International Journal Dental and Medical Sciences Research
Volume 3, Issue 4, July-Aug 2021 pp 552-559 www.ijdmsrjournal.com ISSN: 2582-6018

Effect on Apical Canal Size after Repetitive Insertions at Working Length Using Protaper Next and WaveOne File System: An In-Vitro Study.

Dr. Snehal Kashinath Patil, MDS, Dr. Kulvinder Singh Banga, HOD
Dr. Vathsalya K. Shetty, Associate Professor, Dr. Mit Sanjaykumar Modi, MDS.

Department of Conservative Dentistry And Endodontics, Nair Hospital Dental College, Mumbai, Maharashtra.
Corresponding author: Dr. Snehal Kashinath Patil.

Submitted: 01-08-2021 Revised: 07-08-2021 Accepted: 10-08-2021

ABSTRACT

Introduction: The purpose of this study was to evaluate the apical preparation sizes resulting from repetitive insertions at the working length (WL) by using ProTaper Next and WaveOne file system.**Materials and Methods:**Sixty simulated endodontic training blocks with a J-shaped root canal were instrumented using ProTaper Next X2 and WaveOne Primary (n = 30 each). Each group was divided into 3 subgroups based on the repetitive insertions times at the WL: 1, 3 and 4 times. All specimens were prepared by 1 operator who was competent in instrumenting canals with both file systems. The replica of the prepared canal was taken with silicone impression material. After 24 hours of allowing the impression to set, each sample was evaluated under a stereomicroscope (40X) (Leica microsystems) at the apical tip, and the apical preparation size (diameter) was measured at the D0 level of the impression. The data were analyzed statistically using Student t test and Analysis of Variance at P = .05. Results: The mean diameter (um) varied between 126 and 150 and between 144 and 167 for ProTaper Next and WaveOne, respectively, without significant differences. However, more repetitive insertions at the WL resulted in a larger apical preparation size than the subgroups with less pecking times but that was not statistically significant.

Conclusions: Under the conditions of this study the two file systems did not show significant differences in apical preparation size, but a greater number of repeated insertions did result in larger apical size. Thus, it can be recommended that endodontic instruments be used as per manufacturer's instructions, as less number of times maintaining the WL.

I. INTRODUCTION

Endodontic therapy involves treating vital and necrotic pulp so that patient can retain natural teeth in function and esthetics. Although successful therapy depends on many factors, one of the most important steps in root canal therapy is biomechanical preparation of canal. This preparation determines efficacy of all subsequent procedures that includes mechanical debridement, creation of space for medicament delivery and optimized canal geometrics for adequateobturation.To date many modalities have been used for root canal instrumentation procedures. Niti rotary instruments are important adjunct in endodontic therapy. They are frequently used during shaping procedures because of their super elasticity, shape memory and lower modulus of elasticity which facilitates effective canal preparation[1]. Niti instruments also possess a risk of fracture mainly because of torsional stress. One way to reduce torsional stress is to incorporate multiple progressive tapers into the instrument design. According to West, progressive taper allows for only small areas of dentine to be compromised. This design concept also contributes to maintaining the original canal curvature[2].ProTaper Next files possess the properties of variable taper, offset design, and are manufactured from M-wire technology which can reduce cyclic fatigue by 400% compared with similar instruments manufactured from conventional NiTi alloys[2].

A recently developed concept of root canal preparation aims to reduce working time and incidence of fracture by using single file under reciprocating motion. WaveOne system relies on kinematic safety and M-wire technology. The reciprocating motion of this NiTi rotary instrument has been shown to reduce the impact of cyclic fatigue compared with continuous rotational motion[3].

It is important that root canal preparation must be large enough in the apical segment to increase cleaning and disinfection and at the same time must be compatible with the root anatomy to

International Journal Dental and Medical Sciences Research
Volume 3, Issue 4, July-Aug 2021 pp 552-559 www.ijdmsrjournal.com ISSN: 2582-6018

avoid accidents and not put the tooth at risk[4]. Usually, repeated push and pull movements are recommended until next larger file in sequence moves easily to desired working length (WL) [5]. However apical preparation size may become large when number of repetitive insertions at WL wasincreased.

