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To compare the shaping ability and cleaning efficacy of new reciprocating single file systems wave one and reciproc with a rotary single file system one shape in severely curved root canals: an in-vitro study

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Abstract

The main objective of endodontic treatment is to eliminate or minimize microorganisms in the root canal system while maintaining the original shape and path of the root canal. Many root canals have curvatures, and endodontic instrumentation has a key role in proper shaping and cleaning of these canals. Herein a comparative study was done using 36 samples for the purpose of study, 12 samples (33.3%) each were prepared using One shape files, Reciproc file and Wave One file systems respectively. The results were preoperatively canal angulations ranged from 23 to 38^{o} with a mean value of 30.81±4.23^{o}. Post-operative canal curvature change ranged from 0 to 6^{o} in different groups with a mean value of 2.83±1.59^{o}. It was observed that the time taken to achieve the final canal shape was much shorter in WaveOne file system (74.17±16.90 sec) as compared to Reciproc (87.08±19.24 sec) and OneShape (123.75±47.54 sec) file systems. In present study, we did not observe a significant difference in smear layer scores for different groups.

Introduction

Root canal shaping is a key stage of endodontic treatment; when performed properly, it is a predictive factor for success.[1] many instruments and instrumentation techniques have been recommended but only few seem to be capable of consistently achieving the primary objectives of root canal preparation. It has become evident that rotary nickel–titanium instruments are able to maintain the canal shape even in severely curved canals and more over the preparation with these instruments is substantially faster than hand preparation.[2,3,4] Thus, the introduction of rotary nickel titanium (NiTi) instrumentation was a breakthrough in optimal root canal shaping.

The Reciproc and Wave One system claim to be able to completely prepare and clean the root canal with only one instrument. These files are used in a reciprocal motion that

relieves stress on the instrument and, reduces the risk of cyclic fatigue caused by tension and compression.[5,6] Nickel-Titanium (NiTi) endodontic rotary files revolutionized root canal instrumentation, allowing for less straightening and better centered preparations even in curved canals when compared to earlier stainless steel (SS) files.[7,8,9] Despite all the advantages, NiTi instruments appear to have a high risk of separation.[10,11] A new concept of single-file instrumentation is that a single instrument is to be used in a full clockwise rotation. The OneShape system consists of only one instrument made of a conventional austenite 55-NiTi alloy.

It is characterized by different cross-sectional designs over the entire length of the working part. In the tip region, the cross section represents three cutting edges while in the middle of the cross-sectional design progressively changes from a three cutting- edge design to two cutting edges. Being introduced only recently, there are limited comparative studies on different reciprocating instruments and conventional rotary instruments. The present study is an attempt in that direction.

Material and Method

36 extracted permanent molar teeth with fully formed apices and with at least one curved root and root canal were selected (first and second maxillary molar buccal canals and first and second lower mandibular mesial canal).

A conventional access cavity was prepared in each tooth with an endo access bur at high speed to allow direct access to all the root canals. Occlusal surface was flattened so that a standardized reference point can be maintained. Patency of each canal was determined with a 10 size k-file. Working length was determined 0.5 mm short of the radiographic apex as verified by radiograph.

Apical gauging to determine file selection was done according to manufacturer's instruction with file size 15 and/ or 20. Radiographs were taken. Teeth were attached to Kodak ultra speed film with soft wax and were aligned so that the long axis of the root was parallel and as close as possible to the surface of the x-ray film. Radiographs of each root canal was taken in a bucco lingual direction and the long axis of the root was perpendicular to the central x-ray beam. Exposure time was same for all radiographs with a constant distance of about 40 cms between the film and the x-ray source.

The film was developed, fixed, washed and dried. After that the radiographs was scanned with a computer scanner and the degree of curvature was measured by Schneider's method. Only teeth whose angle of curvature according to Schneider's method was more than 25 degree was selected. Teeth were randomly divided into 3 groups of 12 teeth each: Group A – One Shape Files, Group B – Reciproc Files and Group C – Wave one Files.

The instrumentation sequence for each rotary instrument was used according to the manufacturer's instruction at the recommended speeds using a gear reduction hand piece. Copious irrigation was done between each instrument using a 3ml of 2.5% NaOCl solution via a 27 – guage side venting needle. The needle was inserted as deep as possible into the root canal without binding. A small amount of glyde was coated on the flute of every Ni-Ti file and instrumentation was completed throughout the entire root canal length. The root canals were kept flooded with the irrigation solution throughout the entire instrumentation procedure.

