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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF CANAL TRANSPORTATION AND CENTRING ABILITY OF PROTAPER (NT), RECIPROC AND ONESHAPE FILE SYSTEMS USING CONE BEAM COMPUTED TOMOGRAPHY- AN- IN VITRO STUDY

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ABSTRACT

The purpose of this in-vitro study was to compare the canal transportation and centring ability of Protaper Next (NT), Reciproc and OneShape (OS) file system. Materials and Methods: Thirty human extracted mandibular molars having non-calcified roots with mature apices, minimum length of 18 mm and an apical curvature of 15-30 degrees (according to Schneider's method), were selected for this study. Samples were randomly divided into three groups (n=30) and canal preparation with Protaper NT, Reciproc and OS was performed according to manufacturer's instruction. Pre- and post-instrumentation cone-beam computed tomography (CBCT) images were captured and the extent of canal transportation and centering ability of the files were calculated, using the NNT Viewer software and Photoshop CS5, at levels of 3, 6, and 9 mm from the apex. The One-way analysis of variance (ANOVA) with Tukey's honestly significant difference (HSD) were used to analyze the statistical significance between the three groups. Conclusions: The canal preparation with Reciproc file system showed lesser transportation and better centering ability than Protaper NT and One Shape file system.

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INTRODUCTION

One of the main objectives of root canal preparation is to shape and clean the root canal system effectively whilst maintaining the original con guration without creating any iatrogenic events such as instrument fracture, external transportation, ledge, or perforation (Ruddle 2002). Over the past decade, problems with breakage and inflexibility of stainless steel hand instrumements have resulted in a search for new materials. (Uyanik *et al*., 2006) Procedural errors such as transportation and loss of working length were mainly associated with the use of stainless steel files. (Javaheri *et al*., 2007) The advent of nickel-titanium (Ni-Ti) rotary instrumentation has revolutionized root canal treatment by reducing operator fatigue, time required to finish the preparation and procedural errors associated with root canal instrumentation (Thompson & Dummer 1997, Scha¨fer 2001, Scha¨fer & Lohmann, 2002). Protaper Next (Dentsply Tulsa Dental Specialties) is designed with rectangular cross section design for greater strength. As a result, only two points of the rectangular cross section touch the canal wall at a time. (Dhingra *et al*., 2014) These files have increased flexibility and resistance to cyclic fatigue. (Dhingra *et al*., 2014; Ruddle *et al*., 2013) The Oneshape system (OS Micromega Besancon, France) is another file system that is made of a conventional austenite 55 NiTi alloy and used in continous clockwise deirection. (Uzunoglu and Turker, 2015) These instruments have an innovative design with three different cross-sectional areas over the entire length of the file and have a variable pitch and and a noncutting safety tip (Burklein *et al*., 2013). (Saber *et al*., 2015) The recently introduced Reciproc file system (VDW, Munich, Germany) is able to prepare canals with only 1 instrument, thereby requiring less time than rotary full sequence file systems. These files are made up of M-wire which has provided increased flexibility and improved resistance to cyclic fatigue of the instrument. (Burklein *et al*., 2013) Among methodologies that have been described to evaluate the instrumentation effect on root canals, serial sectioning is probably the most commonly used technique, despite some inherent limitations. (Uyanik *et al*.,

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2006) Since cone-beam computed tomography (CBCT) is more accessible and precise for three dimensional evaluation without destructing the teeth, we used CBCT for evaluating canal transportation and centering ability. (Aminsobhani *et al*., 2014) Thus, the present in vitro study aimed to compare the canal transportation and centering ability of the three instruments, i.e. Protaper NT, Reciproc and OneShape, by means of (CBCT).

MATERIALS AND METHODS

In total, 30 extracted mandibular molars were used in this study and were divided into three groups of 10 teeth each (n=10). Teeth were selected on the basis of mature apices, similar canal curvatures (15-30 degree) according to Schneider method, and separate mesial canals with no abnormal root morphology. Teeth with previous endodontic treatments, metal restorations, resorptions, incomplete apex formations and multiple visible foramina were excluded. Access cavities were prepared with Endo access burs (Dentsply). A size 15 K-Flexofile (DentsplyMaillefer) was placed into the canal until it was visible at the apical foramen, and the working length (WL) was established 1 mm short and the tooth length was standardized to 18mm.Then the teeth were sectioned vertically into two halves with the help of a diamond disc. Further, roots were embedded intopolyvinylsiloxane based material (GC)and a 3D image acquisition was performed using the CBCT CS 9300 (78kV, 2 mA), (Planmeca, Helsinki, Finland). All CBCT measurements were performed by a single experienced investigator. After the pre-operative scans the root canal preparation was performed.

