COMPARATIVE EVALUATION OF APICALLY EXTRUDED DEBRIS FOLLOWING ROOT CANAL PREPARATION WITH PROTAPER, HYFLEX , WAVE ONE AND SELF-ADJUSTING FILE SYSTEMS

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ABSTRACT :

Objective: Extrusion of any particles periapically while root canal preparation may cause post-operative complications such as flare-ups. The reason of this in vitro study was to take a look at out the extent of apically extruded particles with use of rotary and reciprocating nickel-titanium instrumentation systems.

Materials and Methods: Sixty freshly extracted human mandibular first premolar teeth were randomly selected and assigned to four groups (15 tooth/group) according to use of four instrumentation system such as Reciprocating single-file system WaveOne, full-sequence rotary Hyflex, ProTaper and self-adjusting file(SAF) while root canals preparation. The root canals were biomechanically prepared and irrigated with bidistilled water. The apically extruded debris and irrigants were gathered in pre weighted eppendorf tubes in all four groups which then compared and statistically analyzed with help of analysis of variance and the Post hoc Student-Newman-Keuls test.

Results: Findings suggested that WaveOne, ProTaper and Hyflex rotary system create significantly more debris compared to Self-Adjusting File rotary system ($P < 0.05$).

Conclusions: It was concluded that all used systems resulted in extrusion of apical debris to some extent but Full-sequence rotary instrumentation produced less particles extrusion compared to reciprocating single-file systems.

KEYWORDS: Apical extrusion, Hyflex, reciprocating motion, WaveOne, Protaper, Self adjusting file.

INTRODUCTION :

One inherent trouble associated to all root canal shaping and cleansing methods is extrusion of particles through the apex into the periapical tissues which undoubtedly create post-operative complications such as acute inflammation and flare-ups which are characterised by pain, swelling inflicting unscheduled visits of the victims ensuing in inter appointment emergency. Different factors which have an effect on the volume of particles extruded are radial lands, flute depth, tapers, cross-section, operational kinematics of the file structures used and treatment approach.

In today's scenario it is found that all biomechanical root canal preparation technique are associated with apical extrusion of debris to some extent, even if the preparation is maintained short of apical foramen despite of use of variety of strategies and newly advanced instruments.

The ProTaper cross-section is equivalent to reamer, with three machined reducing edges and convex core. ProTaper system follows step wise variable tapers of each instrument that create "progressive preparation" three dimensionally in every directions. The cross section of Hyflex nickel-titanium files is very much similar to EndoSequence and is produced by use of an innovative technology which control material's reminiscence. WaveOne single-file nickel-titanium instruments is claimed to prepare entire root canal with single file in reciprocating action with enough size and taper. These are made of Martensitic NiTi alloy that is manufactured with progressive thermal process and available in sizes of 21.06, 25.08 and 40.08. The Self-Adjusting File (SAF) is the first

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endodontic file with a unique design that does not have a metal shaft. It is a thin-walled gap file with an asymmetrically pointed cylinder with a 1.5 mm diameter made of a NiTi lattice with a rough outer surface that is compressible in a canal. The file operates with use of a handpiece that approves a vertical vibration with 3,000 to 5,000 vibrations per minute and 0.4 mm amplitude conforms to the canal structure and lets in uninterrupted irrigation all through the way of canal.

The apically extruded debris can be used to examine effectiveness of different instrumentation used for root canal preparation. So the aim of this study was to determine effectiveness of WaveOne, HyFlex, ProTaper and Self-Adjusting File system in terms of generation of apically extruded debris during root canal preparation by measuring their quantity.

MATERIALS AND METHODS :

