ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 10, Issue, 05, pp.69041-69046, May, 2018

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

COMPARATIVE EVALUATION OF INCIDENCE OF DENTINAL DEFECTS AFTER ROOT CANAL PREPARATION USING DIFFERENT NICKEL TITANIUM ROTARY FILES: AN IN- VITRO STUDY

***Shikha Kanodia**

Government Dental College and Hospital, Civil Hospital Campus, Asarwa, Ahmedabad, India

ARTICLE INFO

Article History:
Received 17th February, 2018
Received in revised form
26th March, 2018
Accepted 19th April, 2018
Published online 23rd May, 2018

Key words:
Dentinal Defects,
Rotary Files System,
WaveOne,
OneShape.

****Corresponding author***

ABSTRACT

Objectives: The aim of this in vitro study was to evaluate and compare the incidence of dentinal defects caused by different nickel titanium rotary systems like ProTaper, WaveOne and OneShape files.

Methodology: In this study, 150 extracted human mandibular second premolar teeth were selected and decoronated using diamond disk with water cooling, leaving roots approximately 16 mm from apex. Teeth which showed cracks were excluded. Root canal was prepared with K files, ProTaper files, Wave One files and One Shape files. The root canals which not prepared at all were taken as Control group. Then teeth were sectioned horizontally at 3 mm, 6 mm and 9 mm from the apex. To evaluate cracks, cut cross sections were visualized under Stereo Microscope and images were taken with camera attached with microscope. The chi-square test was performed to compare the appearance of cracked roots between the experimental groups.

Results and Conclusion: No defects were found in the unprepared teeth and teeth prepared with hand files showed very less defects. Teeth prepared with ProTaper, WaveOne and OneShape resulted in dentinal defects in percentage 57.78%, 23.33% and 35.56% respectively. No complete crack was found in any sample. More defects were seen in coronal and middle third group. Very fewer percentages of cracks were seen in apical third of all the groups.

Citation: Shikha Kanodia, 2018. "Comparative evaluation of incidence of dentinal defects after root canal preparation using different nickel titanium rotary files: an in- vitro study", *International Journal of Current Research*, 10, (05), 69041-69046.

INTRODUCTION

The goal of endodontic instrumentation is to completely remove microorganisms, debris and tissue by enlarging the canal diameter and create a canal space for medicament delivery and optimized canal geometries for adequate obturation. Biomechanical preparation of root canal is one of the vital step in any root canal treatment (Peters, 2004). Use of stainless steel instrument for canal preparation has been gold standard for many years (Amara Latif Bajwa, ?). Nickel-titanium alloy was developed in the 1960s, initially useful for orthodontic wires and dental burs. The first NiTi rotary file was introduced in market around 1993 (Peters, 2008). In comparison to stainless steel files NiTi files proved to be superior with regards to their shaping ability (Juliane, 2007). However during instrumentation there is a potential risk of dentinal cracks which may further develop into VRF (vertical root fracture). Reasons may be:

1. During canal preparation, the contact between instrument and canal walls creates momentary stress concentrations in dentin walls. These may leave dentinal defects like cracks or craze lines in which VRF can initiate.
2. It is believed that more dentinal defects may be produced by a higher number of rotations and
3. Instrument design variations alter the forces on a root during instrumentation and increase the defects (Abou, 2014).

Various types of rotary file systems are available in market. Amongst them ProTaper system is the most commonly used rotary system in many countries of the world. It is based on sequence of files of different size i.e. Sx, S1, S2, F1, F2 (Juliane, 2007). Recently a new generation of NiTi files has been introduced which completes canal preparation with only 1 instrument.[6] One of the single file systems, WaveOne files (Dentsply Maillefer) are made of M-wire NiTi alloy subjected to an innovative thermal process to increase flexibility of the instrument. WaveOne files have a modified convex triangular cross-section at the tip end and a convex triangular cross-section at the coronal end. WaveOne files are used in reciprocating motion which reduces the risk of cyclic fatigue caused by tension and compression. The counterclockwise (CCW) movement is greater than the clockwise (CW) movement. CCW movement advances the instrument, engaging and cutting the dentine.