Group 1 Protaper Next: The ProTaper Next files were used as per manufacturer's recommendations in the sequence of X1, X2, X3, at a rotational speed of 300 rpm and 200 g/cm torque. Each file was used with a brushing motion.

Group 2 Oneshape: OneShape instruments (size 25, taper 0.06) were operated till the working length in a continuous rotation motion with the X-Smart motor (Dentsply) set to 350 rpm and a 5-Ncm torque with a 16:1 contra-angle.

Group 3 Reciproc: A R25 Reciproc le having a size 25 at the tip and a taper of 0.08 over the rst 3 mm was used in a reciprocating, slow in-and-out pecking motion according to the manufacturer's instructions. The utes of the instrument were cleaned after three in- and-out-movements (pecks).R25 instruments were operated in a reciprocating motion powered by anEndostation motor (ReDent Nova) using pre-set adjustments.

Preparations were made in conjunction with RC Help (PrimeDental) as a lubricant and chelating agent. Irrigation was performed with 3% NaOCl after each instrumentation. CBCTimages were obtained after instrumentation with 90µ high resolution dental mode. The technical outcomes were then compared at 3,6 and 9mm intervals from the apex to evaluate the progressive changes in canal shape after using various rotary and reciprocating file systems. All CBCT images were assessed utilizing the On Demand software for CS 9000 3D, Care stream Dental CBCT system.

Canal transportation

The degree of transportation was calculated according to the formula given by Gambill *et al*. (1996): (A1–A2)–(B1–B2) where,

A1: is the shortest distance from the mesial edge of the root to the mesial edge of the uninstrumented canal.
A2: is the shortest distance from the mesial edge of the root to the mesial edge of the instrumented canal.
B1: is the shortest distance from the distal edge of the root to the distal edge of the uninstrumented canal.
B2: is the shortest distance from the distal edge of the root to the distal edge of the instrumented canal. (Figure 1)

Centering Ability

The centering ability ratio i.e the ability of the instrument to remain in a central position within the canal, was calculated for each cross-section using the ratio of

(A1–A2) / (B1–B2) or (B1–B2) / (A1–A2)

The formula was chosen in such a manner that the lowest of the results obtained through the difference should always be the numerator. A result of 1 (one) indicated perfect centralization capacity and the closer the result to zero the worse the ability of the instrument to keep itself in the canal central axis.

Statistical analysis

One-way analysis of variance (ANOVA) with Tukey's honestly significant difference (HSD) was applied to make inter-group comparison of canal transportation, canal centering ability.

RESULTS

Table 1 shows shows representative pre- and post instrumentation CBCT scans at selected levels 3mm, 6mm and 9mm from the apex. The mean and standard deviation values for canal transportation and the centering ratio after instrumentation are presented in [Table-2,3]. The Tukey's post hoc test revealed that there were no significant differences in the amount of transportation at 6mm and 9mm from the apex between all the three file systems. ($p> .05$). At 3 mm from the apex, OneShape file showed significantly higher mean canal transportation and lower centering ability (0.48±1.12 and 0.51±0.90), as compared to Protaper NT (-0.03±0.06 and 0.58±1.00) and Reciproc (0.01±0.12 and 1.24±1.14) while the differences between OS and Protaper NT were not statistically significant.

The direction of transportation at 3 mm from the the apex for both OneShape and Protaper NT showed transportation towards lateral aspect of the curvature while the samples in Reciproc group remained centered. At 6mm and 9mm levels the transportation was seen towards the furcation area.