Also, repetitive insertion may violate apical preparation size which may result in poor hermetic seal. It is also claimed that the cones match taper and diameter of canals prepared with NiTi instruments[6]. However, instrumented canals may have bigger lumen than designated file and cone size[6]. Therefore, the aim of this study is to evaluate the effect of repetitive insertions at WL on apical preparation size using ProTaper Next and WaveOne file system in simulated resin rootcanals.

II. MATERIALS ANDMETHOD

In this study, 60 endodontic training blocks with J shaped root canal were used. The 60 blocks were divided into two groups ProTaper Next and WaveOne (30 each). Each group was further subdivided into 3 subgroups based on number of repetitive insertions at WL 1, 3 & 4 times. To avoid inter-operator variability all procedures were performed by singleoperator.

The WL was determined by using a #10 k-file (Dentsply Maillefer) in the canals until it was visible at the apical foramen. The WL was calculated to be 0.5 mm less than the initial length. A rubber stop for each file was fixed at the WL to maintain it accurately for all files in both groups.

All canals were shaped according to the manufacturer's instructions. The preparation for ProTaper Next group was performed using two files X1(size 17, .04 taper) andX2(Size 25, .06 taper). During the procedure patency was checked with a # 10K-file and canal was irrigated with saline. The final instrumentation was performed at WL with X2 at 1, 3 and 4 repetitive insertions for 3 subgroups (n=10 each).

For WaveOne group, canals were instrumented to WL by using WaveOne Primary (size 25, .08 taper). The final instrumentation was performed at WL with WaveOne primary file at 1, 3 and 4 repetitive insertions for 3 subgroups (n=10 each).

After the instrumentation sequence was completed, the canals were again irrigated with saline and were dried by using paper points. Replicas of the prepared canals were taken with silicone impression material using dispensing gun. The impressions of prepared canal were taken off after the impression material had set. Images were taken of each replica in all experimental groups. The images were captured by a stereomicroscope (40X) (Leica microsystems).

III. RESULTS

The mean apical preparation size according to the different file systems and the number of pecking times at the WLs are shown in Table 1. The mean diameter varied between 126 mm and 150 mm for ProTaper Next and between 143 mm and 166 mm for WaveOne files, respectively. Two-way analysis of variance revealed no significant differences in the apical preparation size between ProTaper Next and WaveOne files ($P > 0.05$)

Table 1: Mean apical preparationsize

Files	Rotations per minute at working length	Mean (SD)
ProTaper Next	1	126.23
ProTaper Next	3	133.78
ProTaper Next	4	150.16
WaveOne	1	143.54
WaveOne	3	146.37
WaveOne	4	166.79

International Journal Dental and Medical Sciences Research
Volume 3, Issue 4, July-Aug 2021 pp 552-559 www.ijdmsrjournal.com ISSN: 2582-6018

Descriptive and inferential statistical analyses were carried out in the present study. Results on continuous measurements were presented on Mean SD. Level of significance was fixed at p=0.05 and any value less than or equal to 0.05 was statisticallysignificant.
Student t tests (two tailed, unpaired) was used to find the significance of study parameters on continuous scale between two groups. Analysis of variance (ANOVA) was used to find the significance of study parameters between and within the groups (Inter & Intra group analysis).
The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data. Microsoft word and Excel were used to generate graphs, tables etc.

