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EFFECT OF GLIDE PATH PREPARATION ON THE SHAPING ABILITY OF TWO DIFFERENT RECIPROCATING NITI FILES (IN-VITRO STUDY)

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ABSTRACT

Aim: The aim of this study was to evaluate the preservation of canal curvature, apical transportation and centering ability of 2 different reciprocating NiTi rotary files with and without prior use of glide path rotary files using Cone Beam Computed Tomography.

Methods: Forty extracted human mandibular first molar teeth were collected for this study. Teeth were divided into 4 groups (n=10): Reciproc blue group, Reciproc blue with glide path group, M3-L platinum group and M3-L platinum with glide path group. All teeth were scanned before and after preparation. Data were analyzed using for non-parametric data, Kruskal-Wallis test and Friedman's test. For parametric data, repeated measures ANOVA test was used. For qualitative data, Fisher's Exact test was used. The significance level was set at ($p<0.05$).

Results: Regarding overall canal curvature, there is a statistically significant difference between Reciproc blue groups and M3-L platinum groups. Regarding overall canal transportation, there was no statistically significant difference between different groups. Regarding transportation direction, there was no statistically significant difference between different groups at 3 and 6 mm. While at 9 mm, there was a statistically significant difference between transportation directions in M3-L platinum with glide path group, with most of samples showed distal transportation. Regarding overall centering ability, there was a statistically significant difference between different groups.

Conclusion: From the findings of our present study, it was found that glide path files have an important performance during root canal preparation.

KEYWORDS: Canal transportation; CBCT; centering ability; glide path

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INTRODUCTION

The basics of root canal treatment are to enlarge the canal space for proper biomechanical preparation for easy access, effective irrigation and three-dimensional filling of the root canal space. Canal transportation is one of the main procedural errors. Therefore, various NiTi rotary instruments are introduced. They are quick, safe and with enhanced flexibility, which lead to less procedural errors during biomechanical preparation (1-5).

As most root canals are curved, a high prevalence of procedural errors has been reported. Therefore, initial biomechanical preparation with NiTi rotary glide Path instruments represents an easier and less invasive method to provide an adequate glide path. Glide path ensures that a canal has a patent and reproducible channel from its orifice to its apical foramen. Vastly available NiTi rotary instruments did not design for initial negotiation of the root canal because they have non-cutting tips. Therefore, preparation of glide path is strongly recommended when using rotary endodontic file systems (1-5).

However, the usage of reciprocating single file system to prepare root canal can eliminate the need of glide path preparation. Reciprocating files movement inside the canal is in the form of one-movement in one direction, which remove dentin. The other movement is in the opposite direction to disengage the file from the canal walls, avoid stresses and avoid taper lock. Therefore, comparing the effect of glide path preparation on shaping ability of different single reciprocating endodontic file systems was thought to be of value (6-11).

The Reciproc blue (RPC blue, VDW GmbH Bayerwaldstr, Munich-Germany) is a single-file system that is fabricated from M-wire technology with an innovator heat treatment to enhance the file fracture resistance and raise file flexibility and gives its special blue color. It has s-shaped cross section and a progressive taper. It has diameter of 0.25 mm at the tip, and 8% taper through the 1st 3 mm from the tip. The diameter at 16 mm from the tip D16 is 1.05 mm. Reciprocating cutting orientation is 150° ccw cutting direction and 30° in cw reciprocal direction (12-14).

The Flexmaster (FM, VDW GmbH Bayerwaldstr, Munich-Germany) is a glide path file that is fabricated from 3rd generation NiTi, to enhance flexibility and cyclic fatigue resistance. It has a convex cross-section with traditional K-type cutting blades. It has a non-cutting rounded guiding tip with 0.02 taper. It is used at a constant rotation speed of 150 – 300 rpm (14).

The M3-L platinum (United Dental Changzhou**,** Changzhou, P.R.China) is a single-file system that is fabricated from CM-wire to enhance the file fracture resistance and raise file flexibility. It has flat-side s-shaped cross-section and variable taper along the file. It is used as a full-continuous rotational motion file with angle about 360° (15).

The M3-path (United Dental Changzhou**,** Changzhou, P.R.China) is a glide path file that is fabricated from NiTi alloy to enhance flexibility and cyclic fatigue resistance. It has a triangle cross-section and a cutting guiding tip with 0.02 taper. It is used at constant rotation at a speed of 300 rpm (15).