Figure 1. Mandibular second premolar teeth

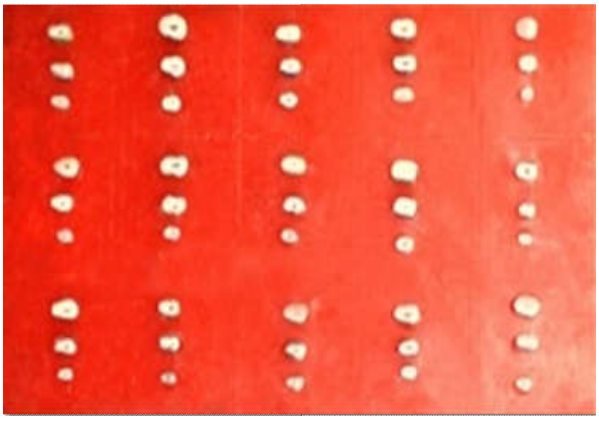

Figure 2. Sections of teeth at 3, 6, and 9mm

Figure 5a: AT 3mm

Figure 5b: AT 6mm

Figure 5c: AT 9mm

Figure-5a,5b,5c : 3mm, 6mm and 9mm sections of teeth prepared with Protaper files (Group III)

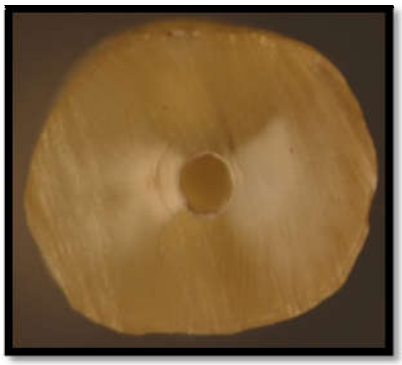

Figure 6a :AT 3mm

Figure 6b :AT 6mm

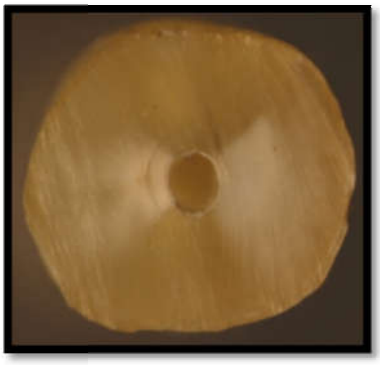

Figure 6c : AT 9mm

Figure 6a, 6b, 6c. 3mm, 6mm and 9mm sections of teeth prepared with Waveone files (Group IV)

CW movement disengages the instrument from the dentine before it can (taper) lock into the canal (Webber, 2011). OneShape files (Micro-Mega, Besancon Cedex, France) are also single file system used in traditional continuous rotational motion. They have a triangle cutting edge in the apical part, 2 cutting edges in the coronal part, and a cross-section that progressively changes from 3 to 2 cutting edges between the apical and coronal parts; this design offers an optimal cutting action (Liu, 2013). The purpose of this study was to compare the incidence of dentinal defects after biomechanical preparation with K files, ProTaper, WaveOne and OneShape rotary systems.

MATERIALS AND METHODOLOGY

This stereomicroscopic in-vitro study was conducted in the Department of Conservative & Endodontics at Govt. Dental College and Hospital, Ahmedabad. 150 freshly extracted single rooted mandibular second premolars due to periodontal reasons with single canal of varied anatomy were selected. The selected specimens were radio graphically examined to confirm single root canal. Teeth grossly destructed were excluded from the study. The collected teeth were cleared of all blood stains, soft tissue tags, hard bony spicules and calculus adherent to the root and stored in purified filtered water at room temperature until use.

