Original Article

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Dentistry Section

Evaluation of Single File Systems Reciproc, Oneshape, and WaveOne using Cone Beam Computed Tomography –An In Vitro Study

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ABSTRACT

Background: Successful endodontic therapy depends on many factor, one of the most important step in any root canal treatment is root canal preparation. In addition, respecting the original shape of the canal is of the same importance; otherwise, canal aberrations such as transportation will be created.

Aim: The purpose of this study is to compare and evaluate Reciprocating WaveOne ,Reciproc and Rotary Oneshape Single File Instrumentation System On Cervical Dentin Thickness, Cross Sectional Area and Canal Transportation on First Mandibular Molar Using Cone Beam Computed Tomography.

Materials and Methods: Sixty Mandibular First Molars extracted due to periodontal reason was collected from the Department of Oral and Maxillofacial. Teeth were prepared using one rotary and two reciprocating single file system. Teeth were divided into 3 groups 20 teeth in each group. Pre instrumentation and Post instrumentation scans was done and evaluated for three parameters Canal Transportation, Cervical Dentinal Thickness, Cross-sectional Area. Results were analysed statistically using ANOVA, Post-Hoc Tukey analysis.

Results: The change in cross-sectional area after filing showed significant difference at 0mm, 1mm, 2mm and 7mm ($p<0.001$, $p=0.006$, 0.004 & <0.001 respectively). There was significant difference between wave one and oneshape; oneshape and reciproc at 0mm, 1mm, 2mm & 7mm (p-values for waveone and Oneshape <0.001, 0.022, 0.011 & <0.001 resp. and for oneshape and reciproc < 0.001, $p= 0.011$, $p=0.008$ & <0.001). On assessing the transportation of the three file system over a distance of 7 mm (starting from 0mm and then evaluation at 1mm, 2mm, 3mm, 5mm and 7mm), the results showed a significant difference among the file systems at various lengths ($p= 0.014$, 0.046, 0.004, 0.028, 0.005 & 0.029 respectively). Mean value of cervical dentinal removal is maximum at all the levels for oneshape and minimum for waveone showing the better quality of waveone and reciproc over oneshape file system. Significant difference was found at 9mm, 11mm and 12mm between all the three file systems ($p<0.001$,< 0.001, <0.001).

Conclusion: It was concluded that reciprocating motion is better than rotary motion in all the three parameters Canal Transportation, Cross-sectional Area, Cervical Dentinal Thickness.

Keywords: Canal transportation, Cross-sectional area, Cervical dentinal thickness, File system

INTRODUCTION

Root canal therapy is one of the most widely accepted treatment modality for pulpally involved teeth. Successful endodontic therapy depends on many factors. One of the most important step in any root canal treatment is root canal preparation [1]. Root canal preparation is not only important but also demanding for the clinician. A uniform taper with increasing diameter from the end point to orifice is required to obtain desired clinical outcome [1]. In addition, respecting the original shape of the canal is of the same importance; otherwise, canal aberrations such as transportation will be created. However, severely curved canals or multiple curved root canals are challenging situations, especially with traditional hand instruments made of stainless steel [2].

Canal Transportation is defined as removal of canal wall structure on the outside curve in the apical half of the canal due to the tendency of files to restore themselves to their original linear shape during canal preparation; may lead to ledge formation and possible perforation [3]. Residual dentin thickness indicates the mechanical limits of instrumentation, to enlarge the diameter of the root canal, to approximately determined values that would not significantly weaken the dentin walls. The thickness of the dentinal wall at the root circumference is critical parameter, and there is a direct correlation between the root thickness and ability of the tooth to resist lateral forces and avoid fracture (Cross-sections of root canal at various levels are commonly used to directly view the shape and position of the root canal [4,5].

To meet this challenge, Nickel –titanium (NiTi) rotary technique have been developed to improve root canal preparation because of the unique properties of the alloy. These instruments are able to improve both the morphological characteristics and safety of canal shaping [6]. It was reported that they can maintain the original shape of the canal with minimal transportation [7].

