Original Article ISSN (O):2395-2822; ISSN (P):2395-2814

Evaluation of Effects of Glide Path on the Centering Ability and Preparation Time of two Reciprocating Single File Systems in Root Canals of Mandibular Molars: An In-Vitro Study.

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Received: February 2018
Accepted: February 2018

ABSTRACT

Background: Root canal preparation procedure must preserve the canal's original anatomy by respecting its initial curvature and creating a continuously tapering funnel. 1The shaping of curved canals remains a major challenge for clinicians, and is one of the most important steps of endodontic therapy.The two single-file systems used in our study are WaveOne and Reciproc in reciprocal motion. The aim of the study was to compare the effect of establishing glide path on the centering ability and preparation time of two different Nickel-Titanium single file systems in mesial roots of mandibular first molars. **Methods:** Eighty extracted mandibular molars with curvatures of 20-35 degrees and were divided into four groups (n=15); WaveOne+glide path; WaveOne; Reciproc+glide path and Reciproc. Non-patent canals were excluded and only one canal in each tooth was instrumented. A manual glide path was established in first and third groups with #10, 15 hand K-files. Preparation was performed with reciprocating in-and-out motion, with a 3-4 mm amplitude and slight apical pressure. Initial and final photographs were taken to analyze the amount of dentin removed in the instrumented canals. The centering ability of the rotary instruments was evaluated using the computer program Corel draw X6 software. **Results:** No statistically significant differences were found with regards to the centering ability between the four groups or amongst the ay three different locations coronal, middle and apical thirds of the root canals. **Conclusion:** Within the limitations of the study, it can be concluded that a manual glide path increased the total time involved in preparation of curved canals with WaveOne and Reciproc instruments. A glide path had no influence on the centering ability of these two single-file systems.

Keywords: Centering Ability; Glide Path; Reciproc; Wave One.

INTRODUCTION

Root canal preparation procedure must preserve the canal's original anatomy by respecting its initial curvature and creating a continuously tapering funnel.[1] The shaping of curved canals remains a major challenge for clinicians, and is one of the most important steps of endodontic therapy.[2] Procedural errors occurring during preparation may lead to remaining debris and poor root canal cleaning/filling, and may also jeopardize the healthy structure of root dentin.[3] The development of engine-driven root canal preparation instruments, attaining a centralized manual preparation without ledges, zips or deviations was made easier after introduction of the balanced force concept by Roane et al.[4] The increasing use of nickel-titanium (NiTi) engine-driven instruments has made shaping more predictable and less time-consuming. However, it still entails a long learning curve.[5-9] Preparation of curved canals is time-consuming. File separation and other procedural mishaps are frequent, leading to unsuccessful treatment outcome. It has been demonstrated that rotary Ni-Ti instruments are able to maintain canal shape even in severely curved canals. However despite these positive results, manufactures continue to introduce Ni-Ti systems with new blade designs and tapers, claiming safety and ease of use.

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Initially most of the Nickel Titanium file systems used multiple files to achieve the goal of successful endodontic treatment.[3]

Recent advances for endodontic canal preparation have focused on the concept "Less is more". Thus a single-file technique has been developed for shaping the vast majority of canals, regardless of their length, diameter, or curvature.[4]

Number of manufacturers have adopted single-file technique and introduced different files with a unique flute design, cross-sectional shape, alloy, and working motion to the market. Canal preparations have become faster with the single file technique.[5] In addition, the single use of files reduces the risk of file separation and prevents possible cross-contamination among patients.[6]

The two single-file systems used in our study are WaveOne and Reciproc in reciprocal motion.