All root canal preparation was completed by one operator whilst the SEM evaluations and the assessment of canal curvatures prior to and after instrumentation were carried out by a second examiner who was unaware with respect to experimental groups and who underwent training process with reference to the scoring system of SEM evaluations. The statistical analysis was done using SPSS

(Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The values were represented in Number (%) and Mean±SD.

Results

36 samples were used for the purpose of study, 12 samples (33.3%) each were prepared using One shape files, Reciproc file and Wave One file systems respectively. In different groups mean values ranged from 30.17±4.84^o (Group I) to 31.75±3.47^o (Group III). In Group II the mean value was 30.50±4.46^o (Table 1).

Table 1: Distribution of samples in different groups

SN	Group	Method	No. of samples	Percentage
1.	I	One shape files	12	33.3
2.	II	Reciproc File	12	33.3
3.	III	Wave One File	12	33.3

Mean change in curvature of the canal ranged from 0 to 6^o. In Group I, mean shaping was 2.25±1.71^o, in Group II it was 3.25±1.48^o and in Group III it was 3.00±1.54^o. In Control group, mean shaping was 0.92±0.90^o (Table 2,3).

Table 2: Distribution of samples according to pre-preparation angulation of the canals in different groups

SN	Group	No. of samples	Mean	SD	Min	Max
1	I	12	30.17	4.84	23	38
2	II	12	30.50	4.46	24	38
3	III	12	31.75	3.47	27	38
4	Total	36	30.81	4.23	23	38

Table 3: Distribution of samples according to post-preparation angulation of the canals in different groups

SN	Group	No. of samples	Mean	SD	Min	Max
1	I	12	2.25	1.71	0	6
2	II	12	3.25	1.48	0	5
3	III	12	3.00	1.54	0	5
	Total	36	2.83	1.59	0	6

Mean time taken ranged from 50 to 240 sec. In Group I, mean time taken was 123.75±47.54 sec, in Group II it was 87.08±19.24 sec and in Group III it was 74.17±16.90 sec (Table 4).

Table 4: Distribution of samples according to time taken for procedure in the canals in different groups

SN	Group	No. of samples	Mean	SD	Min	Max
1	I	12	123.75	47.54	65	240
2	II	12	87.08	19.24	50	120
3	III	12	74.17	16.90	50	110
	Total	36	95.00	37.01	50	240

Mean change in canal angulation ranged from 19 to 36^o. In Group I, mean change was 27.92±5.60^o, in Group II it was 27.25±4.49^o and in Group III it was 28.75±3.72^o (Table 5)

Table 5: Comparison of Change in Canal Shape in different groups

SN	Group	No. of samples	Mean	SD	Min	Max
1	I	12	27.92	5.60	20	36
2	II	12	27.25	4.49	19	34
3	III	12	28.75	3.72	23	35
	Total	36	27.97	4.58	19	36

Smear Layer score of canals ranged from 0 to 3., where 0; no smear layer/all tubules clean and open, 1; slight superficial smear layer/tubule openings visible, but some contain debris plug or soft tissue remnants, 2; moderate smear layer/some tubules open and others closed, 3; heavy smear layer and most/all tubule opening obscured. In Group I, mean score was 1.92±0.79, in Group II it was 1.75±0.75 and in Group III it was 2.00±0.95 (Table 6).

Table 6: Distribution of samples according to post-preparation Smear Layer at Coronal end of the canals in different groups

SN	Group	No. of samples	Mean	SD	Min	Max
1	I	12	1.92	0.79	1	3
2	II	12	1.75	0.75	1	3
3	III	12	2.00	0.95	0	3

Smear Layer score of canals ranged from 0 to 3. In Group I, mean score was 2.33±0.65, in Group II it was 1.92±0.90 and in Group III it was 2.00±0.60 (Table 7).

Table 7: Distribution of samples according to post-preparation Smear Layer at Middle level of the canals in different groups

SN	Group	No. of samples	Mean	SD	Min	Max
1	I	12	2.33	0.65	1	3
2	II	12	1.92	0.90	0	3
3	III	12	2.00	0.60	1	3

Smear Layer score of canals ranged from 0 to 3. In Group I, mean score was 2.50±0.67, in Group II it was 2.50±0.52 and in Group III it was 2.17±0.94 (Table 8).

