How to Cite:
Aliuddin, S. K., Jain, P., Mohiuddin, S., Rai, N., Elsherbini, M. S., & Gaikwad, R. N. (2022). An in-vitro study quantitative evaluation of apically extruded debris during canal preparation using three different motions of hand files: A pilot study. *International Journal of Health Sciences*, *6*(S3), 6188–6195. https://doi.org/10.53730/ijhs.v6nS3.7350

An in-vitro study quantitative evaluation of apically extruded debris during canal preparation using three different motions of hand files: A pilot study

Dr. Syed khaja Aliuddin
MSD, Assistant Professor, College of Dentistry, Buraydah Private Colleges, Qassim, KSA
Email: alialdin@gmail.com
Orcid ID: 0000-0001-8789-2459

Dr. Preet Jain
MDS, PhD Scholar, Department of Biotechnology, MLS University Udaipur
Email: drpreetjain@gmail.com
Orcid ID: 0000-0002-7506-5488

Dr. Sana Mohiuddin
MDS, Consultant Orthodontist, Hyderabad, India
Email: drsana272@gmail.com

Dr. Nitish Rai
PhD, Assistant Professor, Department of Biotechnology, MLS University, Udaipur
Orcid ID: 0000-0002-0601-6682
*Corresponding author email: nitish.rai@mlsu.ac.in

Dr. Mohamed Saber Elsherbini
PhD, Assistant Professor, Preventive Dental Sciences Department, Buraidah Private Colleges, Buraidah, KSA
Orcid ID: 0000-0003-4747-5508
Email: dr.mohamed.saber@qudent.org

Dr. Rahul N. Gaikwad
PhD, MPhil, MDS, Associate Professor, Community Dentistry & amp, Oral Epidemiology Department, College of Dentistry Qassim University, Buraydah Qassim, Kingdom of Saudi Arabia
Email: r.gaikwad@qu.edu.sa
Orcid ID: 0000-0001-9915-0161

Manuscript submitted: 9 March 2022, Manuscript revised: 18 April 2022, Accepted for publication: 1 May 2022

***Abstract*---**This study aimed to evaluate the quantity of apically extruded debris during the bio-mechanical preparation of the root canal treatment. Fifteen extracted premolars with single root canal were collected and divided into three groups for this study. Hand protaper files (reaming motion), K files (watch-wind motion), and K flex files (balanced force technique) were used. The irrigant and debris were collected in pre-weighed (using analytic scale) empty microtainer bottles. The microtainers were kept in an incubator at 700C for 4 days for complete drying and then weighed of dry debris was recorded. Statistical analysis: Data was treated for the mean values of the weight and analysed using kruskall-wallis test at a significance of 0.05. All the three motions of hand files extruded debris. Watch wind motion showed the lowest mean value whereas reaming showed the highest. There were no significant difference between the reaming motion, watch wind motion and balanced force technique ($p < 0.05$). The study revealed that the amount of extruded debris from the apical foramen was comparatively least in watch wind motion among all the three motions in terms of the mean weight but there is no significance difference between the three Groups.

***Keywords*---**root canal treatment, bio-mechanical preparation, reaming motion, watch-wind motion, balanced force technique.

Introduction

The primary goal of endodontics is to debride and clean the root canal system, the motive behind cleaning is to remove irritant factors and maintain the periapical tissues in a healthy condition [1]. One of the most important steps is removal of the irreversible inflamed pulpal tissue and obturate the canal three dimensionally to preserve it in the mouth as a single unit [2]. During the root canal treatment the debris like dentinal shavings, necrotic pulp, bacteria and its byproducts, gets extruded into the peri-radicular tissues which is the main cause of mid-treatment flare-ups [3]. There are many causes of flare ups like mechanical, microbial and chemical injuries to the pulp and peri-radicular tissues which is due to the disturbance between the balance of host defence and microbial aggression [4,5].Even the irrigant solution can cause flare up which extends beyond the apical foramen [1].

