RESEARCH

Shaping ability of WaveOne Gold Primary in combination with different glide path file systems in curved root canals*

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ABSTRACT

Shaping ability of WaveOne Gold Primary in combination with different glide path file systems in curved root canals

Background: The purpose of this *in vitro* study was to evaluate the ability to stay in the center of the root canal and the apical transportation of curved root canals after preparation with WaveOne Gold single-file reciprocating system with guidance of different glide path systems by using Cone-Beam Computed Tomography.

Methods: Seventy-two extracted mandibular first molar teeth with curved mesial roots were selected for this study. Specimens were randomly divided into six experimental groups according to the root canal preparation (n = 12): Group G-File; Group One G; Group ProGlider; Group PathFile; Group K-files; and Group control. After forming a glide path, root canal preparation procedure was completed with WaveOne Gold primary instrument (#25). Cone-beam computed tomographic images of specimens were taken before and after root canal preparation procedure. Apical transportation and centering ability were evaluated at 1, 4, and 7 mm from the apical foramen. The data were statistically analyzed using the Kruskal Wallis test at a significance level of P=0.05.

Results: There were no significant differences among all experimental groups. (p > 0.05)

Conclusion: Creating a glide path in curved root canals with either NiTi glide path files or stainless still manuel K-files before root canal preparation with WaveOne Gold Primary caused similar apical transportation and centering ability results with no glide path used group.

KEYWORDS

Apical transportation, centering ability, cone-beam computed tomography, glide path, WaveOne Gold

ÖZ

Farklı rehber yol sistemleri ile kullanılan WaveOne Gold Primary'nin eğri kanallarda şekillendirme yeteneği

Amaç: Bu *in vitro* çalışmanın amacı, farklı rehber yol oluşturma teknikleri ardından WaveOne Gold tek eğe resiprokasyon sistemi ile yapılan kök kanal preparasyonunun apikal transportasyon ve kök kanalı merkezinde kalma yeteneğinin değerlendirilmesidir.

Gereç ve yöntemler: Bu çalışma için 72 adet çekilmiş alt çene 1. büyük azı dişi seçildi. Örnekler kök kanal preparasyonuna göre rastgele 6 gruba ayrıldı (n:12): Grup G-File; Group One G; Grup ProGlider; Grup PathFile; Grup K-tipi eğe; ve Grup kontrol. Rehber yol oluşturulmasının ardından kök kanal preparasyonu WaveOne Gold Primary eğesi ile tamamlandı. Preparasyon prosedürü öncesinde ve sonrasında Konik Işınlı Bilgisayarlı Tomografi görüntüleri alındı. Apikal transportasyon ve merkezde kalma yeteneği apikal foramenden 1, 4 ve 7 mm uzaklıkta değerlendirildi. Veriler istatistiksel olarak *Kruskal-Wallis* testi ile P=0.05 önem seviyesinde analiz edildi.

Bulgular: Deneysel gruplar arasında anlamlı bir farklılık yoktu (p>0.05).

Sonuç: Eğri kök kanallarında, WaveOneGold Primary ile kök kanal preparasyonundan önce NiTi rehber yol eğeleri ya da paslanmaz çelik el eğeleri ile rehber yol oluşturulması rehber yol oluşturulmayan kontrol grubu ile benzer apical transportasyon ve merkezde kalma bulguları verdi.

ANAHTAR KELİMELER

Apikal transportasyon, merkezde kalma yeteneği, konik ışınlı bilgisayarlı tomografi, rehber yol, WaveOne Gold

The preparation of curved root canals has always been a challenging factor in root canal treatment as procedural errors such as apical transportation, perforation, ledge and zip in curved canals are more likely to occur.[1] Alterations from the original root canal curve can cause some parts of the root canal to remain untouched; this may cause treatment failures because of the bacteria remaining in untouched areas.[2]

Many changes are being made to improve the shaping ability of endodontic instruments such as different alloy types, cross-section geometry, taper, and size.[3] The WaveOne Gold (Dentsply Maillefer, Ballaigues, Switzerland) reciprocating single file system is manufactured with some modifications over its predecessor WaveOne (Dentsply Maillefer, Ballaigues, Switzerland); these modifications

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include using heat treated gold metal alloy, and an off-centered parallelogram-shaped cross-section with two cutting edges.[4] The manufacturer claims that the flexibility increased by %80 with these changes.[5]

The glide path is a smooth tunnel that is extends from the root canal orifice to the minor apical foramen.[6] Glide path preparation can reduce the procedural errors in curved root canals; it also reduces the torsional stress on the instrument, so a glide path may contribute to avoiding instrument breakage.[7] Manuel K-Files or custom engineered NiTi glide-path files can be used for glide path preparation. Previous studies have stated that manual glide path preparation has some disadvantages over NiTi glide path files such as alteration of the original canal shape, requiring more enlargement time and increased apical debris extrusion causing post-operative pain.[8-10] For these reasons, NiTi glide-path files are suggested as a safe and fast glide path preparation.