Table 2: Comparison of the apical canal size (µm) in terms of {Mean (SD)} after 1, 3 & 4 repetitive insertions of ProTaper Next using ANOVA test

Insertions	N	Mean	Std. Deviation	F value	P value
ProTaper Next 1	10	126.2350	18.00531	0.970	0.392
ProTaper Next 3	10	133.7810	36.44630		
ProTaper Next 4	10	150.1630	54.54669		
Total	30	136.7263	39.23566		

There was increase in apical canal size with ProTaper Next files after repetitive insertions at 1, 3 and 4. The maximum increase in apical canal size was at 4 repetitive insertions. But there is no statistically significant difference between the specimens at 1,3 and 4 repetitive insertions. (Table 2, Graph1)

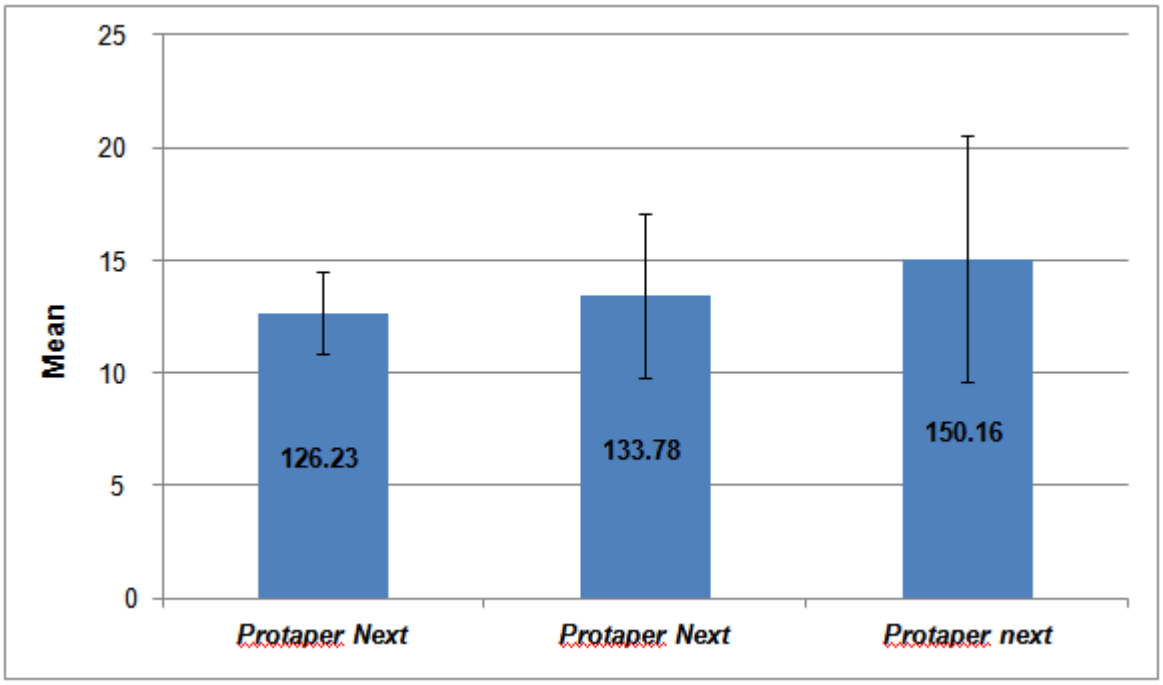
Table 3: Comparison of the apical canal size (µm) in terms of {Mean (SD)} after 1, 3 & 4 repetitive insertions of WaveOne using ANOVA test

Group	N	Mean	Std. Deviation	F value	P value
WaveOne 1	10	143.5420	23.37495	2.646	0.089
WaveOne 3	10	146.3730	27.65024		
WaveOne 4	10	166.7950	22.67904		
Total	30	152.2367	26.02824		

