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Comparison of Efficacy of Different Instruments In The Removal Of Gutta-Percha - An In Vitro Study

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ABSTRACT
Introduction:
Non surgical endodontic retreatment consists of cleaning, shaping, and three dimensional obturation of previously obturated roots canals. It is the treatment of choice for the management of endodontic failure, when access to the root canals is feasible. This study was conceived to determine the efficiency of R-Endo, Universal Protaper, Mtwo rotary instruments in comparison to hand K-files for removal of gutta-percha from root canal during retreatment.
Objective:
1. To comparatively determine whether hand or rotary instruments are more effective in Gutta-percha removal.
2. To comparatively determine which of the four tested systems is most effective in gutta-percha removal.
3. To comparatively determine the effectiveness of the tested file system in removing gutta-percha after lateral condensation.
4. To comparatively determine the effectiveness of the tested file system in removing gutta-percha after vertical condensation.
Materials & Methods:
120 mandibular first premolar were selected on the basis of predetermined criteria. After access cavity preparation, the biomechanical preparation was carried out with Protaper rotary file system. These teeth were randomly divided into two groups, consisting of 60 teeth each. Teeth is group A were obturated with lateral condensation technique, while teeth in group B were obturated with vertical condensation technique.
For obturation gutta-percha cones along with AH plus sealer were used. Teeth in both the groups were further sub divided into four sub groups, consisting of 15 teeth each. Teeth in each sub group were instrumented with hand K files, universal protaper file, Mtwo file and Micro Mega R-Endo file, respectively. The teeth were splited and observed under microscope for evaluation of remaining gutta-percha and sealer. The observer's evaluation was carried out on the basis of predetermined grades. The obtained data was tabulated and statistically analysis using ANOVA along with LHD POST HOC Analysis by using SPSS software version 22.
Results:
The time consumed for removal of the obturated material was found to be least with Mtwo file system, followed by R-Endo, Universal Protaper and Hand K File, respectively. Removal of the obturated material was found to be most effective with Mtwo file, followed by R-Endo, Universal Protaper and Hand K file, respectively.
Conclusion:
Mtwo file is most effective in removal of the obturated material followed by R-Endo, Universal Protaper and Hand K file, respectively.

Key Words: Endodontic retreatment, gutta-percha, Obturation, Rotary files, Hand files, AH Plus sealer

I. INTRODUCTION

The aim of root canal retreatment is to remove the existing root canal filling material completely, thereby allowing the entire root canal system to be cleaned[1]. Gutta-percha and endodontic sealer are widely used as filling materials, and their effective removal in endodontic retreatment is considered essential for success[2].
Many techniques have been employed for the removal of gutta-percha in root filled teeth. These include endodontic hand files combined with heat or chemical solvents, engine – driven rotary files, ultrasonic instruments, heat carrying instruments and lasers[3]. Nonsurgical endodontic retreatment consists of cleaning, shaping and three dimensional obturation 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 obstructions – preventing a direct straight line access to the root canals have to be removed[4]. Complete removal of the obturated material comprising of gutta percha and sealer is difficult[5]. The difficulty increases many fold when the root has a curvature or it has been under prepared. The persistence of the

remaining obturated material complicates the prognosis of re-treatment[6]. So as to achieve, total removal of the previous obturation various adjuncts have been advised, viz gutta-percha solvents and some specialized rotary instruments. In the past, for removal of the obturated gutta-percha, use of guttapercha solvent along with hand K-files was advised. Later use of H-files was advocated and they were found to be quite effective but they had a high rate of fracture. As a result, with the advancement in mechanized rotary instrumentation, rotary gutta-percha removal systems have been developed by different manufacture, with each advocating, their system's higher efficiency and efficacy in the process[7,8].

Aim of this study was to compare the determination of effectiveness of the hand and rotary instruments in removal of gutta-percha as well as we have compare the four tested systems which were used in removal of gutta-percha in both lateral and vertical condensation process.