Several NiTi glide path files have been produced recently; One G (Micro-Mega, Besancon, France) and Proglider (Dentsply Maillefer, Ballaigues, Switzerland) are the single file glide path preparation systems; PathFile (Dentsply Maillefer, Ballaigues, Switzerland) and G-files (Micro-Mega, Besancon, France) are multiple file systems. The cross-sectional geometry, ISO number, taper, file number of NiTi rotary glide path system was shown in Table 1.

The evaluation of apical transportation and the centering ability of root canal instruments has been made using several methods.[10-12] Cone-Beam computed tomography (CBCT) imaging allows the differential diagnosis of periapical lesions, complicated root canal anatomies and root fractures. In addition to this, CBCT images can be used for the three dimensional examination of root canals geometry before and after instrumentation of the root canals in in vitro studies.

This study aimed to examine the effect of different glide-path preparation techniques on the apical transportation and the centering ability of curved root canals by CBCT imaging. The null hypothesis was that there would be no differences in apical transportation and the centering ability parameters among the glide-path preparation techniques.

Table 1.

The cross-sectional geometry, ISO number, taper, file number of NiTi rotary glide path systems.

	Company	Number of files	Cross-section geometry	Taper	Tip diameter (mm)	Composition
Proglider	Dentsply	1	Square	.02 to .08*	0.16	M-Wire NiTi
One G	MicroMega	1	Asymmetrical	.03	0.14	NiTi
PathFile	Dentsply	3	Square	.02	PF1: 0.13 PF2: 0.16 PF3: 0.19	NiTi
G-Files	MicroMega	2	Asymmetrical	.03	G1: 0.12 G2: 0.17	NiTi

** The taper of the file changes gradually from %2 to %8.*

MATERIALS AND METHODS

Selection of teeth

Mandibular molars that were extracted for periodontal reasons were chosen for this study. Digital radiographs were taken to determine the separate mesial canals and the degree of curvature of the mesial root canals. Seventy-two intact, previously untreated mesial roots with two separate root canals and have a curvature between 25° and 35° were selected. Schneider's method was used to measure the degree of root canal curvature.[13] The mesial roots were removed from the cementoenamel junction with a high-speed fissure bur under water cooling. The roots were fixed in a silicone impression material and CBCT images (Promax 3D Mid; Planmeca, Helsinki, Finland) were obtained before instrumentation. The roots were scanned in the high-resolution scan mode with 360° rotation for 18.04s using an isotropic voxel of 0.200 mm with the following parameters: 90 kVp and 10 mA.

Root canal preparation

A pre-curved #08 K-file (VDW GmbH, Munich, Germany) was inserted into the root canal until the tip of the instrument was visible at the apical foramen under a stereomicroscope (Zeiss, Stemi 508, Germany), and the working length was determined by subtracting 1 mm from this length. After the working length determination, the roots were randomly divided into six groups according to the glide path preparation: Group G-File - G1 (#0.12) and G2 (#0.17) files; Group OneG - a OneG (#0.14) file; Group ProGlider - a ProGlider (#0.16) file; Group PathFile - PF1 (#0.13) and PF2 (#0.16) files; Group K-file - pre-curved #10 and #15 K-files (VDW GmbH, Munich, Germany) were used to prepare the glide path; and Group no glide path - no glide path preparation was performed. After the glide path preparation procedures, the WaveOne Gold Primary instrument was used for the final preparation for all specimens.

The speed and torque settings of the electrical endodontic motor (X-Smart Plus, Dentsply Maillefer) were adjusted for each file in accordance with the manufacturers' recommendations. Each file was used to prepare two root canals. One operator that specialized in endodontics was performed all the preparation procedures.