Once the debris is extruded apically it results in antigen-antibody complex causing severe inflammatory response [6]. All bio-mechanical procedures extrude some debris apically but with the difference in quantity [7]. Hand files are the oldest files used in endodontics, there are different types of files available in terms of shape, tip and pitch. The hand files used here are hand protaper files, k files and k flex files. Hand protaper files are designed for crown down technique, they are made up of nickel titanium with a taper from 2 to 9 %. The cuts by scrapping method due to its negative rake angle, the tip of the initial files are partially active while finishing files have a non-cutting tip. The cutting edges are sharp with progressive distance between the flutes. The cross section of the file is triangular, which reduce the contact area of the flutes to the dentin and gives more flexibility

and cutting efficiency. Kerr files are usually made up of square stainless steel blank these files have more cutting flutes than K-Reamer [8]. It has cutting tip with the cutting edge angle of 25 to 40 degrees. Most of the files are placed and withdrawn with pressure [9]. K-flex file are rhomboid or diamond cross section. In these files two cutting edges are acute angle while the other two edges are obtuse angle. The file has a non-cutting tip. They are flexible files.

Materials and Methods

Sampling

Fifteen extracted single and straight (curvature 0^0-10^0) canal premolars are selected and stored in saline to prevent dehydration. Teeth with curved roots, cracks, calcification, open apex and caries involving the pulp chamber were excluded from this study. Teeth in which 15 size K file could bind at the working length were selected. All the teeth are randomly divided into three groups, In order to standardize the length to 18 mm decoronization was done using carborandum disc.

Procedure

Once the working length of theses teeth were determined, bio-mechanical preparation was done along with irrigation and the debris is collected in the microtainer bottles. The patency was determined by passing 10 size K file until the tip was just visible [10]. The working length was determined with 0.02 taper file at 17mm for all the teeth. The bio-mechanical preparation was done by three different Hand files with their particular motion, Hand protaper file (reaming), K file (watch-winding) and K flex file (balanced force technique). The specimen were randomly divided into three groups of 5 samples each. Group A was prepared with reaming motion. Specimens in Group B were prepared with watch winding motion and the biomechanical preparation in Group C was done by balanced force technique. All the three groups were prepared with crown-down technique. The irrigation of 1ml solution with 5.25% sodium hypochlorite with 27 gauge needle (Terumo, Manila) is used on every change of file. The irrigating needle was kept at 12 mm short of the working length with the help of a stopper to standardize [11]. The Bio-mechanical preparation was considered complete when the canal felt smooth all over. 0.5 ml EDTA 17 % solution is used for 30 seconds for smear layer removal, followed by a flush of 1 ml sodium hypochlorite solution and final flush with 1 ml distilled water [12].The irrigation procedure was common in all the three Groups.

Method for collecting debris

The collection of debris was done by Myer's and Montgomery method. The teeth were forced into a rubber stopper of the vial after access preparation. The EDTA microtainer tube was pre-weighed on electronic analytical balance as shown in Figure 1 (Scaltec, Japan). The tube was closed by the rubber stopper. The sample roots were inserted under pressure into the rubber stopper up to CEJ. This facilitated the apical part of the specimen to be suspended within the tube, which promoted collection of apical debris and irrigation solution extruding through

apical foramen. A 25 gauge needle was then inserted forcefully to unify the pressure inside and outside the bottle. Once the Bio-mechanical preparation was done, the tooth was removed along with the rubber stopper. The apical surface was washed with 0.5 ml of distilled water and the debris was collected along with distilled water into the microtainer tube [13]. These tubes were kept in incubator at 70^{o}C for 4 days for the moisture to evaporate [1]. The dry debris and precipitate of the sodium hypochlorite was then weighed on the analytical balance, and was repeated for three consecutive times for more accuracy [11,14]. Weight of extruded debris = (weight of a plastic microtainer with dried debris –preweighed of a plastic microtainer).

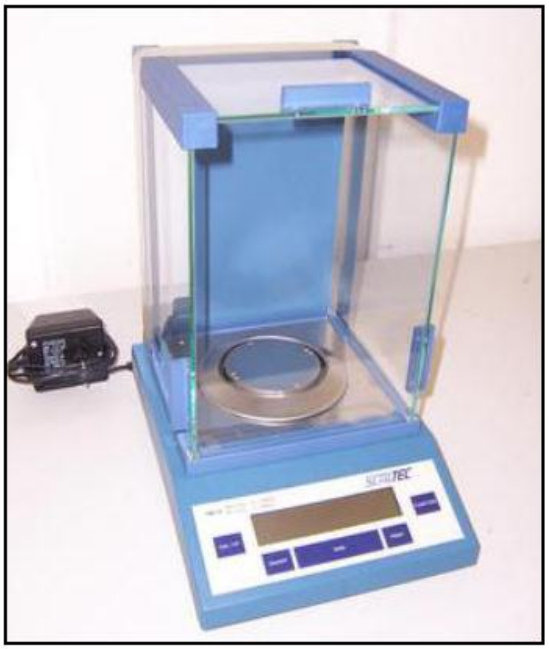

Figure 1. Electronic analytical balance (Scaltec)

Statistics for Analysing Data

The data was treated for the mean values of the weights of each Group and its standard deviation. Statistical analysis between Groups was performed using Kruskal Wallis test using SPSS version 16 (Microsoft USA). $P < 0.05$ was considered as significant.