Instruments: ProTaper rotary file system (Dentsply Maillefer, Ballaigues, Switzerland). The standard set of this system includes 3 shaping and 3 finishing instruments with variable tip size. Three finishing instruments named F1, F2 and F3 have D0 diameters and apical tapers of 20/07, 25/08 and 30/09, respectively. From D4 to D14 each instrument has a decreasing percentage taper. WaveOne rotary file system (Dentsply Tulsa,

Dentsply Maillefer). WaveOne NiTi file system from DENTSPLY Maillefer is a SINGLE-use, SINGLE-file system to shape the root canal completely from start to finish. There are three files in the WaveOne single-file reciprocating system. The WaveOne Small file is used in fine canals. The tip size is ISO 21 with a continuous taper of 6%. The WaveOne Primary file tip size is ISO 25 with an apical taper of 8%. The WaveOne Large file tip size is ISO 40 with an apical taper of 8%. OneShape file (Micro Mega, Besancon, France). One Shape completes canal shaping with only one single file in continuous rotation. Only one file with #25 file with 6% taper.

METHODS

All teeth were decoronated using diamond disk with water cooling, leaving roots approximately 16 mm from apex. All the teeth were seen under stereomicroscope under 12.5 x magnifications. Teeth which showed cracks were excluded. The teeth were randomly divided into five groups as follows: GROUP I: 30 teeth were left unprepared with no instrumentation and it served as Control Group A.GROUP II: Root canal preparation of 30 teeth done with the help of K files using step back technique. Working length established 1 mm short of major apical foramen with master apical file of size 25. Further, by step back method, flaring was done up to file size 45. It served as Control Group B. GROUP III: Root canal preparation of 30 teeth was done with the help of ProTaper system. Working length established 1 mm short of major apical foramen with master apical file F2 which has ISO 25 number apical size and taper of 8% at apex. Crown Down technique was used for preparation. GROUP IV: Root canal preparation of 30 teeth was done with WaveOne rotary file system. Primary file was used in reciprocating motion which has 25 no. apical size and taper of 8% at apical area. GROUP V: Root canal preparation of 30 teeth was done with OneShape rotary file system. OneShape is single file system with 25 no. apical size and 6% taper working in continuous rotational motion.

Specimen preparation: After completion of cleaning and shaping, teeth were stored in purified distilled water. Then teeth were sectioned horizontally at 3 mm, 6 mm and 9 mm from the apex and given name as Sub-group 1,Sub-group 2 & Sub-group 3 respectively (Figure 1,2).

Evaluation: To evaluate cracks, cut cross sections were visualized under Stereo Microscope at 12.5x magnification. And images were taken with camera attached with microscope. The cracks seen in photo images were scored according to Yoldas *et al*[9] as: ''No defect'' was defined as root dentin devoid of any craze lines or micro cracks either at the external surface of the root or at the internal surface of the root canal wall. ''Defect'' was defined as if any lines, microcracks, or fractures were present in root dentin (Figure 3,4,5,6,7).

Statistical analysis: Crack percentages were counted by dividing number of crack with number of cross sections per group. Statistical analysis was done using Chi-Square Test and p value <0.05 was considered statistically significant.

RESULTS

This in-vitro study was conducted to evaluate and compare the incidence of dentinal defects caused by hand instrumentation and different Nickel Titanium rotary files.

Table 1. Percentage distribution of defects among different groups [Coronal (9mm) section]

	Number of cracks	Percentage
Group I	0	0.00
Group II	2	6.67
Group III	19	63.33
group IV	13	43.33
Group V	16	53.33

Table 2. Percentage distribution of defects among different groups (Middle (6mm) section)

	Number of cracks	Percentage
Group I	0	0.00
Group II	0	0.00
Group III	31	103.33
Group IV	6	20.00
Group V	15	50.00

Table 3. Percentage distribution of defects among different groups (apical (3mm) section)

	Number of cracks	Percentage
Group I	0	0.00
Group II	0	0.00
Group III	2	6.67
Group IV	2	6.67
Group V	1	3.33