Oneshape (Micro Mega, Besancon, France) files have emerged as a better alternative for curved canals. In contrast to some other single file system, the Oneshape file is used in continuous rotation. Oneshape instrument provides better cutting action around three zones of root canal due to different cross sections along the length of the file.Also, its high cutting efficiency due to electro polishing and flexibility results in superior apical progression. This further minimizes the risk of minimal instrument fatigue which eliminates the risk of instrument breakage [8,9].

Another concept introduced for the same is the use of balanced force technique which includes the use of clockwise and anticlockwise movements in the preparation of the root canals. It was introduced in 1985 [10]. This technique allows maintenance of the original canal shape in curved root canals during the preparation [11]. Two different reciprocating systems that have been introduced based on this concept are: Reciproc (VDW, Munich, Germany) and WaveOne (DentsplyMaillefer, Ballaigues, Switzerland).It has been proposed that these instrument designs can complete shaping the root canal with single file instrumentation. Thus, only one instrument is required to prepare a root canal which will prove highly beneficial both for the clinician and for the patient.

However, very limited literature exists to evaluate the efficacy of these two new reciprocating systems. Cone beam computed tomography, can be used for measurements before and after instrumentation of the root canals and for determining the amount of dentin removed during cleaning and shaping of root canals. It permits nondestructive and metrically exact analyses of variable such as volume, surface area, cross-sectional shape, and taper.

Hence, the present cross-sectional study was conducted with an aim to compare and evaluate Reciprocating and Rotary Single File Instrumentation System on Cervical Dentin Thickness, Cross Sectional Area and Canal Transportation on First Mandibular Molar Using Cone Beam Computed Tomography.

MATERIALS AND METHODS

Sample collection

Sixty Mandibular First Molars extracted due to periodontal reason were collected from the Department of Oral and Maxillofacial Surgery. Inclusion criteria stipulated that the teeth had curved roots with two distinct, separate canals and portal of exit. Tissue fragments and calcified debris were removed from the teeth by scaling, and the teeth were stored in 10% formalin solution. Standard access cavities were made using Access cavity Kit (DentsplyMaillefer, Ballaigues, Switzerland) for all the teeth, and distal roots of all teeth were separated.

Sample preparation

All root canals were negotiated by a no.10 hand-held NiTi File. Periapical radiography was performed for each tooth to measure curvature of the mesiobuccal root canal according to Schneider technique. The Working Length of the canal was determined by observing the tip of the file protruding through the apical foramen and subtracting 1mm from the recording length. Glyde Path was created using Pathfiles (DentsplyMaillefer, Ballaigues, Switzerland) no 13, 16, 19 upto working Length using Glyde as a lubricating agent. Copious Irrigation was done throughout the procedure. Teeth were embedded in acrylic blocks, six teeth were placed in one block and Pre-instrumentation CBCT Scan was taken at 90µm High Dental Mode Resolution. The setting for the CBCT scanner was 84 kVp and 5 mA

Teeth were prepared using one rotary and two reciprocating single file system. Teeth were divided into three groups 20 teeth in each group.

Group 1 WaveOne (DentsplyMaillefer, Ballaigues, Switzerland)

Group 2 Oneshape (Micro-Mega, Besanc, on, France)

Group 3 Reciproc (VDW Gmbh, Munich, Germany)

Preparation of the sample with Group 1 - Group of 20 samples were prepared with WaveOne. (DentsplyMaillefer, Ballaigues, Switzerland) primary ISO 25 tip with 8% taper. Firstly Sx file was (DentsplyMaillefer, Ballaigues, Switzerland) used to enlarge the canal orifices. Through the entire sequence of operation, recapitulation using ISO #10K file and irrigation with 2.5% sodium hypochlorite was done after every instrument. Glyde (Dentsply, Maillefer) was used as a lubricant during instrumentation. The new WaveOne single-file reciprocating system is designed to reach complete shaping with only 1 instrument used to the full working length.