Table 1 and Graph 1: Comparison of three sections (coronal, middle and apical) with respect to Canal transportation ability of three file systems (Protaper NT, Reciproc and OneShape) by one way ANOVA

Sections	Protaper Next file		Reciproc file		Oneshape file	
	Mean	SD	Mean	SD	Mean	SD
Coronal section (9mm)	0.11	0.09	0.06	0.08	0.12	0.17
Middle section (6mm)	-0.04	0.19	-0.02	0.15	0.08	0.23
Apical section (3mm)	-0.03	0.06	0.01	0.12	0.48	1.12
F-value	3.6919		1.3188		1.1167	
p-value	0.0383*		0.2841		0.3420	

*p<0.05

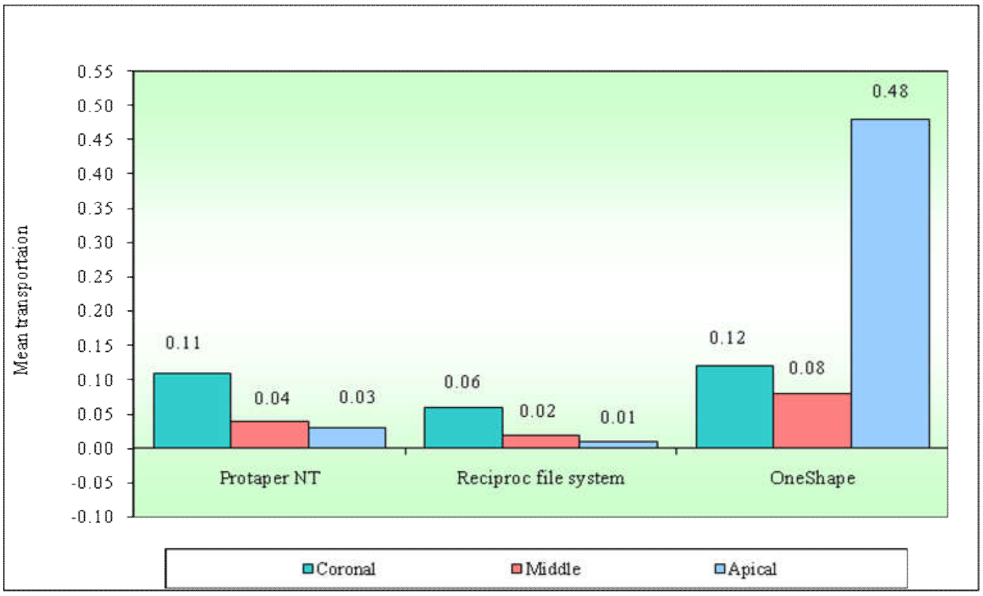
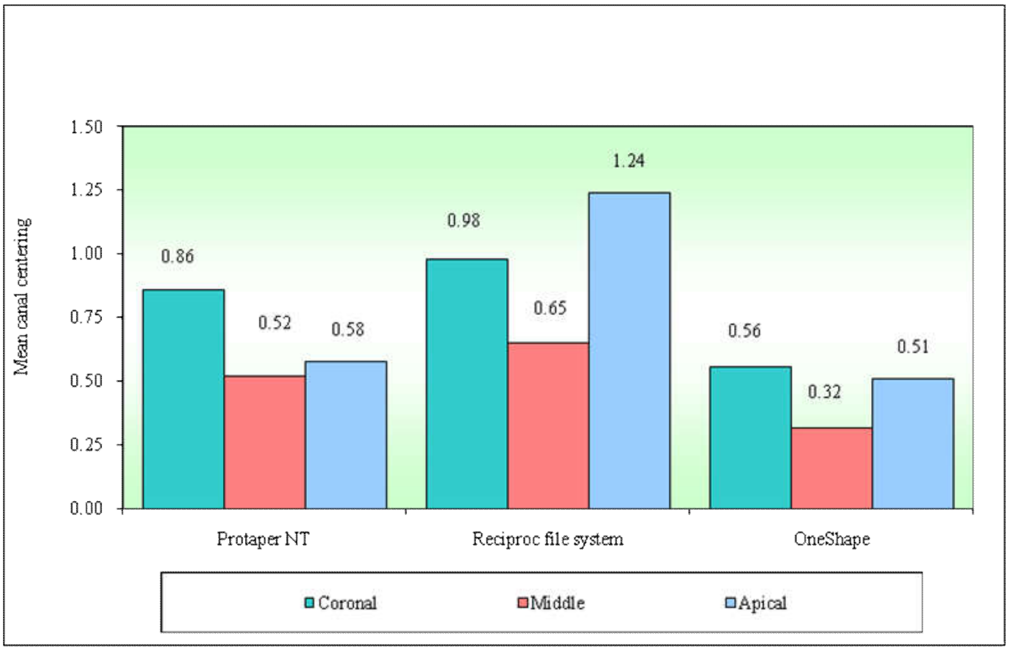