Table 1
Kruskal Wallis table for the comparison of debris extruded with different hand file motions

Groups	No of sample	Extruded debris	P value
A (reaming motion)	5	0.1061±0.0818(mg)	
B (watch winding motion	5	0.0263±0.366(mg)	0.237

C (balanced force technique	5	0.0739±0.0801(mg)	

Results

The amount of apically extruded debris is calculated by subtracting the weight of pre-weighed empty microtainer from the weight after instrumentation and debris collection. The mean dry weight of extruded debris were analysed by using SPSS. The kruskal –wallis test were applied to check if the significant difference exist between the groups ($P < 0.05$). The result of this study showed that all instrumentation showed some extrusion. However, Group B (watch wind motion) showed the minimum amount of debris in terms of the mean weight, although there is no significant difference between the three groups. ($P < 0.05$)

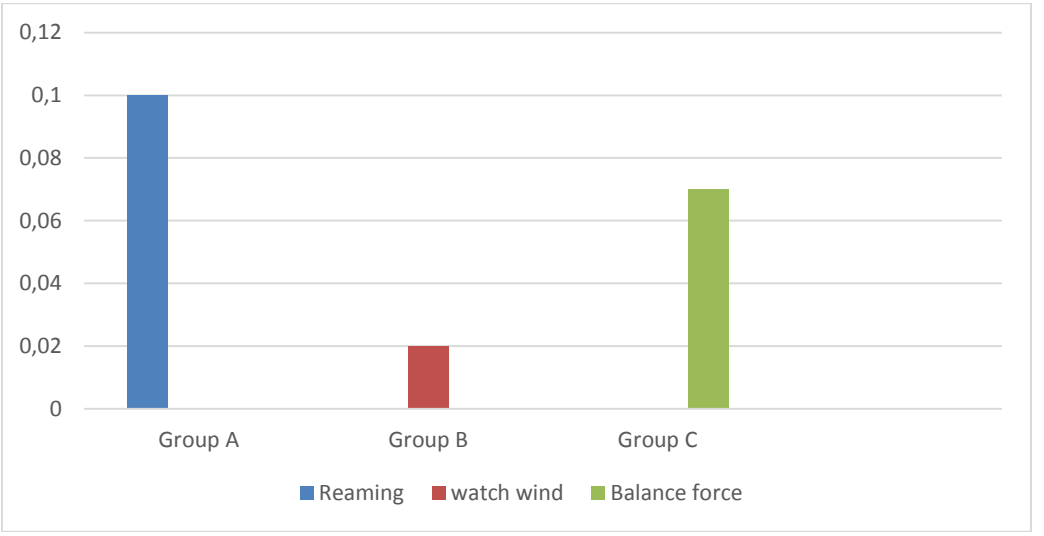

Figure 2. Graphical representation of mean values of extruded debris with different hand file motions

Discussion

Flare-ups are pain and swelling during and after endodontic treatment. There are many causes of flare ups, it's all due to the peri-radicular and pulpal tissue injury. During endodontic treatment, the debris which is composed of microbes, infected dentinal chips, pulpal tissue and irrigant can cause further inflammation of the tissues. Prevention of flare up should be a part of endodontic treatment to reduce the discomfort for the patient. The proposed preventive measures for flare ups are as follows: using file technique which extrude less debris apically, type of files used, length control, completion of the procedure in single visit, pressure of the irrigant used, using antimicrobial medicament between appointments in infected cases, type of needle, aseptic environment during the procedure and not leaving the teeth open for drainage [16]. In the case of Hand protaper files, the cross section of the flutes are convex triangular in shape which reduces the contact area between file and the dentinal surface. The design of balance between

the pitch and the helical angle is incorporated. There is a smaller zone in contact with the dentinal surface which enhances the flexibility, cutting efficiency and reduces the recapitulation needed to achieve length. It has a guided tip and progressive taper which allows the crown-down technique.