The aim of this study was to evaluate the preservation of canal curvature, apical transportation and centering ability of two different reciprocating NiTi rotary files (Reciproc blue file and M3-L platinum file) with and without prior use of glide path rotary files (Flexmaster glide path file and M3-path file) using Cone Beam Computed Tomography (CBCT) (16-17).

MATERIALS AND METHODS

Samples size calculation

A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there is no difference between tested groups. Sample size calculation was performed using

G*Power version 3.1.9.7. The minimum required sample size (n) was found to be (40) samples (i.e. 10 samples per group).

Samples selection

Forty extracted permanent mandibular first molars having moderate curvature 25° – 35° were collected for this study. Ultra sonic scaler was used to clean all samples from any hard-calculus residues. All samples were submerged in 5.26% sodium hypochlorite for 1/2 an hour to eliminate any sticky soft tissues after that were stored in a saline solution as a storage media. CBCT scans were taken to determine degree of curvature according to Schneider's method [18]. According to the rotary system used for root canal Preparation, all samples were divided randomly into 4 groups of 10 each: Group (A): Mesiobuccal root canals were prepared with RPC blue file (25, 4%) without glide path file. Group (B): Mesiobuccal root canals were prepared with RPC blue file (25, 4%) with Flexmaster path file (15, 2%). Group (C): Mesiobuccal root canals were prepared with M3-L platinum file (25, 4%) without glide path. Group (D): Mesiobuccal root canals were prepared with M3-L platinum file (25, 4%) with M3-path file (16, 2%).

Preparation of samples

Proper endodontic coronal preparation was done for all samples, which enables unobstructed access to the canal orifice. Gaining apical patency of mesiobuccal canals was done by a small flexible K-file size 10, which is passively moved through the apical constriction 0.5 – 1 mm beyond the minor diameter without widening it. Working length measurement was done by inserting K-file size 10 until it is visible from the apex then subtracting 1 mm from tooth length. Each group (n = 10) was inserted and aligned in a straight plane into a small cork block as a mold. A small piece of orthodontic wire was placed at the border of the mold to help in standardization of sample positioning and scan orientation.

Pre-instrumentation measurement

Scanning of all samples was done by using GENDEX DP-700 CBCT Unit [19] (90Kvp, 6.3mA, exposure time 8.7 sec and voxel size 300 µm). The CBCT unit software finished image reconstruction with 587 slices in axial direction [20]. M1 and D1 measurements were obtained from pre instrumentation imaging at 3, 6, and 9 mm levels from the root apex in mesiodistal direction as following: in a distal direction from the wall of the canal to the outer surface of the root and called (D1), and in a mesial direction and called (M1)[21]. To determine canal curvature and dentin thickness; to evaluate canal centering and transportation.

Root canal instrumentation

A single operator finished the instrumentation of all root canals according to the manufacturer's directions. Each group was operated with a new set of files. Each canal was prepared to the working length in a crown-down sequence. Initial patency was checked by K-file size 10. Irrigation was done using 2 ml 2.5% sodium hypochlorite after each file. EDTA gel was used for lubrication. File flutes were cleaned after each step with a clean gauze. In group (A), instrumentation to full working length in an up and down brushing motion at operating speed 350 rpm and torque 0.8 N.cm. While in group (C), instrumentation to full working length in an up and down brushing motion at operating speed 350 rpm and torque 3 N.cm. While in group (B) and (D), instrumentation with path files to full working length in an up and down brushing motion at operating speed 300 rpm and torque 0.8 N.cm.

Post-instrumentation measurement

Scanning of all specimens was done under the same conditions. M2 and D2 measurements were obtained from post instrumentation imaging at 3, 6, and 9 mm levels from the root apex in mesiodistal direction as following: in a distal direction from the wall of the canal to the outer surface of the root and called (D2), and in a mesial direction and called (M2) [21]. Figure (1)