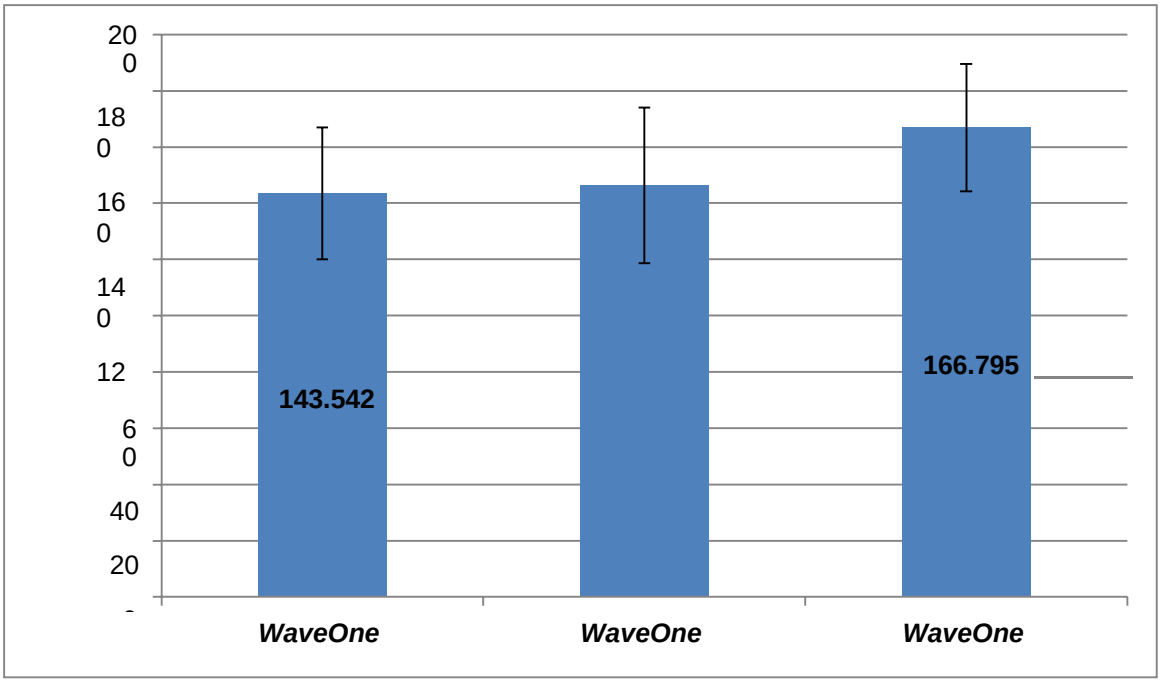
There was increase in apical canal size with WaveOne files at 1, 3 and 4 repetitive insertions but it was not significant as p>0.05. The maximum increase in apical canal size was observed with subgroup at 4 times repetitive insertion. (Table 3, Graph 2)

International Journal Dental and Medical Sciences Research
Volume 3, Issue 4, July-Aug 2021 pp 552-559 www.ijdmsrjournal.com ISSN: 2582-6018

Graph 1: Comparison of the apical canal size (µm) in terms of {Mean (SD)} after 1, 3 & 4 repetitive insertions of ProTaper Next using ANOVA test



Graph 2 Comparison of the apical canal size (µm) in terms of {Mean (SD)} after 1, 3 & 4 repetitive insertions of WaveOne using ANOVA test



International Journal Dental and Medical Sciences Research
Volume 3, Issue 4, July-Aug 2021 pp 552-559 www.ijdmsrjournal.com ISSN: 2582-6018

Table 4: Comparison of the apical canal size (µm) in terms of {Mean (SD)} after 1, 3 & 4 repetitive insertions among both the groups using unpaired t test

Insertion s	Group	N	Mean	Std. Deviation	t value	P value
1	Protaper Next	10	126.2350	18.00531	1.855	0.080
	WaveOne	10	143.5420	23.37495		
3	Protaper Next	10	133.7810	36.44630	0.870	0.396
	WaveOne	10	146.3730	27.65024		
4	Protaper Next	10	150.1630	54.54669	0.890	0.385
	WaveOne	10	166.7950	22.67904		

($p \leq 0.05$ – statistically significant)

IV. INTERPRETATION

1. The p value was 0.392 (Table 2 and Graph 1) for ProTaper Next group at 1, 3 and 4 repetitive insertions. This indicates that the result was statistically insignificant for ProTaper Next group.
2. The p value was 0.089 (Table 3 and Graph 2) for WaveOne group at 1,3 and 4 repetitive insertions. This indicated that the result is statistically insignificant for WaveOnegroup.
3. The p values for intergroup comparison at 1,3 and 4 repetitive insertions were more than 0.05 (Table 4) which indicated that there was no statistically significant difference between twogroups.