Reciprocal motion: The reciprocating working motion consists of a counter clockwise (cutting direction) and a clockwise motion (release of the instrument), while the angle of the counter clockwise cutting direction is greater than the clockwise one, it is claimed that the instrument continuously progresses towards the terminus of the root canal. Reciproc system VDW, Munich, Germany) and WaveOne (Dentsply Maillefer, Ballaigues, Switzerland) belong to this group of file system. The reciprocating motion leads to more centralized canal preparation in comparison with continuous rotation using the same instrument.[7]

Reciproc (VDW, Munich, Germany) and WaveOne (Dentsply Maillefer, Baillagues, Switzerland) are single file systems, and have recently been launched with similar motions and principles, but with different cross- sections.[8-10] They use M-Wire alloy, which is 390% more resistant than the traditional Nitinol.[11] Reciproc has S-shaped cross-section, a non-cutting tip and sharp cutting edges that shapes the canal by means of a reciprocal back-and-forward motion with a speed of 300 rpm (150 degrees counterclockwise and then 30 degrees clockwise). This single file system is available at three different sizes and tapers; R25 (25/0.08), R40 (40/0.06) and R50 (50/0.05).[12]

WaveOne (Dentsply Maillefer, Ballaigues, Switzerland) is another single-file system with a reverse taper, variable helical angle and a non-active edge. It is used with 170° counterclockwise rotation (direction of cutting) and 50° clockwise rotation at a speed of 300 rpm. WaveOne is also available in different tip sizes and tapers; 21/0.06, 25/0.08 (primary) and 40/0.08.[12] These new single-file techniques have the potential of reducing canal preparation time,[13] while performing the similar shaping accomplished by full rotary sequences.[14-16]

The glide path is defined as a smooth patent pathway from the canal orifice to its physiologic terminus, which must be discovered when present or prepared when absent.17Early canal enlargement, up to a #20 file, may significantly reduce the risk of canal modifications and fracture of rotary instruments, mainly in curved canals.[18,19] The manual or rotary creation of a glide path is an effective way to preserve root canal anatomy.[20]

MATERIALS AND METHODS

Eighty freshly extracted mandibular molars, extracted for periodontal reasons collected from the Dental section, Community health centre Sankoo kargil ladakh were used for the study.

Criteria for samples

Teeth with completely formed apices and mesio-buccal canal curvature between 20º and 35º assessed according to Schneider's technique.[21]

Exclusion criteria for sample selection

- Teeth with canal curvature greater than 35°.
- Teeth with open apices.
- Teeth with calcified canals.
- Teeth with anatomical variations.
- Teeth with caries and restorations invading the pulp.

Equipment's used in the study

1. X-Smart plus Endomotor (Dentsply, Maillefer, Ballaigues, Switzerland).
2. DSLR Camera (Nikon digital, Tokyo, Japan).
3. Diamond discs (0.3mm diameter).
4. Radiographic jig.
5. Modified Bermante muffle system.
6. Digital Vernier calliper.

Materials used in the study:

1. RECIPROC rotary files (VDW, Munich, Germany).
2. WAVEONE rotary files (Dentsply, Maillefer, Ballaigues, Switzerland).
3. #10 K file (Dentsply, Maillefer, Ballaigues, Switzerland).
4. #15 K file (Dentsply, Maillefer, Ballaigues, Switzerland).

Selection of root canals

The teeth were disinfected in 5% sodium hypochlorite solution for 30 min. The teeth were then cleaned of calculus, soft tissue tags, debris and attached bone by a periodontal curette and washed with distilled water. The teeth were kept in normal saline until used. Radiographs were taken to evaluate the mesial roots. In each tooth specimen, any one canal of the mesial root was standardized to 9mm length by removing the crown using diamond discs. The canals were controlled for apical patency with ISO no #10 k –files (Dentsply Maillefer, Ballaigues, Switzerland). Only teeth whose canal width near the apex was approximately size 15 were included; this was evaluated with size 15 K-file. Working length was established at 9 mm, and was determined by subtracting 0.5 mm from the length at which the tip of a size #10 K-file could be visualized.