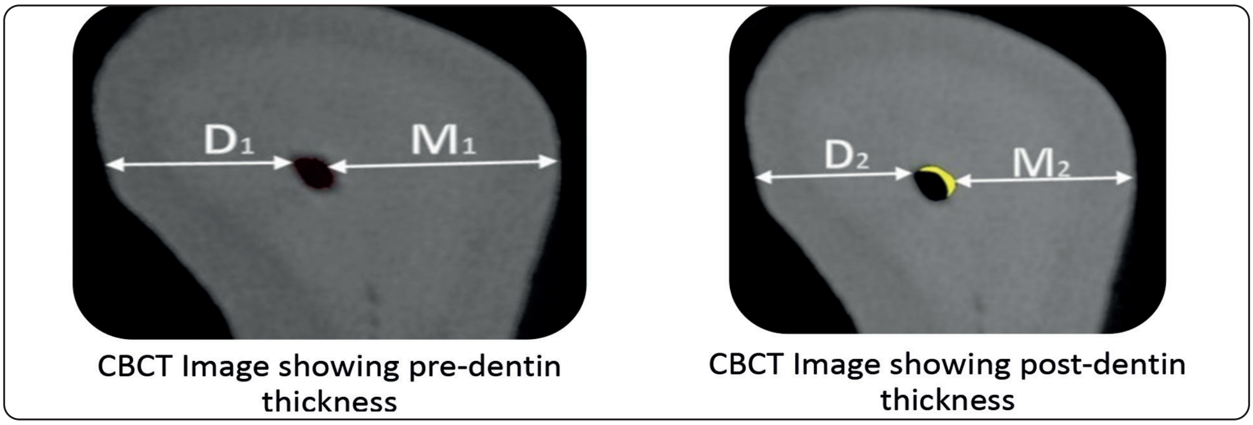

Fig. (1) CBCT Image showing dentin thickness difference

Evaluation:

Canal curvature:

Percent of reduction was calculated according to the following equation: (pre instrumentation measurement – post instrumentation measurement/ pre instrumentation measurement) X 100. The greater the percentage the more change happened.

Calculation of transportation:

Degree of transportation was calculated in mesiodistal direction according to Gambill et al [21], using this equation: [(M1-M2) - (D1-D2)]. Where, M1: refers to the shortest distance from the mesial edge of the root to the mesial edge of the un-instrumented canal. M2: refers to the shortest distance from the mesial edge of the root to the mesial edge of the instrumented canal. D1: refers to the shortest distance from the distal edge of the root to the distal edge of the un-instrumented canal. D2: refers to the shortest distance from the distal edge of the root to the distal edge of the instrumented canal.

A result of zero denoted no canal transportation while, a positive result denoted mesial canal deviation and a negative result denoted distal canal deviation.

Calculation of centering ratio:

Ratio of centering was calculated in mesiodistal direction using the same values obtained during the measurement of transportation according to Gambill et al (21), using the following formula: [(M1-M2) / (D1-D2)].

If those values not equal, the lower figure was considered the numerator of the ratio and a result of one indicated perfect centering [22].

Statical analysis:

Numerical data was explored for normality by checking the distribution of data and using normality tests as Kolmogorov-Smirnov and Shapiro-Wilk tests. Canal transportation, centering ratio data showed non-parametric distribution while canal curvature data showed parametric distribution. Data values were presented as mean and standard deviation. For non-parametric data, Kruskal-Wallis test and Friedman's test was used to compare between the 4 groups. Dunn's test was used for pair wise comparisons when Kruskal-Wallis or Friedman's tests are significant. For parametric data, repeated measures ANOVA test was used to compare between canal curvatures in the 4 groups before and after preparation. Bonferroni's post-hoc test was used for pair wise comparisons when ANOVA test is significant. Qualitative data; Transportation direction, was presented as percentages and frequencies. Fisher's Exact test was used to compare between the 4 groups. The significance level was set at ($P \leq 0.05$). Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

RESULTS

Canal Curvature

The highest change in canal curvature was in group (B), There was a statistically significant decrease in canal curvature after preparation (P = 0.037). While the lowest change in canal curvature was in group (D), There was no statistically significant change in canal curvature after preparation (P = 0.517). Regarding overall canal curvature, there was no statistically significant difference between Reciproc blue groups (group A and B). There was no statistically significant difference between M3-L platinum groups (group C and D). While, there is a statistically difference between Reciproc blue groups and M3-L platinum groups. Table (1)

Canal transportation

At three millimeters from root apex the highest change in MD canal dimension was in-group C (M3-L platinum) (0.199 ± 0.128), while the lowest change was in-group D (M3-L platinum with glide path) (0.096 ± 0.087).