II. METHODOLOGY

The approval for this in vitro study was taken from RKDF institutional ethical committee. For this study, freshly extracted permanent mandibular 1st premolar were collected from the out patients department of Oral and maxillofacial surgery. The collected teeth were washed under running water and were cleaned with ultrasonic scaler for removal of remaining calculus and soft tissues. Teeth were subsequently stored in distilled water. They were examined clinically and radiographically, with the help of Radiovisiography (RVG). On the basis of predetermined criteria, 120 teeth were selected.

Inclusion Criteria:
Single rooted, freshly extracted permanent mandibular 1st premolar with completely formed root apices & free of defects, collected from patients between 25 to 30 years of age.

Exclusion Criteria:
1. Teeth with resorption – internal/external
2. Teeth with caries.
3. Teeth with visible cracks.
4. Teeth with morphological defects.
5. Teeth with developmental defects.
6. Teeth with decalcification.
7. Teeth with fluorosis.

Root Canal Treatment:

With help of a number 2 bur running in air-rotor handpiece with air water spray, the access cavity was made. Patency of canal was checked and working length was established 1mm short apex. With a diamond disc, the teeth were sectioned at the cemento enamel junction, so as to obtain a standardized working length of 18 mm, in all the samples. thereafter the biomechanical preparation was carried out with Protaper rotary file system. These teeth were randomly divided into two groups, consisting of 60 teeth each. Teeth is group A were obturated with lateral condensation technique, while teeth in group B were obturated with vertical condensation technique. For obturation gutta-percha cones along with AH plus sealer were used.

Removal of Obturating Material:

In each group, the 60 samples were subdivided into four subgroups, comparing of 15 samples each. In each sample, 6 mm of the obturated material was removed from the cervical part of the canal using Gates Glidden drills no. 1,2 & 3 sequentially. After using the Gates Glidden drills, a drop of chloroform solvent was introduced into the canal, to soften the gutta-percha. Two or three additional drops of solvent were applied as required to reach the working length. During the removal process, 5% sodium hypochlorite was used as the irrigating agent. Obturated material was removed from each sample, in both the groups as following:-

Sub-Group (I): (n=15) ProTaper Universal rotary instruments were used with crown down technique. All the three protaper universal system retreatment files were used in crown down technique, sequentially, until working length was reached. Initially D1 Protaper file (0.09 taper, 300 rpm) was used to remove the filling material from the coronal third of the root canal. Then D2 Protaper file (0.08 taper, 300 rpm) was used in the coronal two thirds of the root canal. Finally D3 protaper file (0.07 taper, 300 rpm) was used with light apical pressure, until the working length was reached and no further filling material was removed.

Sub-Group (II): (n=15) M2 rotary instruments (Dentsply Maillefer) were used with crown down technique. Root canals were instrumented in a simultaneous technique to the working length using M-two R2 (size 25, 0.05 taper) in a brushing action with lateral pressing movements. Progression of the rotary file was performed by applying slight apical pressure and frequently removing the files to inspect the blades and clean the debris from the flutes. Lastly, conventional Mtwo rotary

instrument (Size 30, 0.05 taper) was used to working length.

Sub-Group (III): (n=15) Micromega R-Endo rotary instruments were used with crown down approach. R-Endo rotary system was used as recommended by manufacturer in crown down technique with push movement and retain the motion circumferentially. R1, R2 and R3 were used respectively to remove the root filling material from the coronal, middle and apical thirds. The removal of the obturation material was considered complete when the working length was reached, no material was observed between the files, and the walls of the canal felt smooth and free of debris.

Sub-Group (IV): (n=15) Hand K files were used with circumferential filling technique. ISO size 15 and 20 Hand K files were used for deep penetration until they reached the working length. The removal of gutta-percha was completed using size 25 to 40 Hand K files in a circumferential quarter – turn push pull motion.

Measurement of time consumed in removal of obturating material:- For each sample, the time elapsed from start of use of the endodontic retreatment file till the file did not display any gutta-percha/sealer debris, was measured with a stopwatch and recorded.

After removal of the obturated material, each sample was placed in wax block, so as to stabilize it. Each sample was sectioned vertically, with the help of micromotor and diamond disc at 300-400 rpm with continuous water cooling to prevent frictional heat.