Sixty freshly extracted human mandibular premolar teeth due to orthodontic and periodontal cause were randomly selected according to inclusion criteria which is used to be the single rooted mandibular premolar tooth with single root canal and apical foramen with root curvature between 0° and 10°. Radiographs were taken both mesiodistally and buccolingually to have a look for internal resorption, root canal calcification and their curvature. Teeth with crack, internal and external resorption, root caries, root canal calcifications and open apex were excluded from the study. Sixty selected teeth were randomly allocated into four experimental groups with fifteen teeth in each group. The soft-tissue remnants present on external root surface were cleansed and then preserved in phosphate-buffered saline solution. To preserve associated tooth lengths, all tooth have been measured and the crown sectioning was done with a high-speed bur under copious water spray till equal lengths obtained. Access cavity preparation completed in each tooth and all exterior tooth surfaces had been blanketed with two coatings of nail paint besides 1 mm of apical foramen. A 15 K-file used to determine the working length till apical foramen. The working length was reestablished by subtracting 1 mm from this measurement. Each individual tooth held in a preweighed eppendorf tube used as debris collection apparatus which was once constant indoors a glass vial with the resource of rubber plug. There should be no possible contact made between the eppendorf tube and glass vial. The tube was vented with a 25 gauge needle to distribute stress equally inside and outside.

For each file, the persona torque and rotational pace programmed in the endomotor was used, whereas Wave-One used in a reciprocating motion. All the preparations was done by single operator. The training sequences was as follows

1. Group 1: ProTaper was used with gentle in-and-out motion in recommended sequence up to F4 (40.06) till the working length.
2. Group 2: Hyflex file was used according to manufacturer's recommendations i.e., 06/20, 06/25, 06/30, 06/35, 06/40.
3. Group 3: WaveOne file (40/08) was used in reciprocating motion.
4. Group 4: Self-Adjusting File system(SAF) (2.0 mm diameter, 21 mm length) was used in each canal till working length for four minutes with continuous irrigation of distilled water at a rate of 5 ml/min.after establishing the glide path using 15 K-File followed by 20 K-File to the working length. The irrigation needle placed coronal to bother the regional resistance used to be encountered.

The eppendorf tube was removed from the glass vial after root canal preparation. Teeth placed in tube were removed from it and their root apex rinsed with 1 ml of bidistilled water which used to be gathered in preweighed eppendrof tube and weighed by means of digital microbalance. All the eppendorf tubes were then incubated at 37°C for 15 days to evaporate moisture until weighing the dry debris. Each eppendorf tube weighted consecutively three times on digital microbalance. The weight of extruded particles in each tube calculated by subtracting pre weighted tube from the weight of tube with dried debris. The weight of extruded particles calculated rapidly in this way for four groups and analyzed

statistically with Kruskal-Wallis one-way analysis of variance and Post hoc Student-Newman Keuls test at a significant level of P less than 0.05.

RESULTS :

All instrumentation techniques produced significant amount of extruded debris. The mean weight of apical extruded debris of four experimental groups is shown in Table 1.

The difference of mean value of extruded debris with different instrumentation was significant (P<0.05).

Table I Comparison of mean values of debris extrusion

Method	Mean (g)	P value
SAF	0.047	0.01
Protaper next	0.091	
Wave one	0.054	
Hyflex	0.051	

Table II Pairwise comparison of mean values of different file systems

Pairwise comparison	System	Mean difference	P value
SAF	Protaper Next	-0.052	0.05
	Waveone	-0.021	0.06
	Hyflex	-0.018	0.09
Protaper Next	Waveone	0.008	0.05
	Hyflex	0.008	0.05
Waveone	Hyflex	0.008	0.07

Amount of apically extruded debris after the use of the WaveOne (0.054 g) was more in contrast with the Hyflex (0.051 g). SAF (0.047 g) showed considerably least amount of debris extrusion. On Statistical analysis by post hoc student-Newman-keuls test it was found that apically extruded debris produced by reciprocating single file Hyflex, WaveOne and ProTaper was appreciably greater when compared to SAF and this difference was statistically significant($P < 0.05$). However, no statistical great distinction was found between WaveOne and ProTaper($P > 0.05$).

DISCUSSION :

The main objective of root canal treatment is to achieve healthy environment inside of root canal. Debris such as dentine chips, necrotic pulp tissue, microorganisms and irrigants get extruded into periapical tissue during biomechanical preparation of root canal which causes endodontic flare up and this is one of the principle cause of postoperative pain felt by patient. Many factors affect the extent of extruded particles such as the instrumentation technique, type and size of instrument and irrigation solution.