Table 2 and Graph 2: Comparison of three sections (coronal, middle and apical) with respect to Canal centering ability at three file systems (Protaper NT, Reciproc and Oneshape) by one way ANOVA

Sections	Protaper Next file		Reciproc file		OneShape file	
	Mean	SD	Mean	SD	Mean	SD
Coronal section (9mm)	0.86	0.56	0.98	1.01	0.56	0.35
Middle section (6mm)	0.52	1.22	0.65	0.85	0.32	0.65
Apical section (3mm)	0.58	1.00	1.24	1.14	0.51	0.90
F-value	0.3201		0.6857		4.4415	
p-value	0.7288		0.5123		0.0215*	

*p<0.05



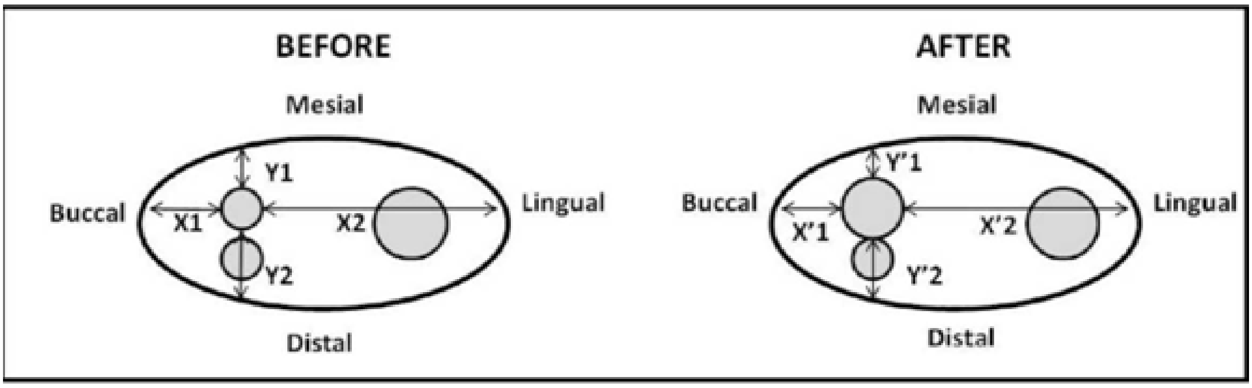


Figure 1. Schematic representations of measurements of image cross sections

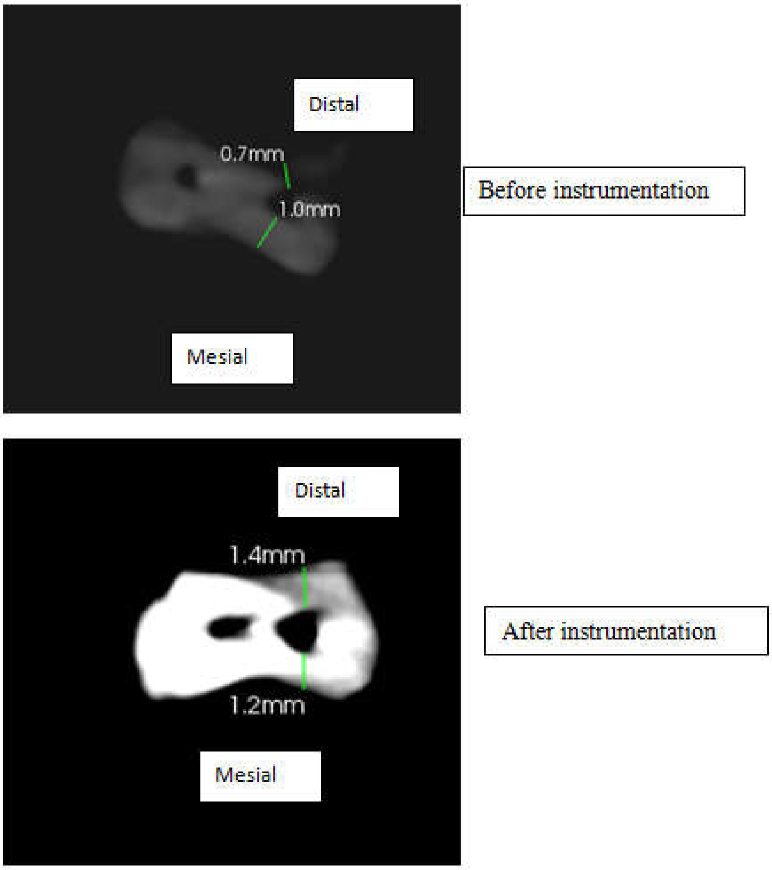


Figure 2. Representative image of tooth sections showing how transportation and centering ratios were derived

DISCUSSION

The main objective of instrumentation is to clean the canal, while maintaining the anatomy and morphology of the root canal. (Yamamura *et al*., 2012) The Reciproc system produced significantly least canal transportation followed by Protaper Next while OneShapeproduced significantly the most transportation. The results of the present study revealed that the use of Reciproc instruments resulted in signi cantly less canal straightening and signi cantly less apical transportation than the use of OneShape instruments. This can be attributed to several reasons: Reciproc instruments are made from M-wire alloy whereas OneShape is made from conventional martensitic NiTi. M-wire NiTi is characterized by superior exibility compared with conventional NiTi (Shen *et al*., 2006). Pereira *et al*. (2012) showed that M-Wire had physical and mechanical properties that can render root canal instruments more exible and fatigue resistant than those made from conventionally martensitic NiTi. (Plotino *et al*., 2012) The reciprocating movement relieves stress on the instrument and, therefore, reduces the risk of cyclic fatigue caused by tension and compression (De-Deus *et al*., 2010b, Varela-Patino *et al*., 2010). The reciprocation working motion consists of a counter-clockwise (cutting direction) and a clockwise motion (release of the instrument), while the angle of the counterclockwise cutting direction is greater than the angle of the reverse direction. Due to the fact that the counterclockwise angle is greater than the clock- wise one, it is claimed that the instrument continuously progresses towards the apex of the root canal. (Burklein *et al*., 2012) Whilst OneShape instruments have a variable 3- cutting-edge