10.5005/jp-journals-10024-1377

ORIGINAL RESEARCH

Comparative Analysis of Efficacy and Cleaning Ability of Hand and Rotary Devices for Gutta-Percha Removal in Root Canal Retreatment: An *in vitro* Study

Narender Reddy, Shilpa Reddy Admala, Sainath Dinapadu, Srikanth Pasari, Manoranjan P Reddy, MS Rama Rao

ABSTRACT

Aim of the study: To evaluate the efficacy and cleaning ability of Hedstrom files, and ProTaper retreatment instruments in removing gutta-percha from root canals with and without xylene as solvent.

Materials and methods: Sixty extracted single rooted human teeth were selected and decoronated, straight access established working length determined 1 mm short of canal, chemomechanical preparation done and obturated with gutta-percha and AH plus sealer. Samples were stored for 1 week in humidifier divided into four groups of 15 teeth each.

- Group I: Hedstrom files without xylene.
- Group II: Hedstrom files with xylene.
- Group III: ProTaper retreatment instruments without xylene.
- Group IV: ProTaper retreatment instruments with xylene. and the following criteria were assessed
  - Time taken for initial plunge of instrument into gutta-percha.
  - Time taken for complete removal of gutta-percha to reach working length
  - Ability of H files and ProTaper retreatment files with/without xylene to remove gutta-percha in coronal, middle and apical 1/3 of canal.

The teeth were grooved in labiolingual cross section, observed under a steromicroscope and scored according to gutta-percha debris left in the canal. Results were evaluated using ANOVA test and multiple comparisons done using Scheffe test.

Results: The least time to reach working length was found with group IV followed by groups III, II and group I respectively. Also the fastest way to remove maximum gutta-percha was group IV followed by groups III, II, and I respectively with a statistically significant difference among all groups. Apical 1/3 has more amount of remaining gutta-percha debris than middle and coronal 1/3 in all groups. The amount of gutta-percha debris in apical 1/3 was least in group IV followed by groups III, II and I respectively.

Discussion: The better performance of ProTaper rotary instruments has been attributed to their special flute design which tends to pull gutta-percha coronally directing it toward orifice. Also the movements of engine driven instruments produce frictional heat which plasticises gutta-percha and aids in easy removal. Apical third of root canals showed more gutta-percha debris compared to coronal and middle 1/3 and has been attributed to the greater anatomic variability and difficulty of instrumentation in the apical area. The existence of deep groves and depressions on dentine walls in this apical 1/3 make them less instrumented areas as it did be difficult to direct the file against the extreme root canal wall.

Conclusion: The fastest technique to remove gutta-percha and the shortest time to reach working length was observed with ProTaper retreatment instruments with xylene followed by ProTaper retreatment files without xylene and Hedstrom files without xylene. After instrumentation for removal of gutta-percha, apical third was found to have more debris compared to coronal and middle 1/3 of the root canal.

Keywords: Root canal retreatment, Gutta-percha, AH plus sealer, Hedstrom files, ProTaper.

How to cite this article: Reddy N, Admala SR, Dinapadu S, Pasari S, Reddy PM, Rao MSR. Comparative Analysis of Efficacy and Cleaning Ability of Hand and Rotary Devices for gutta-percha Removal in Root Canal Retreatment: An *in vitro* Study. J Contemp Dent Pract 2013;14(4):635-643.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

In the recent years the need for endodontic re-treatment has increased because of choice of tooth preservation over extraction. Endodontic failures have been attributed to inadequacies in cleaning and shaping, obturation, iatrogenic causes, loss of coronal or apical seal leading to re-infection of root canal system.[1,2] Hence, the main objective of non-surgical retreatment would be to remove all the filling material and regain access to the apical foramen, which can be time consuming and challenging. Techniques for gutta-percha removal include use of hand instruments, rotary instruments, ultra sonic instruments, heat carrying instruments and solvents or combination of the above techniques.[3-6] Rotary NiTi instruments have also been

proposed for removal of filling materials from root canal walls and various studies reported their efficacy in cleaning ability and safety.[7]

The ProTaper nickel-titanium (NiTi) system has been upgraded to ProTaper universal system, which includes shaping, finishing and retreatment instruments. The three retreatment instruments (D1, D2 and D3) are designed for removing filling materials from root canals. They have various tapers and diameters at the tip, which are size 30, 0.09 taper, size 25, 0.08 taper and size 20, 0.07 taper. The full length of these retreatment files are 16 mm for D1, 18 mm for D2 and 22 mm for D3. D1, D2 and D3 are recommended to remove filling materials from coronal, middle and apical portions of canals respectively. Similar to shaping and finishing instruments, the retreatment series have a convex cross section, however D1 has a working tip that facilitates its initial penetration into filling materials.