Table 4. Total percentage distribution of defects among different groups-(all sections-coronal+middle+ apical)

	Number of cracks	Percentage
Group 1	0	0.00
Group 2	2	2.22
Group 3	52	57.78
Group 4	21	23.33
Group 5	32	35.56

Chi-Square value- 42.30, p value= <0.0001

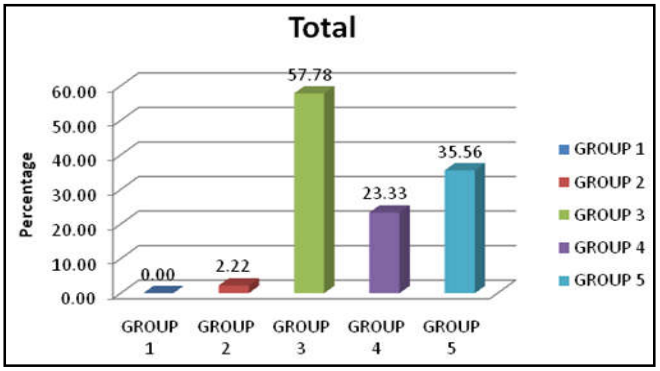

Table 5. Chi square value and p value for different groups

	Chi square test	Degree of freedom	p value	
GI vs GII	1.017	1	0.500**	NS
GI vs GIII	7.925	1	0.005***	VHS
GI vs GIV	4.286	1	0.038*	S
GI vs GV	5.455	1	0.026*	S
GII vs GIII	5.192	1	0.026*	S
GII vs GIV	2.964	1	0.018*	S
GII vs GV	3.963	1	0.037*	S
GIII vs GIV	4.167	1	0.029*	S
GIII vs GV	4.841	1	0.040*	S
GIV vs GV	0.131	1	0.718**	NS

The Control Groups (I, II) and Experimental Groups (III, IV, and V) were compared to determine the percentage of cracks. Table 1 shows percentage distribution of defects among all 5

groups at coronal section 9 mm. Group 3 ProTaper files shows more number of defects and defects with OneShape and WaveOne in decreasing order and group 1 has no defects. Chi Square value is 14.17 and p value is highly significant. ProTaper > OneShape > WaveOne > K files > Unprepared. Table 2 shows percentage distribution of defect among all groups at middle section 6 mm. Group 3 shows highest defects and group 1 has no defects. Group 2 also has no defects. Chi Square value is 26.50 and p value is highly significant. ProTaper > OneShape > WaveOne > K files > Unprepared. Table 3 shows percentage distribution of defect among all groups at 3mm. Chi Square value is 4.12 and p value is not significant. ProTaper = WaveOne > OneShape > K files > Unprepared. Table 4 shows total crack percentage for all groups. Group 1 has 0 percentage cracks which is lowest among all the groups. Chi Square value is 42.30 and p value is highly significant. On the basis of these present defects it is observed that: ProTaper > OneShape > WaveOne > K files > Unprepared. Table 5 shows chi square value and p value for different groups. There was highly significant difference between Group I and Group III. Significant difference was found between Group I & IV, I & V, II & III, II & IV, II & V, III & IV, III & V. No significant difference was found between Group I & II, and between Group IV & V.