Preparation of sample with Group 2 - Group of 20 samples were prepared with Oneshape ISO 25 tip and 8% taper file. Canals were prepared using crown down technique according to manufacturer's recommendations. Firstly SX (Dentsply Maillefer, Ballaigues, Switzerland) used to enlarge the canal orifices.During root canal preparation; frequent recapitulation was done using ISO #10K file and irrigation with 2.5% sodium hypochlorite was done after every instrument. For lubrication; Glyde (Dentsply, Maillefer) was used.

Complete canal shaping was done with only one single file in continuous rotation. The instrument presents a variable cross-section along the blade. Oneshape instrument works on principle of three different cross–section zoneswhere the first zone has a variable 3-cutting edge design , second zone has a cross –section that subsequently changes from 3 to 2 cutting edges and the last zone has 2 cutting edges. This provides high cutting action in 3 zones of canal.

Preparation of sample with Group 3- Third group of 20 samples were prepared with Reciproc 25 specifically designed for curved and narrow canals. Canals were prepared using crown down technique according to manufacturer's recommendations. Firstly SX (DentsplyMaillefer, Ballaigues, Switzerland) used to enlarge the canal orifices. Recapitulation was done with ISO #10K file followed by irrigation with 2.5% sodium hypochlorite after every instrument. Glyde (DentsplyMaillefer) was used as a lubricant. Reciproc instrument provides clockwise and counterclockwise rotation. As, the rotation in the cutting direction is larger than reverse direction; it results in movement towards apex. Regressive taper, make the instruments slimmer at the end of the working part than most conical NiTi instruments of comparable ISO size, preventing unnecessary loss of tooth substance in the coronal part.

Parameters analysed were: Canal Transportation, Cross Sectional Area, Cervical Dentinal thickness;analysed by CS 3D Image analyses software. Images were superimposed by On Demand software at 90µ High Dental mode Resolution.

Calculation of the parameters:

Cross-sectional area: It was calculated using the CS3D software. The pre (R) and the postoperative radius(r) were calculated from the axial sections at the point of maximum curvature. The change in Cross-sectional area was calculated at all the intervals using the formula:

Change in cross-sectional area = $\pi (R_2\text{-}r_2)$

Measurement of canal transportation- The Pre- and post-instrumentation scans were superimposed using the On Demand software. Shortest distance from the edge of the uninstrumented canal to the edge of the tooth in both mesial (A1) and distal (B1) directions were measured and then compared with values measured from prepared canals (A2 and B2) The following formula was used for the calculation of transportation:(A1-A2)-(B1-B2).

Calculation of Cervical Dentinal thickness

- Amount of dentine removed – was expressed as the difference between the pre-operative and post-instrumentation area.

STATISTICAL ANALYSIS

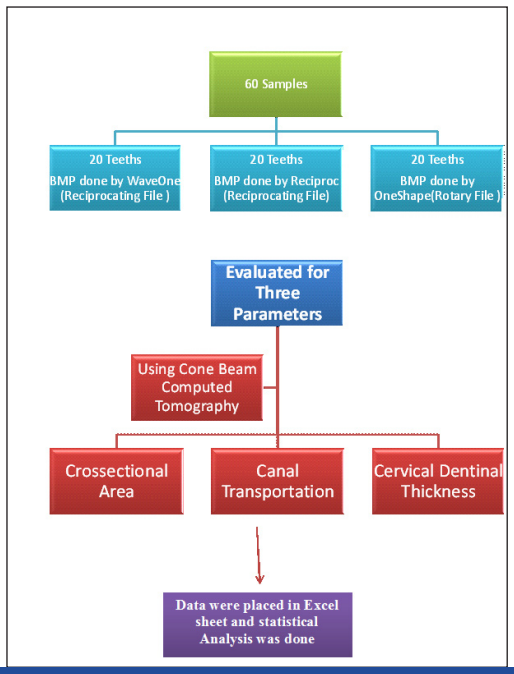
Data was entered into excel sheet and was analysed using SPSS 19.0 (SPSS Inc., Chicago, IL, USA). The Level of significance was set at $p<0.05$. The values were represented in Number (n), Percentage (%), Mean (X) and Standard Deviation (σ). The statistical tests used were one-way ANOVA (Analysis of Variance) test, Chi-square test and Tukeys post-hoc test.