At six millimeters from root apex the highest change in MD canal dimension was in-group B (RPC blue with glide path) (0.192 ± 0.1), while the lowest change was in-group C (M3-L platinum) (0.135 ± 0.106).

At nine millimeters from root apex the highest change in MD canal dimension was in-group B (RPC blue with glide path) (0.224 ± 0.162), while the lowest change was in-group A (RPC blue) (0.085 ± 0.08).

Regarding overall canal transportation, there was no statistically significant difference between the 4 groups. Table (2)

According to transportation direction

At three millimeters from root apex the highest change in transportation direction was in mesial direction (+ve) in the 4 groups. While the lowest change was in distal direction (-ve) in the 4 groups.

At six millimeters from root apex the highest change in transportation direction was in mesial direction (+ve) in the 4 groups. While the lowest change was in distal direction (-ve) in the 4 groups.

At nine millimeters from root apex the highest change in transportation direction was in distal direction (-ve) in the 4 groups. While the lowest change was in mesial direction (+ve) in the 4 groups.

TABLE (1) Descriptive statistics and results of repeated measures ANOVA test for canal curvature.

Preparation	Group A (n = 10)		Group B (n = 10)		Group C (n = 10)		Group D (n = 10)		P-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Before	31.6 a	3.41	34.39 a	1.08	30.93 a	3.97	32.06 a	3.48	0.102
After	30.09 a	4.54	32.4 a	2.98	29.81 a	4.23	31.46 a	5.21	0.509
Mean & SD difference	-1.51 a	1.9	-1.99 a	2.95	-1.12 b	3.31	-0.6 b	3.22	0.338
P-value	0.108		0.037*		0.230		0.517		

Means with different superscript letters within the same row are significantly different (*); significant ($P \leq 0.05$) ns; non-significant ($p > 0.05$).

Centric Ratio

At three millimeters from root apex the highest change in CR was in-group D (M3-L platinum with glide path) (0.41 ± 0.347), while the lowest change was in-group C (M3-L platinum) (0.321 ± 0.228).

At six millimeters from root apex the highest change in CR was in-group A (RPC blue) (0.516 ± 0.31), while the lowest change was in-group B (RPC blue with glide path) (0.388 ± 0.248).

At nine millimeters from root apex the highest change in CR was in-group A (RPC blue) (0.578 ± 0.305), while the lowest change was in-group D (M3-L platinum with glide path) (0.245 ± 0.235).

Regarding overall centering ratio, there was a statistically significant difference between different groups, while there was no statistically significant difference between group (C) and (D). Table (3)

TABLE (2) Descriptive statistics and results of Kruskal-Wallis test for canal transportation.

Root level	Group A (n = 10)		Group B (n = 10)		Group C (n = 10)		Group D (n = 10)		P-value
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	
3 mm	0.133 a	(0.124)	0.183 a	(0.101)	0.199 a	(0.128)	0.096 a	(0.087)	0.089
6 mm	0.136 a	(0.118)	0.192 b	(0.1)	0.135 b	(0.106)	0.155 c	(0.112)	0.711
9 mm	0.085 a	(0.08)	0.224 a	(0.162)	0.172 a	(0.114)	0.137 a	(0.124)	0.148
Overall	0.118 a	(0.056)	0.2 a	(0.094)	0.169 a	(0.09)	0.129 a	(0.072)	0.148

Means with different superscript letters within the same row are significantly different (*); significant (P ≤ 0.05) ns; non-significant (p > 0.05).

TABLE (3) Descriptive statistics and results of Kruskal-Wallis test for centric ratio.

Root level	Group A (n = 10)		Group B (n = 10)		Group C (n = 10)		Group D (n = 10)		P-value
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	
3 mm	0.397 a	(0.366)	0.321 a	(0.306)	0.321 a	(0.228)	0.41 a	(0.347)	0.946
6 mm	0.516 a	(0.31)	0.388 a	(0.248)	0.495 a	(0.337)	0.423 a	(0.351)	0.834
9 mm	0.578 a	(0.305)	0.288 a	(0.172)	0.379 a	(0.281)	0.245 a	(0.235)	0.070
Overall	0.497 a	(0.213)	0.332 b	(0.1)	0.398 c	(0.246)	0.359 c	(0.224)	0.320

Means with different superscript letters within the same row are significantly different (*); significant (P ≤ 0.05) ns; non-significant (p > 0.05).