DISCUSSION

Biomechanical preparation of root canal is one of the main step in achieving endodontic success by enabling bacterial elimination, removal of debris, and facilitating obturation (You, 2010 and European Society of Endodontology, 2006). But perforations, canal transportation, ledge, zip formation, and separation of instruments are some of the complications encountered during root canal preparation and retreatment cases (Yoldas, 2012; Jeon, 2014; Rhodes, 2011). For biomechanical preparation many techniques and instruments have been tried. Stainless steel K files were introduced in 1915 (Michael, 2005). They were considered gold standard for biomechanical preparation and versatile. But due to their limitations in narrow canals, less flexibility, and time consuming, rotary NiTi file systems were introduced (Jeon, 2014 and Munoz, 2014). One of them is rotary ProTaper file system. This system is widely used and most popular. It has a sequence of files to complete biomechanical preparation. Due to an increase in the number of files it becomes time consuming which increases rotations and leads to more damage to dentin. The introduction of single file systems has been both revolutionary and exciting. If these files are found to be safe and effective, they could revolutionize the practice of endodontics (Patil, ?). OneShape is single file system in continuous rotation of 360^0 and WaveOne is has reciprocation motion with clockwise (50^0) and counterclockwise (170^0) rotation of files (Robinson, 2013). Cracks after canal instrumentation were detected in horizontal sections cut at different levels at 9 mm, 6 mm and 3 mm from root apex. It seems useful to examine the root surface and dentin at multiple levels to determine the development of cracks (Liu, 2013).

- In Group I, Control Group A, root canals were kept unprepared to rule out cracks other than biomechanical preparation.
- In Group II, control Group B, root canals were prepared with K files.
- In Group III root canals were prepared with ProTaper files. It is a widely used system. In this system Sx, 2 shaping files S1, S2 and 2 finishing files F1, F2 were included. F2 was taken as master apical file. To overcome the flaws of multiple file system, single files system is used in Group IV and Group V.
- In Group IV root canals were prepared with WaveOne files. This single file system works in reciprocating motion (Gambarini, 2012). This group was taken to differentiate between Continuous rotation and Reciprocating motion. In this system 3 files are available: small (21 no., 6% taper), primary (25 no., 8% taper) and long (40 no., 8% taper) (Jeon, 2014). Primary file was considered as master apical file.
- In Group V root canals were prepared with OneShape files. It is a single file system with continuous rotation. This system included only one file with 25 no. apical size with 6% taper. To avoid variability in results all teeth were prepared till master apical file size ISO 25.

Group I showed no defects in any of the specimen. There was no statistically significant difference between Group I and Group II (p value=0.5). Group III showed highly significant difference with Group I (p value=0.005) whereas Group IV (p value=0.038) and Group V (p value=0.026) showed significant difference. Group II showed almost no dentinal defects and was statistically significant with other rotary Groups, Group III (p value=0.026), Group IV (p value=0.018) and Group V (p value=0.037). This is in agreement with several other studies (Bier, 2009 and Kim, 2013) and could be attributed to the less aggressive movement of the hand files in the canal compared with rotary files (Hin, 2013). All rotary files showed more cracks than K file group. This is attributed to more number of active rotations associated with rotary systems, greater taper compared to standard K files and greater total volume of root dentin removal with NiTi rotary systems (Hin, 2013 and Sathorn, 2005). As more root dentin is removed, greater is the risk of initiating root fracture (Hin, 2013). Group III (ProTaper) showed highest number of defects at all the levels with the statistically significant difference with Group IV (p value=0.029) and Group V (p value=0.040). This may be attributed to the high number of rotations associated with more number of files, progressively increasing taper along the length of the files, smaller pitch and its cross section design all of which removes relatively more dentin compared to other systems (Hin, 2013). This is in association with previous studies who have proved ProTaper to be more stiffer files (Abou, 2014), that generates the most extreme tensile & compressive stresses in dentin (Kim, 2013). Within Group IV, WaveOne showed fewer defects in apical third than in coronal and middle third. At apical 3 mm, numbers of defects were similar to ProTaper but higher than OneShape Group. This may be because Matthew el al have proved that WaveOne leaves significantly more debris in the apical third of canal during biomechanical preparation (Dietrich, 2012). Thus increasing stresses and defects within the dentinal walls compared to OneShape in apical third. In coronal third and middle third levels at 9 mm and 6 mm relatively fewer defects are seen in WaveOne Group. This may be due to the fact that WaveOne is a single file system with M wire alloy technology and works in reciprocating motion. M wire is more flexible than conventional NiTi, thus not only does it induce less stresses on the root canal walls, but also less pressure is exerted on the instrument during instrumentation (Abou, 2014). Hend Mahmoud *et al* have concluded that the alloy from which the instrument is manufactured was a more important factor in determining the damaging potential of