AIMS AND OBJECTIVES

1. To evaluate the root canal walls for the remaining gutta-percha after retreatment with Hedstrom files and ProTaper retreatment instruments.
2. To determine the time taken to reach the working length by Hedstrom files and ProTaper retreatment instruments.
3. To determine the time taken by Hedstrom files and ProTaper retreatment instruments for maximal removal of gutta-percha.

MATERIALS AND METHODS

Sixty human single rooted anterior teeth extracted for periodontal reasons were collected and stored in a mixture of 1% thymol solution until use. Teeth with immature root apices, teeth with root caries, fracture or craze lines fractures, more than one canal, calcification, internal resorption were excluded from the study. Crown of each tooth was removed so that the coronal surface was perpendicular to the long axis of the root and the remaining root length was 13 mm. Digital Vernier Calipers is used to attain the standardization of the specimens. Cleaning and shaping is done on all teeth up to master apical file of size 30 K-files in a step back technique up to a size 50 K-file and obturated by lateral condensation technique using 0.02 taper gutta-percha points with AH plus sealer. All 60 teeth were divided into 4 experimental groups of 15 teeth each.[8,9]

Group I	*Group II*	*Group III*	*Group IV*
Gutta-percha removal is done using H-file without xylene.	Gutta-percha removal is done using H-file and xylene as solvent.	Gutta-percha removal is done using ProTaper retreatment instruments without xylene.	Gutta-percha removal is done using ProTaper retreatment instruments with xylene as solvent.

The teeth were grooved in labiolingual direction with a double sided diamond disk, split longitudinally and viewed under a Stereomicroscope at 20× magnification. The specimens are evaluated for the remaining gutta-percha and the time required for reaching working length and completing removal of gutta-percha.[10,11] Results were statistically analyzed using ANOVA test. Rotary instruments were used with a low torque and at a constant speed of 300 rpm. One set of instruments was used for 4 specimens.

ASSESSMENT

Retreatment time for gutta-percha removal was recorded two times, with a stop watch for each canal and the following factors were assessed:

1. Time elapsed between the initial plunge of the instrument till it reached the working length.[12]
2. The total time needed for maximal removal of gutta-percha.

Gutta-percha removal and reinstrumentation was considered complete when no gutta-percha was observed on the instrument flutes and/or in the irrigating solutions. The teeth were grooved in labiolingual direction with a double sided diamond disk, split longitudinally and viewed under a Stereomicroscope (Global Surgical Corp, St Louis, MO) at 20× magnification which allows the specimen to be viewed in three dimensions. They can have a single fixed magnification, several discrete magnifications, or a zoom magnification system. Working distance is much longer than with a typical compound microscope as well, allowing work to be done on the specimen while it is being observed through the microscope.

The specimen were evaluated separately in the coronal, middle and apical third for the following and scored respectively. (Ezzie.E, Alex Fleury, Eric Solomon).

- Score 1: No to slight presence (0-25%) of obturation debris on the dentinal surface.
- Score 2: Some presence (25-50%) of obturation debris on the dentinal surface.
- Score 3: Moderate presence (50-75%) of obturation debris on the dentinal surface.
- Score 4: Heavy presence (>75%) of obturation debris on the dentinal surface.

Results were evaluated and analyzed using ANOVA test.

OBSERVATION AND RESULTS

The means of the time taken to reach working length and time taken for maximal removal of gutta-percha for each group is shown in Tables 1 to 8 and Graphs 1 to 8. Comparison of the means between the groups was done using one-way ANOVA and multiple comparisons was done using Scheffe test.

Table 1: Scores for group I (H-file without xylene): time to reach working length, maximal removal and root canal cleanliness in the coronal, middle and apical third of the root canals

Group I (H-file without xylene)					
S. no	*WL*	*CR*	*Coronal*	*Middle*	*Apical*
1	10.32	14.33	1	2	2
2	10.11	14.45	1	1	3
3	9.25	13.52	1	2	2
4	8.59	12.57	1	1	1
5	9.24	15.05	2	1	2
6	8.24	14.11	1	2	2
7	9.45	13.21	1	1	2
8	10.22	14.57	1	2	1
9	11.21	16.28	2	1	3
10	10.47	15.27	2	1	2
11	9.27	14.54	1	2	2
12	8.29	13.56	1	2	2
13	10.28	14.49	2	2	3
14	9.52	13.52	1	1	1
15	9.21	14.34	2	2	2
Mean	9.5780	14.2540	1.33	1.533	2
SD	0.84915	0.90889	0.488	0.516	0.655