RESULTS

The present study evaluated the working efficacy of three file system: wave one, reciproc and oneshape. For the three file system a total of 60 specimens were evaluated; 20 specimens per system [Table/Fig-1]. Descriptive Statistics for cross-sectional area of three single file system is shown in [Table/Fig-2].

Cross-sectional Area

The change in cross-sectional area after filing showed significant difference at 0mm, 1mm, 2mm and 7mm ($p<0.001$, $p=0.006$, $p=0.004$ & <0.001 respectively) whereas the difference was found to be non-significant at 3mm & 5mm ($p=0.306$ &0.478 respectively) [Table/Fig-3]. There is significant difference between wave one and oneshape; oneshape and reciproc at 0mm, 1mm, 2mm & 7mm (p-values for waveone and oneshape $p< 0.001$,$p= 0.022$,



[Table/Fig-1]: Methodology

p=0.011 & p<0.001 resp. and for oneshape and reciproc p< 0.001, p=0.011,p= 0.008 & p< 0.001 resp.) but non-significant difference between wave one and reciproc at the same levels (p= 0.973, 0.960, 0.994 & 0.996 respectively). At 3mm & 5 mm there is no statistically significant difference between all the three file systems. There is no statistical significant difference between wave one and reciproc, although wave one is marginally better than reciproc [Table/Fig-4].

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
0mm	Waveone	20	0.571	0.4788	0.1071	0.347	0.795
	Oneshape	20	3.321	2.0841	0.4660	2.345	4.296
	Reciproc	20	0.666	0.9651	0.2158	0.215	1.118
	Total	60	1.519	1.8503	0.2389	1.041	1.997
1mm	Waveone	20	1.4660	0.80436	0.17986	1.0895	1.8425
	Oneshape	20	2.5680	1.90552	0.42609	1.6762	3.4598
	Reciproc	20	1.3560	0.76032	0.17001	1.0002	1.7118
	Total	60	1.7967	1.36689	0.17647	1.4436	2.1498
2mm	Waveone	20	3.0150	1.70533	0.38132	2.2169	3.8131
	Oneshape	20	4.7200	2.09694	0.46889	3.7386	5.7014
	Reciproc	20	2.9550	1.53032	0.34219	2.2388	3.6712
	Total	60	3.5633	1.94618	0.25125	3.0606	4.0661
3mm	Waveone	20	5.355	3.5586	0.7957	3.690	7.020
	Oneshape	20	6.926	3.5253	0.7883	5.276	8.575
	Reciproc	20	5.597	3.2174	0.7194	4.091	7.102
	Total	60	5.959	3.4495	0.4453	5.068	6.850
5mm	Waveone	20	5.6370	3.89854	0.87174	3.8124	7.4616
	Oneshape	20	6.7990	3.44164	0.76957	5.1883	8.4097
	Reciproc	20	5.5965	3.21739	0.71943	4.0907	7.1023
	Total	60	6.0108	3.51549	0.45385	5.1027	6.9190
7mm	Waveone	20	1.5160	0.53819	0.12034	1.2641	1.7679
	Oneshape	20	3.5250	2.32312	0.51947	2.4377	4.6123
	Reciproc	20	1.4760	0.55102	0.12321	1.2181	1.7339
	Total	60	2.1723	1.69105	0.21831	1.7355	2.6092

[Table/Fig-2]: Descriptive Statistics for cross-sectional area of three single file system WaveOne, Oneshape, Reciproc

ANOVA						
		Sum of Squares	Df	Mean Square	F	Sig.
0 mm	Between Groups	97.417	2	48.709	26.549	<0.001
1 mm	Between Groups	17.970	2	8.985	5.551	0.006
2 mm	Between Groups	40.172	2	20.086	6.246	0.004
3 mm	Between Groups	28.607	2	14.303	1.211	0.306
5 mm	Between Groups	18.653	2	9.326	0.748	0.478
7 mm	Between Groups	54.907	2	27.454	13.749	<0.001