single-file instruments than the motion of instrumentation (Abou, 2014). Reciprocating motion is safer than conventional rotation (Abou, 2014) as it shows both Counter Clockwise (170) and Clockwise movement. Counter Clockwise movement engage and cut the dentin (Webber, 2011). Clockwise movement disengage the instrument from the dentin before it (taper) lock into the canal, results into more centered preparation. Effective rotations are less compared to continuous rotation (Robinson, 2013) and its balance force concept (Berutti, 2012), decreases the risk of torsional fracture. Within Group V, OneShape files showed more defects in dentin, in the coronal and middle third and less in the apical third. Defects along the dentinal walls may be attributed to the constant increase in taper and continuous rotational motion of OneShape file that causes more stresses. At apical 3mm, OneShape files showed lesser defects than ProTaper and WaveOne files. This may be because ISO 25 number OneShape file have 6 % apical taper which is less than ProTaper F2 file and WaveOne Primary file with 8 % apical taper. Within the limits of this study we can conclude that WaveOne gives comparably good results in coronal and middle third region i.e. lesser cracks as compared to OneShape which is better than WaveOne for apical third region. However statistically no significant difference has been found between the two. Although WaveOne seems to be a promising system with respect to its shaping ability and less defects and damage to dentin. The clinical significance of these findings are not very clear and still further studies are needed to clarify the clinical performance of WaveOne and OneShape. So we can conclude that fracture susceptibility of teeth can be decreased by maintaining the canal size as small as practical (Sathorn, 2005).

Conclusion

From the results of this study, it can be concluded that Hand instrumentation with K files causes least dentinal defects. Even though NiTi rotary files have many advantages over hand files, NiTi files can induce variable degree of dentinal defects during root canal preparation. ProTaper generated highest defects compared to other file systems at all 3 levels 3mm, 6mm, and 9mm. WaveOne files causes least damage to dentin at coronal and middle third region at 9 mm and 6 mm respectively but comparably more than OneShape at 3 mm. OneShape induced least damage at apical third region at 3 mm but comparably higher at 6 mm and 9 mm than WaveOne system. There was no significant difference found between WaveOne and OneShape.

REFERENCES

Abou, E., Nasr, H.M., Abd, El., Kader, K.G. 2014. Dentinal damage and fracture resistance of oval roots prepared with single- file system using different kinematics. *J.Endod.* 40(6):849-51.

Amara Latif Bajwa, Muhammad Qasim, Abdul Qadir Dall. Influence of instrument size in debriding apical third of the root canal system. *J Liaquat Uni Med Health Sci Jan*., 11(3):133-8.

Berutti, E., Chiandussi, G., Paolino, D.S., Scotti, N., Cantatore, A., Castellucci, A., Pasqualini, D. 2012. Canal Shaping with WaveOne Primary Reciprocating Files and ProTaper System: A Comparative Study. *J Endod.,* Apr;38(4):505-9.

Bier, C.A., Shemesh, H., Tanomaru-Filho, M., *et al*. 2012. The ability of different nickel titanium rotary instruments to induce dentinal damage during canal preparation., *J Endod.,* 35, 236–8.

Dietrich, M.A., Kirkpatrick, T.C., Yaccino, J.M. 2012. In Vitro Canal and Isthmus Debris Removal of the Self-Adjusting File, K3, and WaveOne Files in the Mesial Root of Human Mandibular Molars. *J Endod.,* Aug;38(8):1140-4.