Out of the two sectioned portion, one was selected, which had no cracks, fracture, or craze lines. Each selected sample was examined under stereomicroscope at 10X magnification, for remaining obturated material. This examination was carried out in the cervical, middle and apical third.

The material remaining after retreatment was evaluated with the help of Stereomicroscope with special calibrated slide termed as stage micrometer and eye piece lens known as ocular micrometer.

Result:-

The difference in the amount of material remaining after retreatment and time required for retreatment were analysed via Analysis of variance (ANOVA) along with LHD POST HOC Analysis by using SPSS software version 22.

The mean time required for removal of obturated material after lateral condensation with maximum with hand K – file was found to 12.43±1.98 min, universal file 8.73±1.30 min , Micromega R-Endo file was 8.44± 1.08 min and minimum with M2 file was 7.64± 1.22 min and the statistical result shows highly significant difference among different file system used with F = 33.48 and p value = 0.01. (Table 1)

In vertical condensation the mean time required for removal of obturated material was maximum with hand K – file was found to 13.48±1.98 min, universal file 9.00± 1.78 min, Micromega R-Endo file was 8.82± 1.30 min and minimum with M2 file was 7.86± 1.41 min and the statistical result shows highly significant difference among different file system used with F = 34.22 and p value = 0.01. (Table 1)

In group I the root canal filling material was removed with K file. The mean amount of material left after removal of the obturated material, which was placed with lateral condensation technique was 0.30 mm in the coronal, 0.91mm in middle and 1.49mm in the apical third of the root while 0.35 mm in the coronal, 1.01mm in middle and 1.74 mm in the apical third of the root with vertical condensation technique. There was significant difference in the material remaining in lateral and vertical condensation with $p < 0.01$ with t value 6.27 for coronal third, 11.25 for middle third and 14.76 for apical third. (Table 03)

In group II the root canal filling material was removed with universal protaper. The mean amount of material left after removal of obturated material which was placed with lateral condensation technique was 0.19 mm in the coronal, 0.78 mm in middle and 1.43 mm in the apical third of the root. The mean amount of material left after removal of obturated material which was placed with vertical condensation technique was 0.21 mm in the coronal, 0.81 mm in middle and 1.50 mm in the apical third of the root. There was significant difference in the material remaining in lateral and vertical condensation with $p < 0.01$ with t value 1.76 for coronal third, 1.47 for middle third and 4.15 for apical third. (Table 04)

In M2 File group The mean amount of material left after removal of the obturated material which was placed with lateral condensation technique was 0.17 mm in the coronal, 0.60 mm in middle and 1.19 mm in the apical third of the root. The mean amount of material left after removal of the obturated material which was placed with vertical condensation technique was 0.19 mm in the coronal, 0.65 mm in middle and 1.24 mm in the apical third of the root. There was significant difference in the material remaining in lateral and vertical condensation with $p < 0.01$ with t value 1.18 for coronal third, 3.67 for middle third and 2.51 for apical third. (Table 05)

In Micromega R-Endo file group the mean amount of material left after removal of the obturated material which was placed with lateral condensation technique was 0.19 mm in the coronal, 0.74 mm in middle and 1.37 mm in the apical third of the root while with vertical condensation technique was 0.26 mm in the coronal, 0.83 mm in middle and 1.43 mm in the apical third of the root. There was significant difference in the material remaining in lateral and vertical condensation with $p < 0.01$ with t value 4.87 for coronal third, 7.65 for middle third and 11.24 for apical third. (Table 06)

The time consumed for removal of the obturated material was found to be least with Mtwo file system, followed by R-Endo, Universal Protaper and Hand K File, respectively. Removal of the obturated material was found to be most effective with Mtwo file, followed by R-Endo, Universal Protaper and Hand K file, respectively.

III. DISCUSSION

The main goal of retreatment is to regain access to the constriction by complete removal of the root canal filling material, thereby facilitating sufficient cleaning and shaping of the root canal system and final obturation. Prognostic studies have indicated that endodontic surgery or extraction could be avoided by conventional retreatment[9].

In this study we used four files and significantly found that Mtwo files produced cleanest canal and took smallest period of time followed by R-endo, Universal protaper and Hand K-file.