In this study, all instrumentation systems used for canal preparation extrude debris apically in vitro, but SAF (0.047 g) showed statistically significant least amount of debris. This effects may be explained by differences in file structure and their motion kinetics. Self adjusting file is a single, hollow file system that has no cutting edge or flutes. The back and forth grinding motion of SAF combined with the continuous flow of the irrigation efficaciously clean the canals. Pressure build-up can be eliminated in the root canal space because the irrigant simply escapes by the use of openings in the file lattice which favour greater reduction of particles extrusion in the SAF group. There have been various studies comparing the efficacy of SAF in extruding debris apically with V-Taper, ProTaper Next, ProTaper Universal and WaveOne, which showed least debris extrusion with SAF. Single file systems simplify the instrumentation protocol and at the end much less apical extrusion of particles occurs. Hyflex (0.051 g) showed more extruded debris than SAF. The cross-sectional design of Hyflex is very much similar to EndoSequence. The unwinding of spirals while preparing root canals is a well-known feature of Hyflex file systems. Elmsallati et al (2009) concluded that the short pitch design instruments extruded less debris than the medium and long ones. The unwinding feature of the Hyflex instruments might be the reason for the greater extrusion of debris with the system. The reciprocating single file system showed drastically larger apical particles extrusion compared to the full-sequence rotary NiTi units ($P < 0.05$). This variations may be due to variation in treatment approach and cross-sectional designs of files used for preparation. Bürklein et al. also found that more debris were extruded apically after canal preparation with WaveOne and ProTaper as they have three cutting edges with radial lands to

assist the blades and a incredibly small chip space. This structure may also enhance debris transportation towards the apex when used with a reciprocal motion. On the contray, coronal transportation of dentinal chips and debris occurs with continuous rotation like a screw conveyor.

Many studies have been conducted which concluded that maintenance of apical patency in mesiobuccal roots of maxillary molars resulted in less apical extrusion of sodium hypochlorite. Myers and Bernard Law favoured reassessment of apical dentinal plug to decrease amount of apically extruded debris, irrigants and to prevent over instrumentation. A similar study has proven that maintaining apical patency is correlated with less apically extruded debris in contrast to tooth in which the constriction remained intact.

In this study, the working length was taken 1 mm short of the apical foramen. Myers and Montgomery confirmed that working length 1 mm short of apical foramen causes less periapical particles extrusion. Precautions must be taken when these effects are transferred to the scientific situation due to zero returned stress used in this study design and in addition gravity can carried the irrigating solution out of root canal. This is a well known draw back of in vitro study designs with no periapical resistance. It has been recommended that the floral foam utilization can simulate periapical tissues resistance. Bidistilled water was used as irrigating solution instead of sodium hypochlorite to prevent increase in potential weight due to NaOCl crystal formation.

Previous research have demonstrated that with every rotation while preparing canal with rotary and balanced-force techniques, there is tendency to pull dentinal particles into the flutes of the file and direct it closer to the coronal part of canal. In case of engine-driven devices early flaring of the coronal part of root direct particles toward the orifice, preventing its compaction in the root canal. Ruiz-Hubard et al. studied that apical extrusion of debris with utilization of crown-down technique were much less in curved and straight canals compared with the step-back technique. Garlapati et al. Found that K3 rotary file extruded less debris with use of crown down method. Zarrabi et al.studied ProFile, RaCe and Flex Master rotary devices with the step-back approach and found the similar results that step-back method extruded more particles and irrigants apically with use of rotary instruments. Ghivari et al. found similar finding that is step-back method extruded higher extent of particles and irrigant compared to hand and rotary Ni-Ti systems. De-Deus et al. noted that there is no significant difference in particles extrusion between common ProTaper Universal approach and single-file ProTaper F2 used in reciprocating movement. This result is similar to earlier study by Bürklein and Schafer which showed reciprocating single-file system extruded more debris in contrast to the full-sequence rotary NiTi instruments.

In the current study, the Group three (WaveOne) has greater apical extrusion of debris in contrast to Group one (ProTaper), Group two (Hyflex) and group four (Self-Adjusting File) suggesting that reciprocation motion would possibly cause more apical extrusion compared with continuous motion during root canal preparation.

CONCLUSION :

In this study it was found that WaveOne file sytem is associated with more apical extrusion of debris compared with ProTaper, Hyflex and Self-Adjusting File which supported the possibility that reciprocation motion used in single file system would cause more apical extrusion compared to continuous motion used in full sequence rotary NiTi instruments during root canal preparation.

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