European Society of Endodontology. 2006. Quality guidelines for endodontic treatment: consensus report of the European Society of Endodontolog. *Int Endod J.,* 39(12):921-30

Gambarini, G., Rubini, A.G., AI Sudani, D., Gergi, R., Culla, A., De Angelis, F., Di Carlo, S., Pompa, G., Osta, N., Testarelli, L. 2012. Influence of Different Angles of Reciprocation on the Cyclic Fatigue of Nickel-Titanium Endodontic Instruments. *J Endod*., Oct;38(10):1408-11

Hin, E.S., Wu, M.K.,Wesselink, P.R., Shemesh, H. 2013. Effects of Self-Adjusting File, Mtwo, and ProTaper on the Root Canal Wall. *J Endod.,* Feb; 39(2):262-4

Jeon, H.J., Paranjpe, A., Ha, H.J., Kim, E., Lee, W., Kim, H.C. 2014. Apical Enlargement According to Different Pecking Times at Working Length Using Reciprocating Files. *J Endod.,*40(2):281-4

Juliane, V., Kerstin, B., Andrej, M. 2007. Evaluation of rotary root canal instruments in vitro: a review. *Endo.,* 1 (3); 189-203

Kim, H.C., Lee, M.H., Yum, J.,Versluis, A., Lee, C.J., Kim, B.M. 2013. Potential Relationship between Design of Nickel-Titanium Rotary Instruments and Vertical Root Fracture. *J Endod,* 36(7):1195-9

Liu, R., Hou, B.X., Wesselink, P.R., Wu, M.K., Shemesh, H. 2013. The Incidence of Root Microcracks Caused by 3 Different Single-file Systems versus the ProTaper System. *J Endod.*, 39(8):1054-6.

Michael, H., Peters, O.A., Paul, M.H. Dummer. 2005. Mechanical Preparation Of Root Canals: Shaping Goals, *Techniques And Means, Endodontic Topics.,* 10, 30–76

Munoz, E., Forner, L., Llena, C. 2014. Influence of Operator's Experience on Root Canal Shaping Ability with a Rotary Nickel-Titanium Single-File Reciprocating Motion System. *J Endod.,* 40(4):547-50

Patil, A., Aggarwal, S. To compare and contrast maintenance of root canal geometry using rotary NiTi systems - An in vitro study, *Endodontology,* 14-21

Peters, O.A. 2004. Current Challenges and Concepts in the Preparation of Root Canal Systems: A Review. *J Endod.* 30(8):559-67.

Peters, O.A. 2008. Rotary Instrumentation: An Endodontic Perspective. Endodontics: Colleagues for Excellence, winter, 1-7

Rhodes, S.C., Hülsmann, M., McNeal, S.F., Beck, P., Eleazer, P.D. 2011. Comparison of root canal preparation using reciprocating Safe siders stainless steel and Vortex nickel-titanium Instruments. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*., 111(5):659-67

Robinson, J.P., Lumley, P.J., Cooper, P.R., Grover, L.M., A., Walmsley, A.D. 2013. Reciprocating Root Canal Technique Induces Greater Debris Accumulation Than a Continuous Rotary Technique as Assessed by 3-D Micro–Computed Tomography. *J Endod.*, 39(8):1067-70.

Sathorn, C., Palamara, J.E, Messe, H.H. 2005. A Comparison of the Effects of Two Canal Preparation Techniques on Root Fracture Susceptibility and Fracture Pattern. *J Endod*. 31(4):283-7

Webber, J., Machtou, P., Pertot, W., Kuttler, S., Ruddle, C., West, J. 2011. The WaveOne single-file reciprocating system. *Roots.,* 1, 28–33.

Yoldas, O., Yilmaz, S., Atakan, G., Kuden, C., Kasan, Z. 2012. Dentinal microcrack formation during root canal preparations by different NiTi rotary instruments and the self-adjusting file. *J Endod.*, 38, (2):232-5.

You, S.Y., Bae, K.S., Baek, S.H., Kum, K.Y., Shon, W.J., WooCheol Lee, W. 2010. Lifespan of One Nickel-Titanium Rotary File with Reciprocating Motion in Curved Root Canals. *J Endod,* Dec; 36(12): 1991- 4

****