Table 2: Scores for group II (H-file with xylene): time to reach working length, maximal removal and root canal cleanliness in the coronal, middle and apical third of the root canals

Group II (H-file with xylene)					
S. no	*WL*	*CR*	*Coronal*	*Middle*	*Apical*
1	6.25	8.24	1	1	2
2	7.52	10.35	1	1	1
3	6.44	8.23	1	1	2
4	8.14	11.24	1	1	1
5	7.36	10.26	1	2	2
6	6.2	9.54	2	2	2
7	5.61	8.37	1	1	1
8	6.12	9.33	2	2	2
9	7.24	11.22	1	1	1
10	8.26	10.24	1	1	2
11	9.24	11.54	2	1	2
12	8.29	10.26	1	3	2
13	7.54	10.21	1	1	3
14	6.45	9.44	1	2	2
15	8.24	11.23	1	1	2
Mean	7.2600	9.9800	1.200	1.400	1.800
SD	1.04768	1.10600	0.414	0.632	0.561

Table 3: Scores for group III (ProTaper retreatment instruments without xylene): time to reach working length, maximal removal and root canal cleanliness in the coronal, middle and apical third of the root canals

Group III (ProTaper retreatment instruments without xylene)					
S. no	*WL*	*CR*	*Coronal*	*Middle*	*Apical*
1	3.29	5.02	1	1	2
2	4.12	4.55	1	1	2
3	3.54	6.21	1	2	2
4	4.28	5.27	1	1	2
5	3.42	5.42	1	1	2
6	3.32	5.42	1	1	2
7	3.45	6.19	1	1	2
8	3.44	5.36	1	2	2
9	4.12	5.34	1	1	2
10	3.36	4.12	1	1	2
11	4.34	3.36	1	1	1
12	3.14	5.22	1	1	1
13	3.78	4.16	1	1	1
14	4.31	5.21	2	2	1
15	3.23	4.24	1	2	1
Mean	3.6760	5.0060	1.067	1.267	1.667
SD	0.43633	0.8345	0.258	0.458	0.488

Table 4: Scores for group IV (ProTaper retreatment instruments with xylene): time to reach working length, maximal removal and root canal cleanliness in the coronal, middle and apical third of the root canals

Group IV (ProTaper retreatment instruments with xylene)					
S. no	*WL*	*CR*	*Coronal*	*Middle*	*Apical*
1	3.13	5.21	1	1	1
2	2.32	4.33	1	1	2
3	3.05	4.14	1	1	1
4	3.24	5.01	1	2	2
5	3.12	5.19	1	1	2
6	3.14	4.54	1	2	2
7	2.12	3.14	1	1	2
8	2.56	3.04	2	1	2
9	2.06	3.25	1	1	2
10	2.54	4.26	1	1	2
11	2.12	3.36	1	2	1
12	2.21	3.15	1	1	1
13	3.11	3.57	1	1	2
14	2.54	4.12	1	1	1
15	1.58	3.01	1	1	1
MEAN	2.5893	3.9547	1.067	1.200	1.600
SD	0.51724	0.79698	0.258	0.414	0.507

Time taken to reach the working length:

The shortest time to reach working length was found with group IV followed by groups III, II, I with mean values of 2.58, 3.67, 7.26 and 9.57 minutes respectively. The rotary device ProTaper retreatment instruments proved to be significantly faster than Hedstrom file. Significant difference was found among all the four groups, ($p < 0.0001$) Tables 6 and 7.

Table 5: Mean values for time taken to reach working length

Time taken to reach working length	
Group I (Hedstrom file without xylene)	9.5780
Group II (Hedstrom file with xylene)	7.2600
Group III (ProTaper retreatment instruments without xylene)	3.6760
Group IV (ProTaper retreatment instruments with xylene)	2.5893

Time taken for maximal removal of gutta-percha (Tables 1 to 4 and 8 to 10).

The fastest technique to remove gutta-percha maximally was group IV followed by groups III, II, I with mean values of 3.95, 5.00, 9.98 and 14.25 minutes respectively.

Significant difference was found among all the four groups ($p < 0.0001$) Tables 9 and 10.

Efficacy of instruments: (Tables 1 to 4 and 11 to 14).