[Table/Fig-3]: Comparison of Cross-sectional area among three single file system WaveOne, Oneshape and Reciproc
*ANOVA test applied

Multiple Comparisons					
Tukey HSD					
Dependent Variable	Group	Group	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
0mm	WO	OS	<0.001	-3.780	-1.719
		R	0.973	-1.126	0.935
	OS	R	<0.001	1.623	3.685
1mm	WO	OS	0.022	-2.0702	-.1338
		R	0.960	-.8582	1.0782
	OS	R	0.011	0.2438	2.1802
2mm	WO	OS	0.011	-3.0696	-.3404
		R	0.994	-1.3046	1.4246
	OS	R	0.008	0.4004	3.1296
3mm	WO	OS	0.325	-4.186	1.045
		R	0.973	-2.857	2.374
	OS	R	0.445	-1.287	3.945
5mm	WO	OS	0.554	-3.8487	1.5247
		R	0.999	-2.6462	2.7272
	OS	R	0.532	-1.4842	3.8892
7mm	WO	OS	<0.001	-3.0843	-.9337
		R	0.996	-1.0353	1.1153
	OS	R	<0.001	0.9737	3.1243

[Table/Fig-4]: Tukeys Post Hoc analysis for cross-sectional area of three single file system WaveOne, Oneshape, Reciproc

Canal Transportation

On assessing the transportation of the three file system over a distance of 7 mm (starting from 0mm and then evaluation at 1mm, 2mm, 3mm, 5mm and 7mm), the results showed a significant difference among the file systems at various lengths (p= 0.014, 0.046, 0.004, 0.028, 0.005 & 0.029 respectively). The frequency of 0 was found to be maximum at all the levels [Table/Fig-5]. While the values of wave one were more constant and showed little variation, on the contrast both reciproc and oneshape showed a steep variation between 2mm to 7mm.

Cervical Dentinal Thickness

[Table/Fig-6] shows Descriptive Statistics of Cervical Dentin Thickness in all the three file systems. Mean value of cervical dentinal removal is maximum at all the levels for oneshape and minimum for waveone showing the better quality of waveone and reciproc over oneshape file system. Significant difference was found at 9mm, 11mm and 12mm between all the three file systems (p<0.001, p<0.001,p< 0.001). Significant difference was seen between waveone – oneshape and reciproc – oneshape file systems at all the three levels. (p<0.001,< 0.001,< 0.001) but non-significant results was seen between waveone and reciproc file systems at

INTERVALS	WAVEONE	ONESHAPE	RECIPROC	p-value
0 mm				
-1.50	0(0%)	1(5%)	1(5%)	
-1.00	0(0%)	5(25%)	1(5%)	
-0.50	0(0%)	3(15%)	3(15%)	
0.00	20(100%)	7(35%)	13(65%)	0.014
1.00	0(0%)	3(15%)	2(10%)	
1.30	0(0%)	1(5%)	0(0%)	
Total	20(100%)	20(100%)	20(100%)	
1 mm				
-2.00	0(0%)	1(5%)	1(5%)	
-1.50	1(5%)	6(30%)	3(15%)	
-1.25	0(0%)	0(0%)	1(5%)	
-1.00	0(0%)	2(10%)	2(10%)	
-.10	2(10%)	0(0%)	0(0%)	0.046
.00	17(85%)	7(35%)	12(60%)	
1.00	0(0%)	3(15%)	0(0%)	
2.00	0(0%)	1(5%)	1(5%)	
Total	20(100%)	20(100%)	20(100%)	
2 mm				
-1.50	1(5%)	0(0%)	0(0%)	
-1.30	0(0%)	1(5%)	0(0%)	
-1.10	0(0%)	1(5%)	0(0%)	
-1.00	0(0%)	11(55%)	8(40%)	0.004
-.10	2(10%)	0(0%)	0(0%)	
.00	17(85%)	5(25%)	11(55%)	
1.00	0(0%)	2(10%)	1(5%)	
Total	20(100%)	20(100%)	20(100%)	
3 mm				
-1.00	0(0%)	1(5%)	0(0%)	
0.00	17(85%)	13(65%)	16(80%)	0.028
0.10	3(15%)	0(0%)	0(0%)	
1.00	0(0%)	6(30%)	4(20%)	
Total	20(100%)	20(100%)	20(100%)	
5 mm				
-1.40	0(0%)	1(5%)	0(0%)	
-1.20	0(0%)	1(5%)	0(0%)	
-1.00	0(0%)	4(20%)	0(0%)	
-.50	0(0%)	1(5%)	0(0%)	
-.20	0(0%)	1(5%)	0(0%)	0.005
.00	19(95%)	6(30%)	14(70%)	
.10	1(5%)	0(0%)	0(0%)	
1.00	0(0%)	6(30%)	4(20%)	
1.50	0(0%)	0(0%)	2(10%)	
Total	20(100%)	20(100%)	20(100%)	
9 mm				
-1.00	0(0%)	1(5%)	0(0%)	
.00	19(95%)	9(45%)	14(70%)	
.10	1(5%)	0(0%)	0(0%)	0.029
.50	0(0%)	2(10%)	1(5%)	
1.00	0(0%)	8(40%)	5(25%)	
Total	20(100%)	20(100%)	20(100%)	