Image 1: Representative stereomicroscopic image of apical tip diameterfor ProTaper Next group

International Journal Dental and Medical Sciences Research
Volume 3, Issue 4, July-Aug 2021 pp 552-559 www.ijdmsrjournal.com ISSN: 2582-6018

Image 2: Representative stereomicroscopic image of apical tip diameter for WaveOne group

V. DISCUSSION

Root canal treatment may be defined as the combination of mechanical instrumentation of the root canal system, its chemical debridement, and filling with an inert material designed to maintain the health of the periradicular tissue. The primary objective of the entire procedure is to eliminate microorganisms and pathologic debris from the root canal system and to prevent its reinfection[18]. Preparation of the root canal system is one of the most important stages in root canal treatment. The aim is to prepare the canal space to facilitate disinfection by irrigants and intracanal medicaments. Prevention of reinfection is then achieved through the provision of a fluid-tight seal of root canal filling and a coronalrestoration.

The introduction of rotary endodontic NiTi instruments has led to significant progress in treatment by reducing the time required for root canal preparation and maintaining the original canal shape. NiTi instruments are characterized by their super-elastic behavior, shape memory property and lower modulus of elasticity. The super elasticity of the NiTi alloy has made it possible to reduce the incidence of canal aberrations such as zips, ledges, or perforations, especially in narrow and curved canals[19]. Since the introduction of these instruments a few NiTi rotary systems have been introduced to the market. These systems essentially differ from one another in the design of cutting blades and taper of their files[20].

In this study, changes in apical preparation size wereanalyzed using ProTaper Next (PTN) (Dentsply Maillefer, Ballaigues, Switzerland) rotary system. PTN is a novel NiTi rotary system designed with progressive and regressive percentage tapers, an off-centered rectangular design for superior strength and a novel asymmetric rotary motion that is claimed by the manufacturer to improve canal shaping effectiveness[4,5,6].PTNsystemalsooffersmorecross-sectionalspaceforimproved cutting, loading and augering debris out of canal. Furthermore, it results in reduction of probable lateral compaction of debris and the blockage of root canal system, thus ensuring the maintenance of the patency inside the root canals[21].

PTN system includes a set of 5 files with varying lengths, design, and taper. The first instrument in the system is ProTaper Next X1 with a tip size of 0.17mm and a 4% taper. The ProTaper Next X2 file with a tip size of 0.25mm and taper of 6% can be regarded as the first finishing file in the system. The last three finishing files are the ProTaper Next X3 tip size 0.3mm with 7% taper, X4 tip size 0.4mm with 6% taper and X5 tip size 0.5mm with 6% taper.

A recently developed concept of root canal preparation aims to reduce working time and the incidence of fracture by using a single file under a reciprocating motion [22]. The concept of reciprocating motion based on balanced force technique was introduced by **Yared et al** [7]. They utilized the single F2 ProTaper instrument in reciprocating motion to shape the root canals. The recently introduced NiTi WaveOne file claims to be able to completely prepare and clean root canals with only one instrument. These files are made of

special NiTi alloy called M-wire that is created by an innovative thermal treatment process. The benefits of this M-wire are increased flexibility of the instrument and improved resistance to cyclic fatigue[3].

The WaveOne single-file reciprocating system is available in three different file sizes in lengths of 21, 25, and 31m [8].

WaveOne Small File- The tip of the file is ISO 21 (0.21mm or 210 µm) with a continuous fixed taper of 6%.