Apical third had a more amount of remaining filling material than the middle and the cervical third in all the

Table 6: Time taken to reach working length (ANOVA test)

	Sum of squares	*Degree of freedom*	*Mean square*	*F*	*p-value*
Between groups	468.335	3	156.112	274.288	<0.0001
Within groups	31.872	56	0.569		
Total	500.207	59			

The p-value indicates that there is significant difference among the four groups

Table 7: Multiple comparisons: dependent variable: time taken to reach working length (Scheffe test)

Group (I)	*Group (J)*	*Mean difference (I-J)*	*Standard error*	*Significance*
Group I	Group II	2.31800*	0.27548	<0.0001
	Group III	5.90200*	0.27548	<0.0001
	Group IV	6.98867*	0.27548	<0.0001
Group II	Group I	– 2.31800*	0.27548	<0.0001
	Group III	3.58400*	0.27548	<0.0001
	Group IV	4.67067*	0.27548	<0.0001
Group III	Group I	– 5.90200*	0.27548	<0.0001
	Group II	– 3.58400*	0.27548	<0.0001
	Group IV	1.08667*	0.27548	0.003
Group IV	Group I	– 6.98867*	0.27548	<0.0001
	Group II	– 4.67067*	0.27548	<0.0001
	Group III	– 1.08667*	0.27548	0.003

*The mean difference is significant at the 0.05 level

Table 8: Mean values for time taken for maximal removal of gutta-percha

Time taken for maximal removal of gutta-percha	
Group I (Hedstrom file without xylene)	14.2540
Group II (Hedstrom file with xylene)	9.9800
Group III (ProTaper retreatment instruments without xylene)	5.0060
Group IV (ProTaper retreatment instruments with xylene)	3.9547

groups. Though it was observed that more amount of remaining gutta-percha was seen in apical third but it was least in group IV followed by groups III, II, I with mean values of 1.60, 1.66, 1.80 and 2.00 minutes respectively.

DISCUSSION

In are root canal therapy removing as much sealer and gutta-percha as possible from inadequately prepared and obturated

Table 9: Time taken for maximal removal of gutta-percha (ANOVA test)

	Sum of squares	*Degree of freedom*	*Mean square*	*F*	*p-value*
Between groups	1020.03	3	340.024	412.364	<0.0001
Within groups	46.16	56	0.825		
Total	1066.249	59			

The p-value indicates that there is significant difference among the four groups

Table 10: Multiple comparisons: dependent variable: time taken for maximal removal of gutta-percha (Scheffe's test)

Group (I)	*Group (J)*	*Mean difference (I-J)*	*Standard error*	*Significance*
Group I	Group II	4.27400*	0.33158	<0.0001
	Group III	9.24800*	0.33158	<0.0001
	Group IV	10.29933*	0.33158	<0.0001
Group II	Group I	– 4.27400*	0.33158	<0.0001
	Group III	4.97400*	0.33158	<0.0001
	Group IV	6.02533*	0.33158	<0.0001
Group III	Group I	– 9.24800*	0.33158	<0.0001
	Group II	– 4.97400*	0.33158	<0.0001
	Group IV	1.05133*	0.33158	0.025
Group IV	Group I	– 10.29933*	0.33158	<0.0001
	Group II	– 6.02533*	0.33158	<0.0001
	Group III	– 1.05133*	0.33158	0.025

* The mean difference is significant at the 0.05 level

Table 11: Means of remaining gutta-percha in coronal, middle and apical regions

Group	*Region*					
	Coronal		*Middle*		*Apical*	
	Mean	*Standard deviation*	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*
Group I	1.333	0.488	1.533	0.516	2.000	0.655
Group II	1.200	0.414	1.400	0.632	1.800	0.561
Group III	1.067	0.258	1.267	0.458	1.667	0.488
Group IV	1.067	0.258	1.200	0.414	1.600	0.507

Table 12: Amount of remaining gutta-percha in the coronal third of the root canals (ANOVA test)

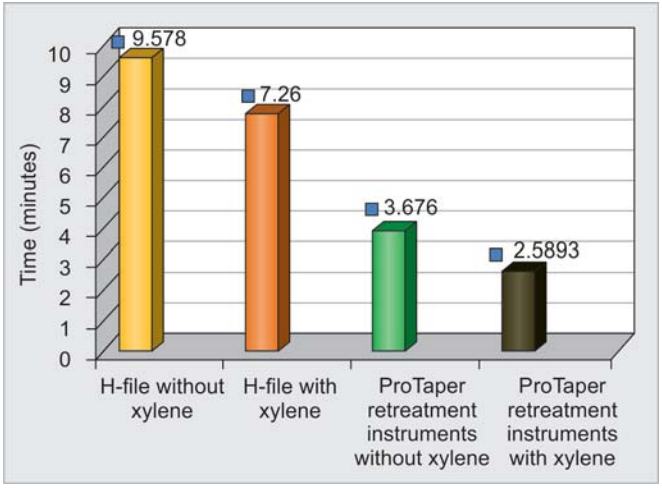
	Sum of squares	*Degree of freedom*	*Mean square*	*F*	*p-value*
Between groups	0.733	3	0.244	1.801	0.157
Within groups	7.600	56	0.136		
Total	8.333	59			