[Table/Fig-5]: Chi-square test for canal transportation of three single file systems WaveOne oneshape, reciproc

Cervical area		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
9 mm	WO	20	0.7480	0.16888	0.03776	0.6690	0.8270
	R	20	0.7925	0.14264	0.03190	0.7257	0.8593
	O	20	1.2975	0.14889	0.03329	1.2278	1.3672
	Total	60	0.9460	0.29332	0.03787	0.8702	1.0218
11 mm	WO	20	0.7930	0.19410	0.04340	0.7022	0.8838
	R	20	0.8625	0.11872	0.02655	0.8069	0.9181
	O	20	1.3910	0.08735	0.01953	1.3501	1.4319
	Total	60	1.0155	0.30272	0.03908	0.9373	1.0937
12 mm	WO	20	0.7115	0.16365	0.03659	0.6349	0.7881
	R	20	0.7895	0.10797	0.02414	0.7390	0.8400
	O	20	1.3455	0.13851	0.03097	1.2807	1.4103
	Total	60	0.9488	0.31558	0.04074	0.8673	1.0304

[Table/Fig-6]: Descriptive statistics of cervical dentin thickness in all the three file systems WaveOne, oneshape, reciproc
*WO=Waveone, R=reciproc, O=oneshape

all the levels (p-values- 9mm=0.633, 11mm=0.270, 12mm= 0.186) [Table/Fig-7,8].

DISCUSSION

Preparation of the root canal determines the success of all subsequent steps. Adequate instrumentation(shaping) combined with effective irrigation is required to achieve sufficient disinfection and for achieving the biological and mechanical objectives of the root canal treatment [12-14].

Cervical region		Sum of Squares	Df	Sig.
9 mm	Between Groups	3.726	2	<0.001
11 mm	Between Groups	4.278	2	<0.001
12 mm	Between Groups	4.781	2	<0.001

[Table/Fig-7]: ANOVA test applied at different intervals of cervical length among three various file system WaveOne, Oneshape, Reciproc

Cervical area		Std. Deviation	Std. Error	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
9 mm	WO R	0.633	0.1616	-.1616	0.0726
	WO O	<0.001		-.6666	-.4324
	R O	<0.001		-.6221	-.3879
11 mm	WO R	0.270	0.1766	-.1766	0.0376
	WO O	<0.001		-.7051	-.4909
	R O	<0.001		-.6356	-.4214
12 mm	WO R	0.186	0.1835	-.1835	0.0275
	WO O	<0.001		-.7395	-.5285
	R O	<0.001		-.6615	-.4505

[Table/Fig-8]: Tukeys post hoc analysis applied for comparison of different single file systems WaveOne, Oneshape, Reciproc at different cervical length intervals