WaveOne Primary File – The tip of the file is ISO 25 (0.25mm or 250 µm) WaveOne Large File – The tip of the file is ISO 40 (0.4mm or 400 µm).

Owing to the high complexity of canals with multiple curves in different planes, endodontic cleaning and shaping procedures have become very difficult within the preparation norms. To reduce this variability extracted teeth were not used in this study. Also resin blocks allow the visualization of intracanal changes and reproducibility when compared to natural teeth[10].

In this study, changes in apical preparation size wereanalyzed using ProTaper Next X2 and WaveOne primary file system (Dentsply Maillefer, Ballaigues, Switzerland). These files have different cross section but have same apical tip diameter. The apical preparation size of standardized resin blocks wasanalyzed by canal impression method with silicon impression material. The apical tip of the impression replica was measured by using stereomicroscope. According to specifications, the nominal file diameter is measured at D0. The D0 level or apical tip of impression replica was measured to evaluate the apical preparation size under stereomicroscope using 40 Xmagnification.

The more repetitive insertions at WL resulted in increase in apical preparation size[11]. The present study concluded that increasing the number of pecking times at the WL by both the file systems resulted in an apical preparation size that is larger than the ‘‘designated’’ size of the file.

Apical portion of root canal system has been regarded as a critical zone for infection control. Larger apical preparations allow better removal of infected dentin, enhance flushing action of irrigants in apical region, significantly reduces the bacterial load and untouched root canal walls in the canal system[12,13,14,15]. Extent of apical enlargement required is still a matter of debate.

It is reported that increased number of pecks would increase the apical size of preparation from the actual size of the instrument being used. Therefore, the selected GP cone corresponding to the size and taper of Ni-Ti rotary instrument used in canal preparation might have insufficient tug-back. Apical transportation may be another factor that causes unreliable cone fitness, especially in curved canals. Even though there is disagreement amongst endodontic specialists about the ideal apical diameter of the root canal preparation, there is universal agreement that the ideal size varies from tooth to tooth and depends on anatomical, microbiological, and mechanical factors[12,16,17].

Under the conditions of study, the two file systems did not show significant differences in apical preparation size but a greater number of repeated insertions did result in larger apical size. Thus, it can be recommended that endodontic instruments be used as per manufacturer’s instructions, as less number of times maintaining the WL.

Also, it can be concluded that although there is necessity of apical enlargement to optimize irrigation and disinfection and to facilitate the elimination of microbes mechanically, the main mechanical imperative is to preserve the apical foramen in its initial position and in its narrowest diameter as possible. The myriad of rotary endodontic files available in market are a boon to endodontics but caution while in use isimperative.

REFERENCES:

[1]. **Prof. Peet J. van der Vyver & Dr Michael J. Scianamblo.** Clinical guidelines for the use of ProTaper Next instruments (Part I). Dental Tribune Asia Pacific Edition No.7-8/2014

[2]. **GordonMP,LoveRM,ChandlerNP**.Anevaluationof.06 taperedgutta-perchaconesforfillingof .06 taper prepared curved root canals. Int Endod J. 2005 Feb;38(2):87-96.

[3]. **Iqbal MK, Firic S, Tulcan J, Karabucak B, Kim S**. Comparison of apical transportation between ProFile and ProTaper NiTi rotary instruments. Int Endod J.2004;37(6):359-64.

[4]. **Giuliani V, Di Nasso L, Pace R, Pagavino G.** Shaping ability of waveone primary reciprocating files and ProTaper system used in continuous and reciprocating motion. J Endod. 2014 Sep;40(9):1468-71.

[5]. **Anil Dhingra, Ruchi Gupta, Amteshwar Singh.** Comparison of Centric Ability of Protaper Next, Wave One & Protaper using Cone Beam Computed Tomography. Endodontology December 2014; 26 (2):244-251.