The cross section of K files is made up of square blank with cutting edges. It is the most common file used in biomechanical preparation. It has less chances of apical extrusion since it moves with clock and counter clock wise motion until it reaches the desired length. The cutting edges are acute between 25 to 40 degrees. The K flex file has a modified tip design, the tip is non-cutting type. These files are made up of rhomboidal blank which has a smaller cross section for more flexibility compared to the other file of comparable size. The flutes are twisted in such a way that two angles are acute and two are obtuse. The acute angles of the flutes improve the cutting efficiency while the obtuse angle flutes helps in clearing the debris. But in spite of the sophisticated design of protaper file according to Luisi et al,[13] the tapering of the Protaper files favors the preparation of the apical third as soon as the instrumentation begins, thus wear occurs early throughout the whole canal because the instruments reaches the working length in the beginning of the preparation, which causes greater apical extrusion. This can be a probable reason behind the results obtained in the present study which showed greater apical extrusion of the irrigant with Protaper files while the files used in other two groups showed less irrigant extrusion probably due to the fact that they prepare the coronal third of the canal first followed by the middle and then the apical third.

As the tapering of protaper file (7-9%) 10 is greater than the other two file systems (2%) used in this study so a wider canal preparation is achieved resulting in greater irrigant accumulation in the canal which could be another reason for greater irrigant extrusion observed in Group A (Protaper) of the present study. There is progressive distance between the cutting edges in protaper file which means that the protaper files have a long pitch. Elmsallati et al, [5] reported that the file with the short pitch design extrudes less debris than the medium and long ones. Protaper, with a long pitch design of the instrument, extrudes greater amount of irrigant and debris compared to other groups. In the present study, Group-A (protaper) showed greater amount of irrigant extrusion compared to the other two groups, probably due to the long pitch design of the protaper file. The rake angle of all the files used in this study is negative. There was no significant difference between hand protaper and balanced force technique in terms of the mean weight of debris which is in accordance to the previous study [14,7]. The results of the present study are also supported by a study conducted by Alper K. et al,[16] which reported that the manual instrumentation technique shows greater apical extrusion of the debris as the file used in the apical one-third of the tooth acts as a piston that tends to push the debris through the foramen leading less space availability to flush it out coronally. As the taper of the Protaper file used in the present study is far greater than that of other two files, it leads to more binding of the file with the canal walls that creates a greater piston effect and tends to push the irrigant more apically. Moreover, the absence of periapical tissues in the present in- vitro study might have led to greater extrusion of the irrigant. According to Luisi et al. & Alper K. et al.[16,17], there is a difference in the amount of in-vivo and in-vitro extrusion because of the periapical tissues

which serves as a natural barrier inhibiting excessive extrusion of the debris in an in-vivo model. The other possible reason for the observation of more weight in Group-A of this experiment could be that the microtainer contained more irrigant during the preparation which left more precipitate behind, adding weight in addition to the dry debris. Since the irrigant used in this study was 5.25% sodium hypochlorite, it gave a precipitate after drying which added weight along with debris. Few studies recommended the use of distilled water [16] to reduce the particulate matter contained in irrigant but since sodium hypochlorite is the most widely used irrigant in clinical conditions, therefore we have used it as an irrigant in this study.

Summary

There are many causes of flare ups such as chemical, mechanical and microbial injury to the peri-radicular and pulpal tissue. Among the above mentioned causes, microbial injury is thought to be the prime factor. The microbes are already present in the canal which causes the infection. During endodontic treatment, the mobilization of debris which includes the microbes, infected and affected dentinal chips, pulpal tissue and irrigant can cause further inflammation of the tissues. Prevention of pain should be taken into account for the undesirable clinical phenomenon and unnecessary discomfort for the patient. The proposed preventive measures for flare ups are as follows : using file technique which extrude less debris apically, length control, completion of the procedure in single visit, using antimicrobial medicament between appointments in infected cases, aseptic environment during the procedure and not leaving the teeth open for drainage [18]). Even though there is no relationship between the flare up and the outcome of root canal treatment [19], the unnecessary pain and discomfort to patient can still affect the relationship of the doctor and patient.