DISCUSSION

The aim of root canal treatment is creating tapering profile developed from the original root canal anatomy, extending from the coronal to apical regions of the canal (18). Shaping of root canals was achieved using stainless steel manual files [(23)]. The use of NiTi rotary files has enhanced the quality of root canal shaping [(24)]. These developments empowered the manufacturers to innovate single-file reciprocating systems [(25)]. The **RPC blue file** is a single-file system that is fabricated from M-wire technology with an innovator heat treatment to enhance the file fracture resistance and gives its special blue color [(26)]. The **M3-L platinum file** is a single-file system that is fabricated from CM-wire to enhance the file fracture resistance and raise file flexibility [(26)]. Hence, the aim of this study was to evaluate the shaping ability of two different reciprocating single file systems (RPC blue and M3-L platinum). Extracted human mandibular molars were used rather than synthetic canals despite of these canals are more standardized in shape and curvature but they differ from natural teeth in dentin structure, natural canal morphology and canal irregularities [(27, 14)]. The measurement took place at distinct levels 3, 6 and 9 mm from mesiobuccal root apex to evaluate the parameters needed minutely. Mesiobuccal roots of mandibular molars were selected because they show curvature at least in mesiodistal plane [(28, 15)]. Prepared by RPC blue and M3-L platinum files with the size of 0.25 by endodontic motor with torque limiting control. CBCT machine [(20)] was used in this study since it is non-invasive and do not require tooth sectioning [(21, 29-30)]. Schneider's method was used to evaluate the results because of its precision and validity [(18)]. Newly series of files in each group were used for preparing each root canal for standardization. The results of this study demonstrated that, regarding preservation of canal curvature, all groups showed significant reduction in canal curvature. There was no statistically significant difference found in groups prepared by RPC blue and M3-L platinum files prior and post glide path preparation. This is in agreement with Çetinkaya I et al [(31)] and Perez AR et al [(32)] reported that reciprocating files maintained the original canal curvature. Piţ A et al [(33)] reported that reciprocating shaping systems with reduced taper are more conservative and efficient in root canal shaping.

Chole et al. 2016 defined canal transportation as "the removal of canal wall shell on the outside curve in the apical half of the canal consequent the tendency of files to return themselves to their main linear form during canal instrumentation" [(34)]. Transportation can worsen the prognosis of the treatment by different routes. It can cause over-reduction of intracanal dentin that decreases the fracture resistance. It can also leave an un-prepared portion of the apical part which harbour residues bacteria causing a constant post-operative periapical lesion [(34-35)]. Regarding root canal transportation at the three different root levels (3 mm, 6 mm and 9 mm) results showed that there was no statistically significant difference between the 4 groups. This could be attributed to several similarities between the two systems where they work in crown down technique, reciprocation motion, and terminated preparation with the same tip diameter. This is in agreement with Daou C et al [(36)] and Guedes I et al [(37)] who reported that no transportation was found when using reciprocating files. As well, Roshdy N et al [(38)] reported that the use of glide path with reciprocating file had no influence on the canal transportation. Gambill et al. 1996 defined centering ratio as "ability of instrument to remain centered in the canal" [(21)]. Alternatively, "the utmost value of the removed dentin width from canal sides" [(39)]. Instruments centralization in curved canals is of paramount importance. A prepared root canal should have a continuous tapering. The existent curvatures lead to preparation difficulty and deviations evolvement from the original configuration. As follow, any degree of deviations will lead to excessive and improper dentin removal and canal straightening. Results showed that there was a statistically significant difference in centric ratio at the three different levels (3 mm, 6 mm and 9 mm) between different groups. Our results are in agreement with Lim Y et al[40], Carvalho GM et al[41] and Hartmann R et al[42] who reported that glide path preparation minify the risk of canal deviation, and improves the ability of instruments to remain centered in the canal. Hage W et al (24) reported that by using glide path file in reciprocating motion, the canal shape was more centered.

CONCLUSION

Within the limitations of this study, Regarding preserving canal curvature: RPC blue and M3-L platinum files showed minimal changes. Regarding transportation and centering ratio of the canal: both files were comparable. Regarding glide path preparation: both files were comparable. Nevertheless, further investigations are needed to clarify the role played by the heat treatment technology and the use of glide path NiTi files prior to root canal shaping.

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