[6]. **Cui Z, Wei Z, Du M, Yan P, Jiang H.** Shaping ability of protaper next compared with waveone in late-model three-dimensional printed teeth. BMC Oral Health.

2018 Jun25;18(1):115.

[7]. **Yared G.** Canal preparation using only one Ni-Ti rotary instrument: preliminary observations. Int Endod J. 2008Apr;41(4):339-44.

[8]. **Peet van der Vyver.** The WaveOne reciprocating endodontic system. International Dentistry – African Edition Vol. 3, no.5:6-20.

[9]. **Ceyhanli KT, Kamaci A, Taner M, Erdilek N, Celik D.** Shaping ability of two M-wire and two traditional nickel-titanium instrumentation systems in S-shaped resin canals. Niger J Clin Pract. 2015 Nov-Dec;18(6):713-7.

[10]. **Weine FS, Kelly RF, Lio PJ.** The effect of preparation procedures on original canal shape and on apical foramen shape. J Endod. 1975Aug;1(8):255-62.

[11]. **Jeon HJ, Paranjpe A, Ha JH, Kim E, Lee W, Kim HC.** Apical enlargement according to different pecking times at working length using reciprocating files. J Endod.2014;40(2):281-4.

[12]. **Fornari VJ, Silva-Sousa YT, Vanni JR, Pécora JD, Versiani MA,** increased apical enlargement for cleaning the apical third of curved canals. Int Endod J. 2010Nov;43(11):988-94.

[13]. **Dalton BC, Orstavik D, Phillips C, Pettiette M, Trope M**. Bacterial reduction with nickel-titanium rotary instrumentation. J Endod. 1998Nov;24(11):763-7.

[14]. **Falk KW, Sedgley CM**. The influence of preparation size on the mechanical efficacy of root canal irrigation in vitro. J Endod. 2005Oct;31(10):742-5.

[15]. **Brunson M, Heilborn C, Johnson DJ, Cohenca N.** Effect of apical preparation size and preparation taper on irrigant volume delivered by using negative pressure irrigation system. J Endod. 2010Apr;36(4):721-4.

[16]. **Elayouti A, Dima E, Judenhofer MS, Löst C, Pichler BJ.** Increased apical enlargement contributes to excessive dentin removal in curved root canals: a stepwise microcomputed tomography study. J Endod. 2011Nov;37(11):1580-4.

[17]. **Silva Santos AM, Portela FMSF, Coelho MS, Fontana CE, De Martin AS.** Foraminal Deformation after Foraminal Enlargement with Rotary and Reciprocating Kinematics: A Scanning Electronic Microscopy Study. J Endod. 2018Jan;44(1):145-148.

[18]. **Saini HR, Tewari S, Sangwan P, Duhan J, Gupta A.** Effect of different apical preparation sizes on outcome of primary endodontic treatment: a randomized controlled trial. J Endod. 2012 Oct;38(10):1309-15.

[19]. **Thompson SA, Dummer PM.** Shaping ability of ProFile.04 Taper Series 29 rotary nickel-titanium instruments in simulated root canals. Part 2. Int Endod J. 1997Jan;30(1):8-15.

[20]. **IqbalMK,FiricS,TulcanJ,KarabucakB,KimS**.Comparisonofapicaltransportationbetween ProFile and ProTaper NiTi rotary instruments. Int Endod J.2004; 37(6):359-64.

[21]. **Saha Ganguly Suparna, Shrivastava Poorvi, Dubey Sandeep, Kala Shubham**. Comparison of Root Canal Cleaning Ability of ProTaper NEXT and WaveOne Rotary file systems - A Scanning Electron Microscopic (SEM) study. Endodontology December 2015; 27(2):124-128.

[22]. **You SY, Bae KS, Baek SH, Kum KY, Shon WJ, Lee W.** Lifespan of one nickel-titanium rotary file with reciprocating motion in curved root canals. J Endod. 2010Dec;36(12):1991-4.