design at the tip region that progressively changes from 3 to 2 cutting edges in the middle part, whilst near the shaft, the instrument has 2 cutting edges (Burklein *et al*., 2013). This design used in continuous rotation at a relatively higher speed allows the instruments to rapidly progress into the curved root canals. This could create some stress that might have resulted in the observed canal straightening and apical transportation. Also the difference between OneShape and Reciproc may be attributed to the different working motions and the different rotational speeds. OneShape was used with a rotational speed of 400 rpm whilst Reciproc instruments operate at about 282–300 rpm with a 150-158-degrees counterclockwise rotation followed by a 30-34-degrees clockwise rotation (Kim *et al*. 2012; Fiedler 2014). Protaper Next was proven to be a better file system in cleaning and shaping the root canals. This might be due to Protaper Next's modified tip design awith progressive and regressive tapers and an offset rectangular cross-section that gives the file swagerring movement as it advances into the root canal. These instruments are manufactured from M-wire NiTi alloy that is claimed to improve file flexibility and resist cyclic fatigue while retaining cutting efficiency. (Plotino *et al*., 2012) Abou-Rass, Frank, Glick first described the danger zone of the mandibular molars and established its importance during cleaning and shaping procedures. Sinai observed that aggressive instrumentation in the cervical third of the root canal can lead to strip perforations and inflammatory complications. Less transportation towards this area can be considered a favourable feature for the Reciproc system. (Agarwal *et al*., 2015) Apical transportations that are more than 0.3 mm can jeopardize the outcome of treatment due to the significant decrease in the sealing ability of root filling material. (Wu *et al*., 2000)

Conclusion

Within the limitations of this study, all the three groups showed significant difference and it was found that Reciprocsingle-file reciprocation has better centering ability and less canal transportation than One Shape and ProTaper. All the tested file systems were safe to use. Reciproc and Protaper Next instruments respected the original canal curvature better than OneShape les. The use of OneShape instruments required less time to prepare the curved canals compared with Reciproc and Protaper Next files.

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