Calculation of apical transportation and centering ability

After preparation, the roots were fixed into the same silicone impression material, and post-operative CBCT images were obtained with the same parameters. The measurements were done via the Planmeca romexis 4.3.0.R software. Pre- and post-instrumentation images were analyzed at 1, 4, and 7 mm from the apical foramen for apical transportation and at 1, 4, and 7 mm from the apical foramen for the centering ability. Apical transportation was calculated according to the following formula: (M1-M2) – (D1-D2).[14] M1 and M2 represents the shortest mesial distance from the periphery of the root to the edge of the root canal before and after the root canal preparation, respectively. D1 and D2 represents the shortest distal distance from the periphery of the root to the edge of the root canal before and after the root canal preparation, respectively. Figure 1 shows the measurement of M1, M2, D1, and D2 lengths. A result of zero meant there was no transportation, a positive result meant there was transportation to the distal aspect of the root, and a negative result meant there was transportation to the mesial aspect of the root.

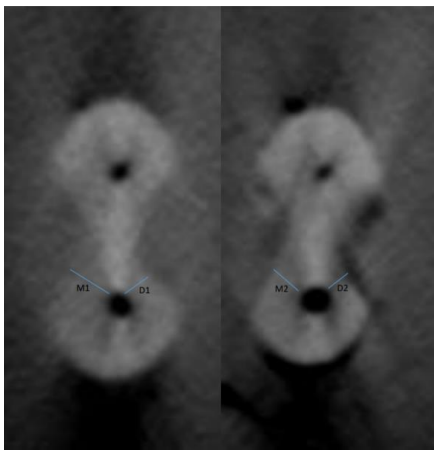

Figure 1.

Measurement of M1, M2, D1, and D2 lengths on CBCT axial cross-section image

The centering ability was calculated according to the following formula: (M1-M2)/(D1-D2) or (D1-D2)/(M1-M2).[14] The numerator was determined as the smaller of the two results. When evaluating the canal centering ratio, a result of "1" showed that the centering ability of the file was perfect, whereas a result of "0" indicated a weak centering ability.

Statistical analysis

The data were analyzed using the Kruskal Wallis test at a significance level of P=0.05. All the statistical analyses were performed with IBM SPSS Statistics 18.0 software (IBM SPSS Inc., Chicago, IL, USA).

RESULTS

There was no significant difference among all the six experimental groups for either the apical transportation or centering ability. (P>0.05) Table 2 shows the mean and standard deviations of the apical transportation for each group at 1, 4, and 7 mm from the apical foramen. Table 3 shows mean and standard deviations of the centering ability for each group at 1, 4, and 7 mm from the apical foramen.

Table 2.

Informative statistical analyze results for the apical transportation factor at 1, 4 and 7 mm for six experimental groups (mm)

	Groups	N	Mean	SE Mean	StDev	Minimum	Median	Maximum	P value
1mm	Pathfile	12	0,1250	0,0897	0,3108	0,0000	0,0000	1,0000	0.671
	Proglider	12	0,2080	0,1140	0,3960	0,0000	0,0000	1,0000	
	G-files	12	0,2500	0,1310	0,4520	0,0000	0,0000	1,0000	
	OneG	12	0,1670	0,1120	0,3890	0,0000	0,0000	1,0000	
	K-files	12	0,4170	0,1490	0,5150	0,0000	0,0000	1,0000	
	No glidepath	12	0,2500	0,1150	0,3990	0,0000	0,0000	1,0000	
4mm	Pathfile	12	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0.089
	Proglider	12	0,1670	0,1120	0,3890	0,0000	0,0000	1,0000	
	G-files	12	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	
	OneG	12	0,2500	0,1310	0,4520	0,0000	0,0000	1,0000	
	K-files	12	0,3330	0,1420	0,4920	0,0000	0,0000	1,0000	
	No glidepath	12	0,0417	0,0417	0,1443	0,0000	0,0000	0,5000	
7mm	Pathfile	12	0,1250	0,0897	0,3108	0,0000	0,0000	1,0000	0.856
	Proglider	12	0,0417	0,0417	0,1443	0,0000	0,0000	0,5000	
	G-files	12	0,1670	0,1120	0,3890	0,0000	0,0000	1,0000	
	OneG	12	0,1670	0,1120	0,3890	0,0000	0,0000	1,0000	
	K-files	12	0,2500	0,1310	0,4520	0,0000	0,0000	1,0000	
	No glidepath	12	0,2500	0,1310	0,4520	0,0000	0,0000	1,0000	

Table 3.