A radiographic platform, as described by previous researchers was used to take standardized radiographs prior to instrumentation with the k-file size #10 has been inserted into the buccal or lingual canal in order to determine the degree and radius of the curvature using periapical Kodak Insight films (Eastman Kodak Company, Rochester, NY).[22] The X-ray tube (Siemens, Heliodent, Germany) was aligned perpendicular to the root canal. The exposure time (0.125; 70Kv, 7mA) was the same for all radiographs. The degree and radius of canal curvature were obtained from these preoperative radiographs with a computer program Corel draw X6 software tools using Schneider technique.[22]

Preparation of model

A muffle-block was constructed as given by Aviad et al.23After sealing the apices with wax, the canals were mounted in the muffle-block using self-cure acrylic resin (Orthoplast; Vertex, Zeist, the Netherlands). After complete polymerization of the resin, the block was removed from the model, the wax removed and the apical foramen exposed. The blocks were sectioned horizontally at three sites (coronal, middle and apical) by a thin cutting disk (0.3-mm thick) at two levels: one 3 mm from the apex and the other 6 mm from the apex. The disk was mounted on an electric saw (CIR-SAW, Confident Dental Equipments Ltd, India) for cutting the blocks. Photographs were taken of all three cross-sections of each tooth using a DSLR Camera (Nikon Digital, Tokyo, Japan) at a fixed position. The sections were reassembled in the muffle. The specimens were randomly divided into the following four groups:

Group 1: WaveOne Primary+glide path;
Group 2: WaveOne Primary;
Group 3: Reciproc R25+glide path;
Group 4: Reciproc R25.

All canals were prepared by a single experienced operator. Copious irrigation with 5.0 ml of 5% NaOCl solution using side-vented close ended needles. Finally, the canal were irrigated with 5.0 ml of a 17% EDTA for 3 minutes, followed by 5 ml of 5% NaOCL. All the canals were rinsed with 10 ml of 0.9% sterile saline. A manual glide path was established in first and third groups up to #15 hand K-files. X-Smart plus motor (Dentsply Maillefer), and the torque was adjusted to 1.8 Ncm. Preparation was performed with reciprocating in-and-out motion, with a 3-4 mm amplitude and slight apical pressure. After instrumentation, all sectioned canals were separated, and then photographed in the same manner as pre-instrumentation photographs. The shaping ability of the rotary instruments was evaluated using the computer program Corel draw X6 software.

Pre-and post-instrumentation measurements were recorded to evaluate the canal transportation and centering ratio based on the method described by Gambill et al.[24]

Assessment of the canal preparation

Centering ability: Centering ability of the instruments towards the original canal was evaluated by the ratio of (a1-a2) ÷ (b1-b2) or (b1-b2) ÷ (a1-a2) according to the method developed by Gambil et al, in this formula, a1 and b1 represent the thickness of the internal and external sides of the canal wall, respectively, mesiodistally, before instrumentation and a2 and b2 after instrumentation.[24] If these numbers were not equal, the lower number was considered as numerator of the ratio. A result with ratio 1 indicates that the canal has remained centered and a result less than 1 indicates deviation of the canal outward, and result of more than one show that the canal deviates inward.

Statistical Methods

Statistical software SPSS (version 20.0) and Microsoft Excel were used to carry out the statistical analysis of data. Descriptive statistics of data including mean, standard deviation, minimum and maximum values were reported. The normality test of Kolmogorov-Smirnov (K-S) and Levene's variance homogeneity test were applied to the data. The data were normally distributed, and there was homogeneity of variance amongst the groups. Analysis of variance (ANOVA) and the post hoc Tukey-HSD test were used for analysis of data. Graphically the data was presented by bar diagrams. A P-value of less than 0.05 was considered statistically significant. All P-values were two tailed.