Conclusion

Based on this study, it was clear that most of the Hand file motions produce some amount of extruded debris from the apical foramen. The least amount was produced by watch-winding motion using K- files, followed by the other two techniques. This study does not stimulate the peri-apical tissues which may resist apical extrusion of debris in vivo, further studies are needed to replicate as close as natural body.

References

1. Zarrabi, M. H., Bidar, M., & Jafarzadeh, H. (2006). An in vitro comparative study of apically extruded debris resulting from conventional and three rotary (Profile, Race, FlexMaster) instrumentation techniques. *Journal of oral science*, *48*(2), 85-88.
2. Camões, I. C. G., Salles, M. R., Vieira, M., Fernando, M., Freitas, L. F., & Gomes, C. C. Relationship between the size of patency file and apical extrusion of sodium hypochlorite. *Indian journal of dent Res* 2009; 20 : 426-427

3. Logani, A., & Shah, N. Apical extruded debris with three contemporary Ni-Ti instrumentation systems: an ex vivo comparative study. *Indian journal of dentistry* 2008; 19(3):182-185.
4. Nazari, H. & Motaleb, F. M. A comparative study on the amount of extruded material from the apical foramen with Niti rotary and stainless steel hand instrument. *International endodontic journal* 2006; 1: 69-73.
5. Elmsallati, E, A., Wadachi. R., Suda, H. Extrusion of debris after use of rotary nickel-titanium files with different pitch: a pilot study. Australian endodontic journal 2008;35: 65-69.
6. Ghivari, S. B., Kubasad, G. C., Chanak, M. G., & Akate, N. R. Apical extrusion of debris and irrigant using hand and rotary systems, A comparative study. *Journal of conservative dentistry* 2011; 14: 187-190.
7. Ferraz, C. C. R., Gomes. N. V., Gomes, B. P. F. A., Zaia, A. A., Teixeira, F. B. & Filho, F. J. S. Apical extrusion of debris and irrigants using two hand and three engine-driven instrumentation techniques. *International endodontic journal* 2001; 34: 354-358.
8. Tronstad, L. Text Book of Clinical Endodontics.2nd ed. USA: Thieme, Inc;2003.p158
9. Garg,N., & Garg, A.Text Book of Endodontics. 3rd ed. India: Jaypee Brothers Publication Inc; 2007.p145
10. Luisi, S. B., Zottis, A. C., Piffer, C. S., Vanzin, A. C. D. M., & Ligabue, R. A. (2010). Apical extrusion of debris after hand, engine-driven reciprocating and continuous preparation. *Revista Odonto Ciência*, *25*, 288-291.
11. Ghivari, S. B. & Kubasad, G. C. Apical extrusion of debris and irrigant using two rotary system – A comparative study. *Archives of Oral Sciences & Research* 2011;1: 185-189.
12. Ghivari, S. B., Kubasad, G. C., Chanak, M. G., & Akate, N. R. Comparative evaluation of apical extrusion of bacteria using hand and rotary systems : An in vitro study. *Journal of conservative dentistry* 2012; 15: 32-35.
13. Dadresanfar, B., Mehrvarzfar, P., Saghiri, M, A., Ghafari, S., khalilak, Z. &Vatanpour, M. Efficacy of two rotary systems in removing guttapercha and sealer from the root canal. *Iranian endodontic journal* 2011; 6 : 69-73.
14. Garry, L. M., & Steve, M. A comparison of weights of debris extruded apically by conventional filing and canal master technique. *Journal of endodontics* 1991; 6: 275-279.
15. Adl, A., Sahebi1, S., Moazami, F., & Niknam, M. Comparison of apical debris extrusion using a conventional and two rotary techniques. *International endodontic journal* 2009; 4: 135-136.
16. Al-Omari, M. A. O., & Dummer, P. M. H. (1995). Canal blockage and debris extrusion with eight preparation techniques. *Journal of endodontics*, *21*(3), 154-158
17. Siqueira, J.F. Jr. Microbial causes of endodontic flare up. *International endodontic journal* 2003; 36: 453-463.
18. Alper, K ., Demet. A., & Kerem. E.A. Comparitive study of apically extruded debris using one manual and two rotary instrumentation technique for endodontic treatment. *Journal of dental science* 2011; 9: 1-6.
19. Sjögren, U. L. F., Hägglund, B., Sundqvist, G., & Wing, K. (1990). Factors affecting the long-term results of endodontic treatment. *Journal of endodontics*, *16*(10), 498-504.