Mtwo instruments is especially designed for endodontic retreatment, have an increasing pitch length, S - shaped cross-section in the apical - coronal direction which is characterized by positive rake angle with two cutting edges, which are claimed to cut dentin effectively. Unlike the other NiTi instruments, the Mtwo rotary instruments do not require a crown down instrumentation sequence. Using the Mtwo instruments with the single length preparation removes more filling material in the canal during retreatment[10].

Anil et al in a study concluded that the rotary instruments were significantly fast in removing gutta-percha, while Mtwo require less time than EdgefileXR and R-Endo rotary instruments. This is due to the specific design of Mtwo, resulting in aggressive cutting edges and positive rake angle which requires less energy to cut dentin[11].

Somma et al and Marifis et al in a separate study concluded that, Mtwo R files require significantly less time to remove gutta-percha than ProTaper R. Mtwo retreatment files have some special characters in design compared to ProTaper resulting in better performance of these files in removing root filling material. Mtwo R files have positive rake angle with two cutting angle with two cutting edges, an increasing pitch length in apical coronal direction and S Shaped cross section. As they have sharp blades, it is feasible to cut obturation material and reach the apical end point by passing through the canal[12].

Garg e*t al* found that Mtwo retreatment was the fastest among all retreatment system tested. The probable reason they assigned was due to active cutting tip and two cutting edges which help in easy initial penetration progression into gutta-percha[13].

The next cleanest canal and fast removal of gutta-percha was achieved by R-Endo rotary system. It is a rotary system, completely dedicated for retreatment. Perfectly adapted to the material generally used in endodontic retreatment such as gutta-percha or filling material and combined with simple and safe manner, the single unique method is used to remove filling materials and to finish the root canal. It prepares the first few millimeters (1-3 mm) of the canal orofice, and has an optional finishing file Rs (#30.04). The files have an inactive tip, no radial land, and a triangular cross-section with three equally spaced cutting edges. R-Endo comprises of a stainless steel Rm handfile used to break the hard layer of filling material and 4 NiTi instruments in continuous rotation for flaring (Re) and progressive shaping of the 3 root canal areas (R1, R2 and R3)[14].

Ramakant et al found that the better performance of R-Endo retreatment instruments may be attributable to their design. These features may enable the retreatment instruments to cut not only gutta-percha but also the superficial layer of dentine during root filling removal[15].

Contrary to our finding Mollo et al found that R-Endo instrumentation system to be better than Mtwo instrumentation system. This difference could be attributed to the fact that the study used R-Endo instrumentation system followed by Hero sharper file with ISO size 35 for removal of the obturation material[16].
The 3 Protaper Universal system retreatment files are designed to facilitate the removal of filling material. Each file has different length, taper and apical tip diameter. The D1 instrument has an active tip to facilitate initial penetration into the filling material; it has a length of 16 mm, a tip of 0.30 mm, and a 0.09 % taper. The D2 instrument used for removal of filling material at the level of the middle third of the root has a length of 18 mm, a tip of 0.25 mm and posses a 0.08 % taper. The D3 instruments used for apical filling removal has a length of 22 mm, a tip of 0.20 mm, and a 0.07% taper, which is helpful to reach the working length. Guiliani *et al* found that the gutta-percha removal ability of ProTaper universal retreatment instruments is due to the spirals running around the instruments and the negative cutting angle, which produces cutting action instead of planning the gutta-percha against the canal walls. Many authors have found ProTaper Universal file to be the best among other rotary file and Hand files for retreatment[17].

Komal et al. found that the time taken by ProTaper UR files was significantly less in comparison to R-Endo retreatment files. This may be attributed to their design. D1, D2 and D3 have progressive taper and length that enable retreatment instruments to cut only GP but also the super-facial layer of dentin during root filling removal[18].

Mittal et al reported better performance of hand files in comparison to protaper UR files, which might be due to the difference in apical preparation and last Protaper UR used[68]. According to Somma et al better performance of R-Endo files and Mtwo R files in comparison to Hand files can be attributed to their design[19].