RESULTS

Table 1: Mean (SD) of canal centering in different canal sections

		Mean	P-Value
Coronal	Group 1	1.636	<0.001*
	Group 2	1.346	
	Group 3	1.572	
	Group 4	1.446	
Middle	Group 1	1.414	<0.001*
	Group 2	1.805	
	Group 3	1.619	
	Group 4	1.900	
Apical	Group 1	1.652	<0.001*
	Group 2	1.610	
	Group 3	1.483	
	Group 4	1.725	

Table 2: Mean (SD) of total time (sec) required for canal preparation in study groups

Group 1	Group 2	Group 3	Group 4
265.37	220.12	265.12	210.10

A total of 80 samples, 20 from each groups were taken. Distribution of samples in four groups has been shown in [Table 1] below:

No statistically significant differences were found with regards to the centering ability between the four groups or amongst the ay three different locations coronal, middle and apical thirds of the root canals [Table 1]. No instrument fracture or signs of deformation was detected.

Groups with glide path had significantly longer total preparation times ($P<0.05$) [Table 2].

DISCUSSION

In our study we observed no difference between WaveOne and Reciproc regarding the canal centering ability of prepared canals with or without glide path establishment. The two systems also performed similarly when the total preparation time was evaluated not considering the time required for glide path creation. The total preparation time increased due to creation of glide path, but decreased the time required for both reciprocating systems to reach the WL.

In our study we evaluated the canal preparation using two NiTi rotary single file systems with or without glide path on natural human teeth. The parameters assessed were canal centering ability and the time taken for instrumentation. Human teeth were chosen as they simulate clinical conditions better than acrylic blocks. Acrylic resin is not an optimum material to reproduce the micro hardness of testing rotary instruments because it does not emulate dentin or the anatomic variations (enlargements, oval root canals, etc.).[25] It has been mentioned that shape of the flutes of NiTi files was altered when used in plastic blocks, which was not seen with natural teeth; moreover, rotary instrument generated heat when used inside the resin block, which softened the resin material.[26,27] Other studies have shown that the softening of the resin block lead to binding of cutting blades and increased chance of instrument fracture.[28]

Recent studies have focused on the two-dimensional (2D) evaluation of preparation; however, in spite of providing a reproducible model this methodology has the limitation of not showing a three-dimensional (3D) evaluation.[10,29-31] The formula used in the present study is based on the formulation suggested by Gambill et al. that used computed tomography for image acquisition but assessed a 2D cross-section of specimens.[6] The procedure of making measurements at different distances from the canal apex has been adopted by other authors.[10,31] This method was used to compare the influence of glide path establishment on Reciproc and WaveOne in simulated canals by Lim et al.[10]

Glide path preparation is well established as an important step before rotary instrumentation, which prevents instrument wear and its separation rate.[18,19,32] However, the role of a glide path for single-file reciprocating systems has yet to be fully understood. A recent study has shown better preparations for WaveOne when a glide path was created.[33] In our study, both WaveOne and Reciproc had the same performance, and the creation of manual glide path had no influence on centering ability. Our results are in agreement with previous studies.[20,21,31] Further studies are required to provide more information to establish the influence of reciprocating angles on centering ability, about the preparation technique, new instruments, and methodologies used to evaluate the action of the endodontic instruments inside the root canals, aiming at solving the problems inherent to such an important and difficult phase of endodontic therapy.

Preparation of a glide path decreased the time required to reach the WL for WaveOne and Reciproc, respectively. Bürklein et al. showed that Reciproc R was faster than WaveOne Primary.[8,25] On the other hand, Park et al. reported that preparation with WaveOne was faster than Reciproc.[34] In the our study, Reciproc R without a glide path was faster than WaveOne,[25] although the difference between them was not statistically significant. Both systems performed similarly when a glide path was present. Single-instrument root canal preparation is less time-consuming and more comfortable for both the patient and the clinician.[35] In our study we found that a glide path had no influence on the centering ability of both WaveOne and Reciproc single-file systems. The time required by these systems to prepare curved canals decreased, but total preparation time increased; nevertheless, further investigation is warranted to ascertain the full extent of the role played by the preparation of a glide path on the shaping of curved root canals.