Table 13: Amount of remaining gutta-percha in the middle third of the root canals (ANOVA test)

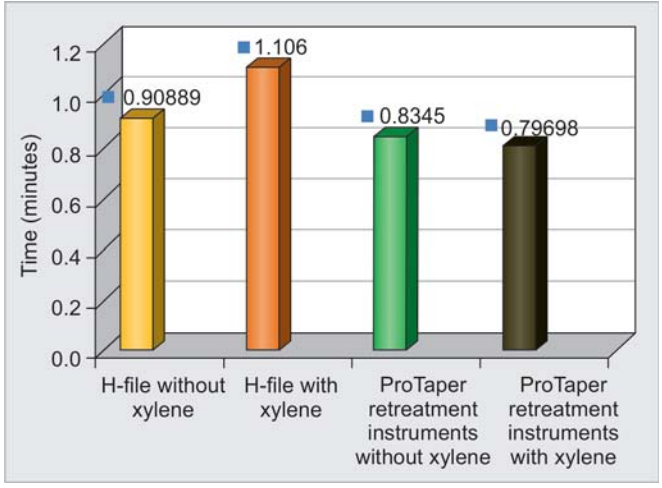
	Sum of squares	*Degree of freedom*	*Mean square*	*F*	*p-value*
Between groups	0.938	3	0.328	1.252	0.300
Within groups	14.667	56	0.262		
Total	15.650	59			

Table 14: Amount of remaining gutta-percha in the apical third of the root canals (ANOVA test)

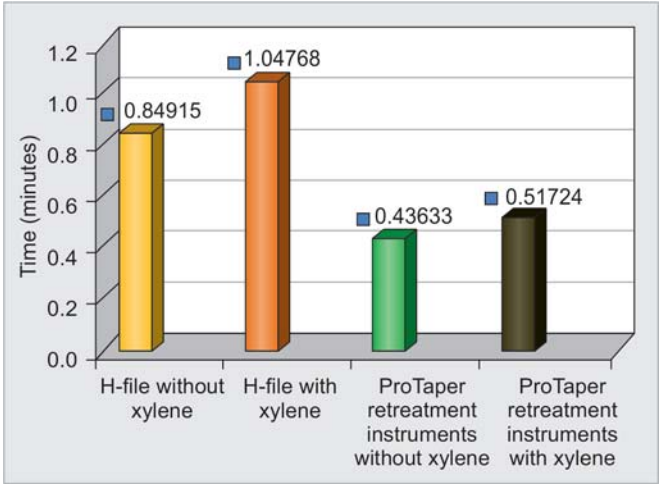
	Sum of squares	*Degree of freedom*	*Mean square*	*F*	*p-value*
Between groups	1.400	3	0.467	1.508	0.233
Within groups	17.333	56	0.310		
Total	18.733	59			



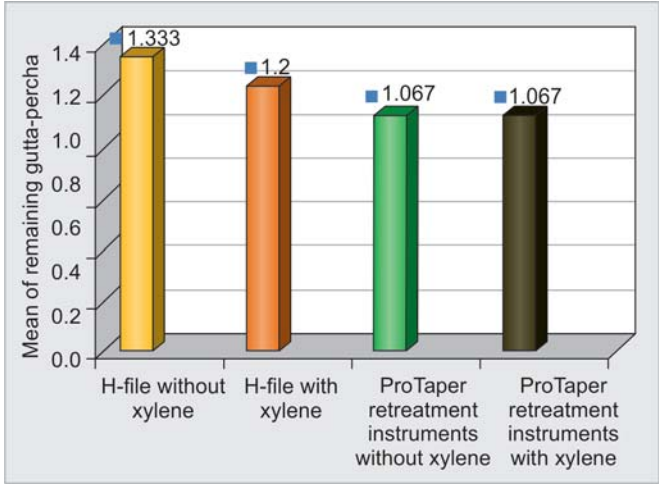
Graph 1: Mean values for time taken to reach working length