Informative statistical analyze results for the centering ability factor at 1, 4 and 7 mm for six experimental groups (mm)

	Groups	N	Mean	SE Mean	StDev	Minimum	Median	Maximum	P value
1mm	Pathfile	12	0,1667	0,0482	0,1670	0,0000	0,2000	0,6000	0.325
	Proglider	12	0,2000	0,0550	0,1907	0,0000	0,2000	0,6000	
	G-files	12	0,0667	0,0284	0,0985	0,0000	0,0000	0,2000	
	OneG	12	0,1000	0,0389	0,1348	0,0000	0,0000	0,4000	
	K-files	12	0,1167	0,0386	0,1337	0,0000	0,1000	0,4000	
	No glidepath	12	0,1333	0,0284	0,0985	0,0000	0,2000	0,2000	
4mm	Pathfile	12	0,1167	0,0297	0,1030	0,0000	0,2000	0,2000	0.476
	Proglider	12	0,0500	0,0261	0,0905	0,0000	0,0000	0,2000	
	G-files	12	0,0833	0,0386	0,1337	0,0000	0,0000	0,4000	
	OneG	12	0,0500	0,0261	0,0905	0,0000	0,0000	0,2000	
	K-files	12	0,0833	0,0297	0,1030	0,0000	0,0000	0,2000	
	No glidepath	12	0,1167	0,0386	0,1337	0,0000	0,1000	0,4000	
7mm	Pathfile	12	0,0500	0,0261	0,0905	0,0000	0,0000	0,2000	0.662
	Proglider	12	0,1333	0,0376	0,1303	0,0000	0,2000	0,4000	
	G-files	12	0,1000	0,0461	0,1595	0,0000	0,0000	0,4000	
	OneG	12	0,1000	0,0302	0,1044	0,0000	0,1000	0,2000	
	K-files	12	0,1000	0,0389	0,1348	0,0000	0,0000	0,4000	
	No glidepath	12	0,1333	0,0512	0,1775	0,0000	0,1000	0,6000	

DISCUSSION

This study aimed to evaluate that whether the use of different glide path preparation techniques affect the apical transportation and centering ability in curved root canals before subsequent root canal shaping with WaveOne Gold or not. In this study, there were no statistically significant differences between the experimental groups in the all parameters; so, the null hypothesis was confirmed.

In this study, the apical transportation and centering ability parameters of different experimental groups were evaluated at levels 1, 4, and 7 mm from the apical foramen. These areas of the curved root canals are where the instruments are more likely to cause iatrogenic errors.[14,15]

In the PathFile group, the PF3 instrument was not used to keep the apical enlargement diameter among the experimental groups close to each other to ensure the comparability and homogeneous baseline for the final shaping.

The methods previously used for evaluating the shaping ability of the instruments are radiographs[16], tooth sections[17], and plastic blocks.[1] The most recent techniques for the evaluation of the shaping ability of root canal instruments are micro-tomography[18], high-resolution CT[19], and Cone-beam CT[11], which are nondestructive and show more details. In this study, CBCT imaging was used for the evaluation of the shaping ability of different glide path preparation techniques before final shaping with WaveOne Gold.

The effect of glide path preparation before final shaping The effect of glide path preparation before final shaping on the apical transportation and centering ability has been widely investigated.[11,18,20] The results of the studies are controversial. While some studies showed no significant difference among the different glide path preparation groups[10,11,18,20], other studies have stated significant differences.[9,21] According to our results, there was no significant difference among all six different glide path preparation groups. Two recent studies examined the effects of different glide path preparation techniques before final shaping with WaveOne Gold on the apical transportation and the centering ability[18,22]. The results of this study are in accordance with our results. The alterations caused by the different glide path preparation techniques might be eliminated by final shaping with WaveOne Gold. WaveOne Gold is a new instrument with modified properties such as a new gold alloy and a modified cross sectional design. These properties provide better flexibility to the WaveOne Gold. Also, it has been stated that a reciprocating motion causes less transportation and provides better centering than continuous rotation.[23,24] Additionally, one operator performed all the preparation procedures who is a specialist in endodontics. These might be the possible causes for similar results among experimental groups.

It has been stated by Fan et al. that apical transportation is clinically relevant when the transportation is greater than 0.3 mm.[25] According to the present study, the apical transportation results were not greater than 0.3 mm for all groups. Within the limitations of this study, it is true to say that the WaveOne Gold reciprocating system provides minimally apical transportation, irrespective of the glide path preparation instruments used. It is important to note that in this study, only the centering ability and apical transportation parameters were

evaluated. Other benefits of glide path preparation such as; less instrument breakage[7], less post-operative pain[26], and faster root canal preparation[27] should not be overlooked. Also, it should be stated that none of the glide path preparation group were able to maintain the WaveOne Gold perfectly within the root canal.

CONCLUSION

Within the limitation of this study, no significant difference was found among different glide path preparation systems that were used before final shaping with WaveOne Gold in the apical transportation and the centering ability of curved root canals.

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