CONCLUSION

Within the limitations of the study, it can be concluded that:

1. A manual glide path increased the total time involved in preparation of curved canals with WaveOne and Reciproc instruments.
2. A glide path had no influence on the centering ability of these two single-file systems.

REFERENCES

1. Schilder H. Cleaning and shaping the root canal. Dent Clin North Am 1974;18(2):269-96.
2. Peters OA. Current challenges and concepts in the preparation of root canal systems: a review. J Endod 2004;30(8):559-67.
3. Wu MK, Fan B, Wesselink PR. Leakage along apical root fillings in curved root canals. Part I: effects of apical transportation on seal of root fillings. J Endod 2000;26(4):210-6.
4. Roane JB, Sabala CL, Duncanson MG, Jr. The "balanced force" concept for instrumentation of curved canals. J Endod 1985;11(5):203-11 H. Cleaning and shaping the root canal. Dent Clin North Am 1974;18(2):269-965ĝ

5. Walia HM, Brantley WA, Gerstein H. An initial investigation of the bending and torsional properties of Nitinol root canal files. J Endod 1988;14(7):346-51.
6. Gambill JM, Alder M, Del Rio CE. Comparison of nickel-titanium and stainless steel hand-file instrumentation using computed tomography. J Endod 1996;22(7):369-75.
7. Franco V, Fabiani C, Taschieri S, Malentacca A, Bortolin M, Del Fabbro M. Investigation on the shaping ability of nickel-titanium files when used with a reciprocating motion. J Endod 2011;37(10):1398-401.
8. Bürklein S, Hinschitza K, Dammaschke T, Schäfer E. Shaping ability and cleaning effectiveness of two single-file systems in severely curved root canals of extracted teeth: Reciproc and WaveOne versus Mtwo and ProTaper. Int Endod J 2012;45(5):449-61
9. Yoo YS, Cho YB. A comparison of the shaping ability of reciprocating NiTi instruments in simulated curved canals. Restor Dent Endod 2012;37(4):220-7.
10. Lim YJ, Park SJ, Kim HC, Min KS. Comparison of the centering ability of Wave.One and Reciproc nickel-titanium instruments in simulated curved canals. Restor Dent Endod 2013;38(1):21-5.
11. Johnson E, Lloyd A, Kuttler S, Namerow K. Comparison between a novel nickel-titanium alloy and 508 nitinol on the cyclic fatigue life of ProFile 25/.04 rotary instruments. J Endod 2008;34(11):1406-9.
12. Plotino G, Grande NM, Testarelli L, Gambarini G. Cyclic fatigue of Reciproc and WaveOne reciprocating instruments. Int Endod J 2012;45(7):614-8
13. Bane K, Faye B, Sarr M, Niang SO, Ndiaye D, Machtou P. Root canal shaping by single-file systems and rotary instruments: a laboratory study. Iran Endod J 2015;10(2):135-9.
14. Yoo YS, Cho YB. A comparison of the shaping ability of reciprocating NiTi instruments in simulated curved canals. Restor Dent Endod 2012;37(4):220-7. 21.
15. Lim YJ, Park SJ, Kim HC, Min KS. Comparison of the centering ability of Wave.One and Reciproc nickel-titanium instruments in simulated curved canals. Restor Dent Endod 2013;38(1):21-5. 22.
16. Johnson E, Lloyd A, Kuttler S, Namerow K. Comparison between a novel nickel-titanium alloy and 508 nitinol on the cyclic fatigue life of ProFile 25/.04 rotary instruments. J Endod 2008;34(11):1406-9.
17. West JD. The endodontic Glidepath: "Secret to rotary safety". Dent Today 2010;29(9):86, 88, 90.
18. Berutti E, Negro AR, Lendini M, Pasqualini D. Influence of manual preflaring and torque on the failure rate of ProTaper rotary instruments. J Endod 2004;30(4):228-30.