Table 8: Distribution of samples according to post-preparation Smear Layer at Apical level of the canals in different groups

SN	Group	No. of samples	Mean	SD	Min	Max
1	I	12	2.50	0.67	1	3
2	II	12	2.50	0.52	2	3
3	III	12	2.17	0.94	0	3

Discussion

Curvature is a frequent occurrence in human dentition and when curvature is present, endodontic preparations become difficult.[12] From a biological perspective, the goals of chemo mechanical preparation are to eliminate microorganisms from the root canal system, to remove pulp tissue that may support microbial growth. Mechanical instrumentation is one of the important contributors to bacterial reduction in the infected root canal. The canal shaping should be performed with respect to the unique anatomy of each root and in relation to the technique of root canal filling.[13,14]

In present study, we used three file systems – One Shape files (MICROMEGA Besancon, France), Reciproc file (VDW, Munich, Germany) and Wave One file (DENTSPLY, Maillefer, Ballaigues, Switzerland).

If instrumentation were 100% effective in removing all bacteria and debris from the canal, irrigation would be an insignificant adjunct to mechanical debridement.[15] Irrigating solutions have been used during and after instrumentation to increase cutting efficiency of root canal instruments and to flush away debris. Sodium hypochlorite (NaOCl) was used in our study and also it is the most favoured endodontic irrigant in modern practice.

Preoperatively canal angulations ranged from 23 to 38^o with a mean value of 30.81±4.23^o. The definition of severely curved root canals has been provided variedly in different studies. Nagy et al. in their study determined the canal curvature severity on the basis of shape.[16] Although some of our samples did not meet the criteria of severe curvature as envisaged by Schneider et al. who classified the root canals with a curvature more than 25 degrees as the severely curved root canals however, one of the flaws in Schneider's classification is that they do not place canals with curvature 20-25 degrees into any class.[17] Owing to this discrepancy in their classification we preferred to include canals with curvature more than 20 degrees into the severely curved canals. Some workers have checked the root canal shaping ability for canals as to reach the angulation of 99 degrees.[18]

Mean pre-operative canal curvatures were found to range from 30.17±4.84 to 31.75±3.47. Using a criteria similar to that used by us, Schafer et al. also observed the mean value of canal curvature in their different study groups to range from 30.15±3.54 to 30.21±3.33^o.[19]

In present study, post-operative canal curvature change ranged from 0 to 6^o in different groups with a mean value of 2.83±1.59^o. In different groups mean values ranged from 2.25±1.71^o to 3.25±1.48^o. The level of straightening obtained in present study is similar to that reported by Burklein et al. who also reported achieving a canal curvature ranging from 2.00±1.91^o to 3.15±2.49^o.[20]

Contrary to findings of present study, use of One Shape resulted in significantly greater canal straightening than Wave One and Reciproc ($P < 0.05$).[21] In present study,

though post-procedure canal angulation was minimum in One Shape group yet its difference from the other groups was not significant statistically, moreover, the extent of change in canal angulation was maximum in Wave One group and minimum in Reciproc group.[22]

We found that although canal shaping ability of different file systems was similar but time taken to achieve this similar ability was different. It was observed that the time taken to achieve the final canal shape was much shorter in Wave One file system (74.17±16.90 sec) as compared to Reciproc (87.08±19.24 sec) and One Shape (123.75±47.54 sec) file systems. In a previous study Bürklein et al. have also shown the time take to achieve similar level of canal shape was significantly different when continuous motion rotary files were compared with reciprocating motion files.[20] However, contrary to our study, in their study, time taken for preparation of canals using Reciproc system (73.1±12.2 sec) was lower than that for Wave One (82.3±9.8 sec). In another study by Saber et al. instrumentation with One Shape was significantly faster than with Wave One and Reciproc ($P < 0.05$), whilst Reciproc was significantly faster than WaveOne ($P < 0.05$).[21]

In present study, we did not observe a significant difference in smear layer scores for different groups. All the groups had an equivalent cleaning efficacy.

Conclusion

Within the confines of the present study all the three file systems showed similar canal shaping ability and almost equivalent canal cleaning ability. However, the time taken for procedure was longer in One Shape group as compared to Reciproc and Wave One file systems. The study emphasized on the relevance and importance of proper irrigation and debris removal in order to get a well-shaped and smear free canal.

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