Siddhartha et al, demonstrated that the use of ProTaper Universal retreatment instrumentation system with the use of solvent is more effective than Mtwo and R-Endo files system because of effectiveness of ProTaper Universal retreatment instrumentation due to convex triangular cross section which renders a large internal area than Mtwo and R-Endo instrumentation system for removal of the root filling material[20].

Hand K files are the instruments used during cleaning and shaping of the root canals for machining of the dentin. Files are predominantly used with filling or rasping action in which there is little or no rotation in the root canals. They are triangular, square or rhomboidal in cross section, manufactured from stainless steel wire, which is grounded into desired shape, K-files have 1.5 to 2.5 cutiing blades per mm of their working end which have tighter twisting of the file spirals increases the number of flutes in files. Triangular cross - sectioned files shows superior cutting and increased flexibility than the file or reamers with square blank. At initial stage of retreatment we used the Hand K files but this files have disadvantages like it have less cutting efficiency and extrusion of debris and obturating material periapically and takes more time it leaves the rough surface after removal of obturating material[21].

Bramante et al reported better performance of H-files in comparison to Mtwo R which might be due to the difference in final apical preparation and last Mtwo R files used. Also, they used Gates Glidden Burs and solvents was used along with Hand Files[22].

Hulsmann et al observed that the presence of different results concerning the cleaning ability of Ni-Ti rotary files could depend on the characteristics of the cross-sectional design of the instruments[23].

Gergi et al and Schirrmeister et al reported several advantages of rotary files which include maintenance of canal shape, reduced working time and reduced working time and reduced operator fatigue whereas disadvantages include higher incidence of file separation[24]. According to Schirmeister et al extrusion of obturating material and debris through the apical foramen, alterations of root canal morphology, are the major disadvantages but this study utilized only one parameter which was the time required for retreatment procedure, as the criteria for evaluation[25].

The result of our study elaborate that when the effectiveness of removal of canal filling residue considered, Mtwo file was found better between R-Endo, Universal Protaper and Hand K-file. In terms of residual material removal time, Mtwo proved to be the fastest system a followed by R-Endo, Universal Protaper and Hand K-file system. Hand K Files took maximum amount of time for the entire retreatment procedure followed by rotary files.

IV. CONCLUSION

On the basis of the results obtained in our study, it can be concluded that :

1. Rotary instruments are more effective than hand instrument in removal of previously obturated gutta-percha from the root canal.
2. Out of the tested system, Mtwo files are most effective in gutta-percha removal followed by R-Endo, Universal Protaper and hand K-files, respectively.
3. After lateral condensation, for removal of gutta-percha, Mtwo files are most effective followed by R-Endo, Universal Protapar and hand K-files, respectively.
4. After vertical condensation, for gutta-percha removal, Mtwo files are most effective followed by R-Endo, Universal Protapar and hand K-files, respectively. For removal of gutta-percha, Mtwo files consume least amount of time followed by R-Endo, Universal Protapar and hand K-files respectively.