19. Patino PV, Biedma BM, Liebana CR, Cantatore G, Bahillo JG. The influence of a manual glide path on the separation rate of NiTi rotary instruments. J Endod 2005;31(2):114-6.
20. D'Amario M, Baldi M, Petricca R, De Angelis F, El Abed R, and D’Arcangelo C. Evaluation of a new nickel-titanium system to create the glide path in root canal preparation of curved canals. J Endod 2013;39(12):1581-4.
21. Schneider SW. A comparison of canal preparations in straight and curved root canals. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1971;2(32):271-5.
22. Sydney GB, Batista A, de Melo LL. The radiographic platform: a new method to evaluate root canal preparation in vitro. J Endod. 1991;17:570-2.
23. Tamse A, Raphael Pilo. A new muffle model system to study root canal morphology and instrumentation techniques. JEndod. 1998;24(8):
24. Gambill JM, Alder M, del Rio CE. Comparison of nickel-titanium and stainless steel hand-file instrumentation using computed tomography. J Endod 1996;22(7):369-75. 7
25. Aydin C, Inan U, Yasar S, Buluci B, Tunca YM. Comparison of shaping ability of RaCe and Hero Shaper instruments in simulated curved canals. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008;105(3):92-7.
26. KazeStenman E, Spangberg LS. Machining efficiency and wear resistance of nickel titanium endodontic files. Oral Surg Oral Med OralPathol Oral Radiol Endod. 1996;81:596-602
27. Kum KY, Spangberg L, Cha BY, Young J, Seung-Jong L, Chan-Young L. Shaping ability of three ProFile rotary instrumentation techniques in simulated resin root canals. J Endod. 2000; 26:719-23.
28. Thompson SA, Dummer PM. Shaping ability of ProFile.04 Taper Series 29 rotary nickel titanium instruments in simulated root canals. Part 1. Int Endod J. 1997;30:1-7.
29. Goldberg M, Dahan S, Machtou P. Centering Ability and Influence of Experience When Using WaveOne Single-File Technique in Simulated Canals. Int J Dent 2012;2012:206321
30. Munoz E, Forner L, Llena C. Influence of operator's experience on root canal shaping ability with a rotary nickel-titanium single-file reciprocating motion system. J Endod 2014;40(4):547-50.
31. 31. Burklein S, Poschmann T, Schafer E. Shaping ability of different nickel-titanium systems in simulated S-shaped canals with and without glide path. J Endod 2014;40(8):1231-4.
32. Ehrhardt IC, Zuolo ML, Cunha RS, De Martin AS, Kherlakian D, Carvalho MC. Assessment of the separation incidence of mtwo files used with preflaring: prospective clinical study. J Endod 2012;38(8):1078-81.
33. Berutti E, Paolino DS, Chiandussi G, Alovisi M, Cantatore G, Castellucci A. Root canal anatomy preservation of WaveOne reciprocating files with or without glide path. J Endod 2012;38(1):101-4.
34. Park SK, Kim YJ, Shon WJ, You SY, Moon YM, Kim HC, et al. Clinical Efficiency and Reusability of the Reciprocating Nickel-Titanium Instruments According to the Root Canal Anatomy. Scanning 2014;36(2):246-51
35. Yared G. Canal preparation using only one Ni-Ti rotary instrument: preliminary observations. Int Endod J 2008;41(4):339-44.

How to cite this article: Sajad M, Ahmed A, Singh A, Sagar M. Evaluation of Effects of Glide Path on the Centering Ability and Preparation Time of two Reciprocating Single File Systems in Root Canals of Mandibular Molars: An In-Vitro Study. Ann. Int. Med. Den. Res. 2018; 4(2):DE64-DE68.

Source of Support: Nil, **Conflict of Interest:** None declared