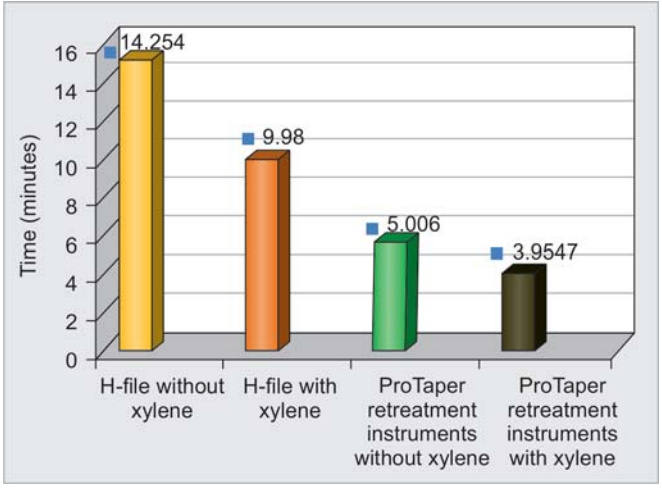
Graph 4 : Standard deviation for time taken for complete removal of gutta-percha



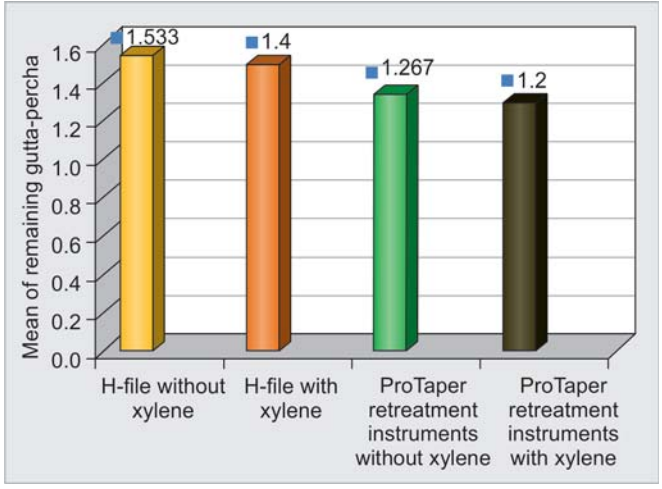
Graph 2: Standard deviation for time taken to reach working length



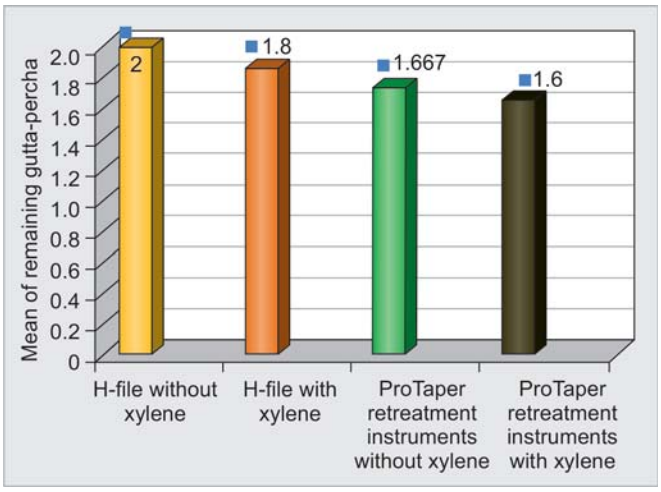
Graph 5: Means of the remaining gutta-percha in the coronal mean of remaining gutta-percha third of root canal



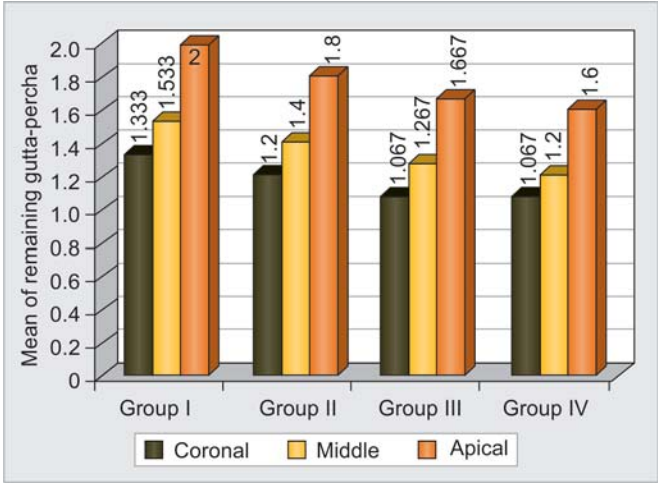
Graph 3: Mean values for time taken for complete removal of gutta-percha



Graph 6: Means of the remaining gutta-percha in the middle third of root canal



Graph 7: Means of the remaining gutta-percha in the apical third of root canal



Graph 8: Means of the remaining gutta-percha in all the groups

root canal systems is critical in order to uncover remnants of necrotic tissue or bacteria that may be responsible for periapical inflammation and failure. The working length of all the specimens was determined by a No.10 K-file until the tip was just visible at the apical foramen and then 1mm was subtracted from this measurement in a view that most of the pathogenic bacteria are generally harbored in apical 1/3rd, and hence it is important to establish correct working length so that bacterial load can be significantly reduced. Chemomechanical preparation was given due importance as narrow unprepared root canals lead to failure and the canals were obturated with gutta-percha and AH plus sealer using lateral condensation technique to obtain acceptable obturation. The retreatment procedure was started with Hedstrom file and ProTaper retreatment instruments with and without xylene as per the above groups. Then the following parameters were recorded.