NiTi based instruments and files are used very frequently nowadays. These instruments offer many advantages; they are flexible and have increased cutting efficiency. Furthermore, these instruments maintain the original canal shape during preparation and have a reduced tendency to transport the apical foramen. However, as these techniques also require the use of instruments to enlarge the canal to an adequate size and taper, they are relatively time consuming [14]. Oneshape instrument is made up of NiTi alloy and has a tip size of 25mm with constant taper of 0.06mm such that it has different cross sectional designover its entire working length and variable pitch length .This asymmetrical design is alleged to eliminate threading and binding of the instrument in continuous rotation [15]. To overcome the failures of NiTi rotary files; three main changes which have been included are use of improved alloys, different movements used and new concepts of use [16,17].

Wave One hence introduces a single file shaping system which can be used in any canal irrespective of its length, diameter or curvature. This utilizes unequal CW/CCW angles which are more than 4 times safer and 3 times faster [18]. Further, the instrument has reverse helix and 2 distinct cross- sections on the length with modified convex triangular cross section [19]. Reciproc is another single reciprocating file available in different size.These files have a continuous taper over the first 3mm of their working part followed by a decreasing taper until the shaft with S-shaped cross-section [20].

This study is the first attempt to compare the Cross-sectional area among three single file system [Table/Fig-2,3].The study findings showed a significant difference between wave one and oneshape; oneshape and Reciproc at 0mm, 1mm, 2mm & 7mm. Wave one was marginally better than Reciproc [Table/Fig-4]. This highlights that reciprocating motion (waveone and reciproc) is better than rotary motion (oneshape).

On assessing the canal transportation of the three file system [Table/Fig-5]; WaveOne single-file showed significant constant value as compared to the other two. Reciprocation had a very good centering ability when shaping simulated canals regardless of the level of operator experience and canal anatomy. Besides,

the overall shaping time was fast, and there was a reduced risk of aberrations, blockages, and fractures. Similar findings have been reported by Goldberg M et al., and Dhingra A et al., [21,22]. Single-file reciprocation creates a cutting action that is much greater than disengagement, thereby allowing better apical progression and higher efficiency [21]. Investigation showed that the application of reciprocating motion during instrumentation did not result in increased apical transportation when compared with continuous rotation motion [23].

[Table/Fig-6-8] showed the comparison of cervical dentin thickness for the three file system. It was also found that the Oneshape presented more effective wears in the cervical third, when compared to reciproc. Ruddle CJ and Webber J et al., reported the similar findings in their study [24,25]. This might be attributed to the torsional and flexural stresses which are reduced due to reciprocating movement which increases the canal centering ability and reduces the taper lock within the root canal [25]

It was found in the present study that the rotary system presented more effective wears in the danger zone when compared to reciprocating systems [24]."Danger zone" basically concerns with distal area of mesial root in mandibular molars which becomes a preferable site for strip perforation during instrumentation. On the other hand; Safety zone is the mesial area of the root, with a thicker layer of dentin which usually remains safe by the endodontic instruments.

LIMITATIONS

The small sample size posed a major limitation for the study. Within the limitation of this it was found that Reciprocating motion is better than Rotary motion and WaveOne file system showed better results than Reciproc although the results are not statistically significant in term of Crossectional Area, Canal Transportation and Cervical Dentinal thickness. Oneshape showed Inferior result among the all the three single file system.

CONCLUSION

Within the limitations of the study ,it was concluded that statistically significant difference between Oneshape, WaveOne and Reciproc at all levels except at 3 & 5 mm and there is no statistically significant difference between Wave One and Reciproc at all the levels were found for the change in cross sectional area. Cervical dentinal removal is maximum at all the levels for oneshape and minimum for WaveOne showing the better quality of preparation by WaveOne and Reciproc over Oneshape file system WaveOne and Reciproc showed less canal transportation in comparison to the Oneshape at all the level. Thus, WaveOne and Reciproc are the direct full sequence counterparts of the single reciprocating systems. Curved canals can be instrumented with only minor canal straightening by only one instrument used in a reciprocating motion. Therefore, Single Reciprocating files WaveOne and Reciproc are suitable instruments for the root canal preparation.

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