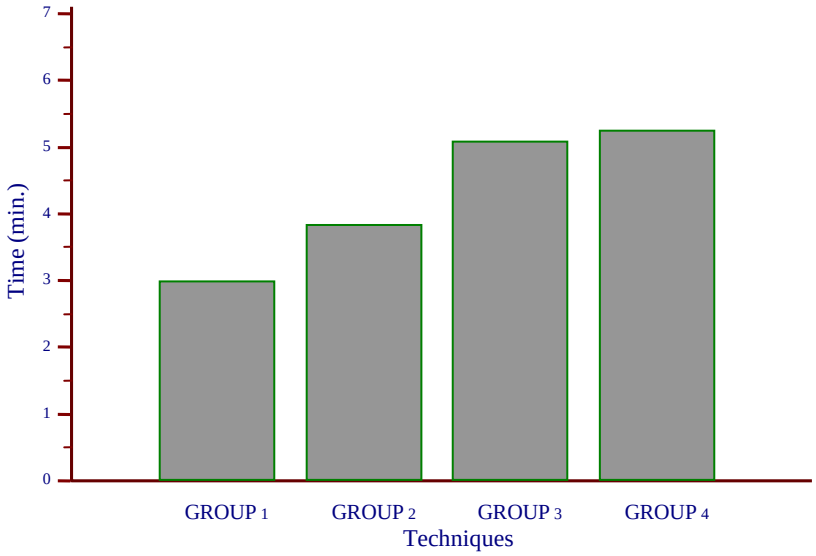

Figure (2): Graph showing mean time taken to complete removal of gutta perch for the four groups