In the present study the results demonstrated that the use of ProTaper retreatment instruments were significantly more effective. The shortest time to reach the working length and for maximal removal of gutta-percha were seen in group IV (ProTaper retreatment instruments with xylene), followed by group III (ProTaper retreatment instruments without xylene), group II (H-file with xylene) and then group I (H-file without xylene).

The better performance of ProTaper retreatment instruments is attributable to their design. The special flute design and rotary motion of ProTaper retreatment instruments tend to pull gutta-percha into the file flutes and direct it toward the orifice. Furthermore, the rotary movements of the engine-driven files produce a certain degree of frictional heat which plasticize gutta-percha and thus presents less resistance and is easy removal (Betti and Bramante 2001).[13] Also the use of xylene resulted in shorter working times for all groups and in better root canal cleanliness which are in accordance with similar studies reporting on reduced working time when using solvent.[14]

In the present study apical third had a more amount of remaining filling material than the middle and the cervical third in all the groups. Among the groups the amount of remaining gutta-percha was least in group IV (ProTaper retreatment instruments with xylene), followed by group III (ProTaper retreatment instruments without xylene), group II (H-file with Xylene) and then group I (H-file without xylene).

The following studies showed similar results to present study. Saad AY et al[10] in 2007 showed ProTaper and K3 required significantly less time for removal of the filling material when compared to Hedstrom files and left significantly less remaining filling material compared with hand instruments similarly Tasdemir T et al in 2007[6,15] compared ProTaper, R-Endo, Mtwo Rotary instruments and Hedstrom files and concluded that ProTaper instruments left less filling material than other groups. The retreatment time with Mtwo and ProTaper instruments was significantly shorter than manual instrumentation with Hedstrom files. Hulsmann M et al in 2004[16] demonstrated that ProTaper and Flexmaster with and without Eucalyptol left less amount of remaining gutta-percha compared to Hedstrom files and GT rotary instruments and apical third of the root canals showed more amount of gutta-percha compared to coronal and middle third. Likewise Valentina Giuliani et al[17] (2008) compared profile system, ProTaper retreatment system and H-files and observed that in coronal and middle third ProTaper retreatment system obtained better results followed by profile in crown down technique and most residual gutta-percha was seen with usage of Hedstrom files. Furthermore Gergi R et al (2007) evaluated effectiveness of H-files, ProTaper, R-endo from curved root canals and concluded that both rotary NiTi systems proved to be helpful and safe devices for gutta-percha removal.

However, literature shows the following studies which contradict the findings of the present study. G Celik Unal et al (2009)[18] compared gutta-percha removal with a combination of K- and H-files with R-Endo retreatment files, profile and ProTaper retreatment systems and observed that the combination of K and H-files were more efficient in removing gutta-percha. Similarly, Bharathi G et al (2002)[19] observed that working length can be reached in shortest time by a combination of gates glidden drills and H-files, followed by profile and H-files and xylene. Also H-files and xylene showed less remanants of gutta-percha. Also, studies conducted by N Imura et al (2000)[7] conducted showed that H-files were more efficient in removing more gutta-percha in less time compared to K-files, Quantec LX rotary instruments and profile 0.04 taper instruments.

In the present study, apical third had a more amount of remaining filling material than the middle and the cervical third in all the groups. In general, there is increased anatomical variability and difficulty of instrumentation in the apical area. The existence of deep grooves and depressions on dentin walls in the apical third may well explain the presence of these less instrumented areas making it impossible to direct nickel-titanium instruments against entire root canal walls.

In the middle and coronal parts of the root canals ProTaper retreatment instruments performed better than in the apical part, which was due to variable taper of the instrument. The more effective removal of debris in the coronal and middle thirds by Hedstrom file may be explained, because stainless steel instruments are stiffer than nickel-titanium (NiTi) rotary instruments and can be safely directed toward the canal walls allowing for better performance.

However, further clinical long-term studies should be carried out to further support the results of this study to effectively use these instruments for successful endodontic retreatment.