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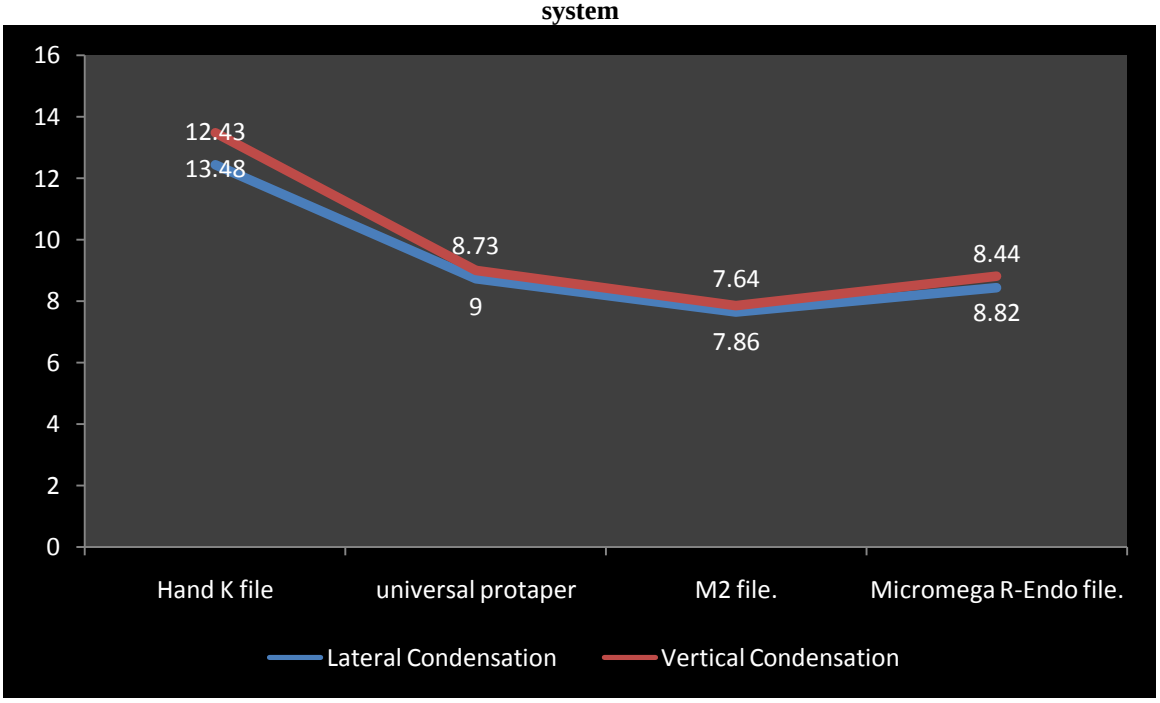
Type of Condensation	File System	Mean Time	S.D	F value	Sig.
Lateral Condensation	Hand K file	12.43	1.98	33.48	0.01*
	universal protaper	8.73	1.30		
	M2 file.	7.64	1.22		
	Micromega R-Endo file.	8.44	1.08		
Vertical Condensation	Hand K file	13.48	1.98	34.22	0.01*
	universal protaper	9.00	1.78		
	M2 file.	7.86	1.41		
	Micromega R-Endo file.	8.82	1.30		

ANOVA test, * Significant

Table 1: Comparison of time taken for removal of material with Lateral condensation with different file system



Graph 1: Time taken for removal of material with Lateral condensation

		Hand K file	universal protaper	M2 file.	Micromega R-Endo file.	F value	Sig.
Lateral Condensattion	Coronal	0.30	0.19	0.17	0.19	6.56	0.01*
	Middle	0.91	0.78	0.60	0.74	10.98	0.01*
	Apical	1.49	1.43	1.19	1.37	9.69	0.01*
Vertical Condensattion	Coronal	0.35	0.21	0.19	0.26	6.56	0.01*
	Middle	1.01	0.81	0.65	0.83	10.98	0.01*
	Apical	1.74	1.50	1.24	1.43	9.69	0.01*

ANOVA test, * Significant

Table 2: Comparison of Material remaining after removal with Lateral condensation with different file system

	Coronal	middle	Apical
Lateral	0.30	0.91	1.49
Vertical	0.35	1.01	1.74
T value	6.27	11.25	14.76
P Value	0.01*	0.01*	0.01*

T test, *significant

Table 3: Comparison of lateral and vertical condensation after removal of material with Hand k file

	Coronal	middle	Apical
Lateral	0.19	0.78	1.43
Vertical	0.21	0.81	1.50
T value	2.76	2.47	4.15
P Value	0.02*	0.03*	0.01*

T test, *significant

Table 4: Comparison of lateral and vertical condensation after removal of material with universal protaper

	Coronal	middle	Apical
Lateral	0.17	0.60	1.19
Vertical	0.19	0.65	1.24
T value	2.08	3.67	2.51
P Value	0.04*	0.01*	0.01*

T test, *significant

Table 5: Comparison of lateral and vertical condensation after removal of material with M2 file

	Coronal	middle	Apical
Lateral	0.19	0.74	1.37
Vertical	0.26	0.83	1.24
T value	4.87	7.65	11.24
P Value	0.01*	0.01*	0.01*

T test, *significant

Table 6: Comparison of lateral and vertical condensation after removal of material with Micromega R-Endo file.

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