REFERENCES

1. Allen RK, et al. A statistical analysis of surgical and nonsurgical endodontic retreatment cases. Journal of Endodontics 1989; 15(6):261-266.
2. Staboltz A, Friedman S. Endodontic retreatment case selection and technique part-2: treatment planning for retreatment. Journal of Endodontics 1988;14:607-614.
3. Barrieshi-Nussair. gutta-percha retreatment: effectiveness of nickel-titanium rotary instruments versus stainless steel hand files. Journal of Endodontics 2002;28:454-456.
4. Somma F, Cammarota G, Plotino G. The effectiveness of manual and mechanical instrumentation for the retreatment of three different root canal filling materials. Journal of Endodontics 2008;34(4):468-469.
5. Hulsmann M, Stotz S. Efficacy, cleaning ability and safety of different devices for gutta-percha removal in root canal retreatment. International Endodontic Journal 1997;30:227-233.
6. Tasdemir T, Yeldrium T, Celik D. Comparative study of removal of current endodontic fillings. Journal of Endodontics 2008;34: 326-329.
7. Imura1, Katol AS, Hata GI. Comparision of relative efficacies of four and rotary instrumentation techniques during endodontic retreatment. International Endodontic Journal 2000;33:361-366.
8. Kosti E, Lambrianidis T, Economides N. Ex vivo study of the efficacy of H-files and rotary NiTi instruments to remove gutta-percha and four types of sealer. International Endodontic Journal 2006;39:48-54.
9. Retreatment efficacy of hand versus automated instrumentation in oval-shaped root canals: an ex vivo study International Endodontic Journal 2006;39:521-526.
10. Saad AY, Al-Hadlaq SM, Al-Katheeri NH. Efficacy of two rotary NiTi instrumentation in the removal of gutta-percha during root canal retreatment. Journal of Endodontics 2007;33(1):38-41.
11. Zmener O, Pameijer CH, Banegas G. Retreatment efficacy of hand versus automated instrumentation in oval-shaped root canals: an ex vivo study. International Endodontic Journal 2006; 39:521-526.
12. Cuhna RS, Martin AS, Barros PP, Mendonce. F, Jacinto R, Bueno CE. In vitro evaluation of cleansing working time and analysis of the amount of gutta-percha or resilon remnants in root canal walls after instrumentation for endodontic retreatment. Journal of Endodontics 2007;33(12)1426-1428.
13. Betti LV, Bramante CM. Quantec SC rotary instruments versus hand files for gutta-percha removal in root canal retreatment. International Endodontic Journal 2001;34:514-519.
14. Wolcott JF, Himel VT, Hicks ML. Thermafil retreatment using a new system B technique or solvent. Journal of Endodontics 1999;25:761-764.
15. Tasdemir T, Yildirim T, Celik D. Efficacy of three rotary NiTi instruments in removing gutta-percha from root canals. International Endodontic Journal 2008;41:191-196.
16. Hulsmann M, Bluhm V. Efficacy, cleaning abilty and safety of different rotary NiTi instruments in root canal retreatment. International Endodontic Journal 2004;37:468-476.
17. Giuliani V, Cocchetti R, Pagavino G. Efficacy of ProTaper universal retreatment files in removing filling materials during root canal retreatment. Journal of Endodontics 2008;34(11): 1381-1384.
18. Celik G, Unal B, Kaya U, Tac AG, Kececi AD. A Comparison of efficacy of conventional and new retreatment instruments to remove gutta-percha in curved root canals: an ex vivo study. International Journal of Endodontics 2009;42:334-350.
19. Bharathi G, Chacko Y, Lakshminarayanan L. An in vitro analysis of gutta-percha removal using three different techniques. Endodontology 2002;14:41-45.

ABOUT THE AUTHORS

Narender Reddy

Senior Lecturer, Department of Conservative and Endodontics, SVS Institute of Dental Sciences, Mahabubnagar, Andhra Pradesh, India

Shilpa Reddy Admala (Corresponding Author)

Associate Professor, Department of Conservative and Endodontics SVS Institute of Dental Sciences, Mahabubnagar, Andhra Pradesh India, e-mail: shilpareddyadmala@gmail.com

Sainath Dinapadu

Reader, Department of Conservative and Endodontics, SVS Institute of Dental Sciences, Mahabubnagar, Andhra Pradesh, India

Srikanth Pasari

Senior Lecturer, Department of Conservative and Endodontics SVS Institute of Dental Sciences, Mahabubnagar, Andhra Pradesh India

Manoranjan P Reddy

Professor and Head, Department of Conservative and Endodontics Aditya Dental College, Beed, Maharashtra, India

MS Rama Rao

Professor and Head, Department of Conservative Dentistry and Endodontics, Sree Sai Dental College and Research Institute, Srikakulam Andhra Pradesh, India