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Research Article

Cyclic fatigue resistance of the WaveOne Gold Glider, ProGlider, and the One G glide path instruments in double-curvature canals

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No potential conflict of interest relevant to this article was reported.

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ABSTRACT

Objectives: The aim of this study was to compare the cyclic fatigue resistance of the WaveOne Gold Glider, ProGlider and One G glide path instruments in artificial double-curvature canals.
Materials and Methods: This study included 15 WaveOne Gold Glider (size 15/0.08), 15 ProGlider (size 16/0.08), and 15 One G (size 16/0.06) nickel titanium files. The files were used in accordance with the manufacturer's instructions until they were broken in artificial double-curvature canals made of stainless steel. The time to fracture was recorded via a digital stopwatch and the number of rotations until fracture was also calculated. The data were statistically analyzed via the Kruskal-Wallis test.
Results: The highest average number of rotations until fracture of the files was found for the WaveOne Gold Glider, followed by ProGlider and One G in order. Statistically significant differences were present between all groups of files ($p < 0.05$).
Conclusions: In our study, the resistance of the WaveOne Gold Glider nickel-titanium (Ni-Ti) file to cyclic fatigue in S-shaped curved canals was found to be higher than that of the ProGlider and One G Ni-Ti files.

Keywords: Cyclic fatigue; ProGlider; WaveOne Gold Glider; One G

INTRODUCTION

The main aims of root canal procedures, which are among the most significant phases of endodontic treatment, are eliminating bacteria from the root canal system, removing debris, and hermetically filling the root canal space in 3 dimensions [1]. The complications that can be encountered during root canal preparation include perforations, root canal transportation, ledge formation, and handpiece fracture [2-5].

New-generation nickel-titanium (Ni-Ti) rotary handpieces are used to minimize potential complications during the preparation procedure. Creating a glide path is recommended in order to use these handpieces safely. Several rotary files have been developed to create glide paths.

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The ProGlider (Dentsply Sirona, Ballaigues, Switzerland) file is a single-use file launched by Dentsply for creating a glide path in preparation for a root canal [6]. The file comes in 3 different lengths: 21, 25, and 31 mm. The tip diameter of the file is 0.16 mm, and the apical taper of the file is 0.2%. The One G (Micro-Mega, Besançon Cedex, France) file is also a single-file system for creating glide paths. Its tip diameter is 0.14 mm and the taper of the file is 3%. The file is produced in 3 different lengths: 21, 25, and 29 mm. Flexible pits on the edger increase the screwing effect of the file. The file has 3 asymmetric cross-section edgers, and having 3 edgers in 3 different sizes provides space for more effective debris elimination.

The WaveOne Gold Glider (Dentsply Sirona) is a single-use file that works via a reciprocating motion. Produced with gold-wire metallurgy, the tip of the file has a cone angle that begins at 2% and increases to 6%. The tip diameter of the file is 0.15 mm.

In our broad literature review, no studies were found that evaluated the cyclic fatigue resistance of the WaveOne Gold Glider in artificial double-curvature canals. The aim of this study was to compare the cyclic fatigue resistance of the ProGlider, One G, and WaveOne Gold Glider files in artificial double-curvature (S-shaped) canals under a static model. The null hypothesis was that there would be no statistically significant difference between the files' cyclic fatigue resistance under a static model in double-curvature canals.

MATERIALS AND METHODS

Forty five rotary-system Ni-Ti files were used in this study, including 15 ProGlider, 15 One G, and 15 WaveOne Gold Glider files. All of the files were evaluated by stereomicroscopy (Olympus BX43, Olympus Co., Tokyo, Japan) under ×20 magnification to check for deformation and manufacturing defects before they were used in the test device.

A stainless steel mechanism with a stainless steel artificial canal in which files could freely rotate was installed for the cyclic fatigue tests (diameter 1.5 mm, length 18 mm). (**Figure 1**). The angle of the first curvature in the coronal area was 60°, and the diameter of the curvature was 5 mm in an artificial double-curvature canal. The distance between the center location of the coronal curvature and the tip of the canal was 8 mm. The apical curvature angle was 70°, and its diameter was 2 mm. The distance between the centers of curvature was 2 mm.

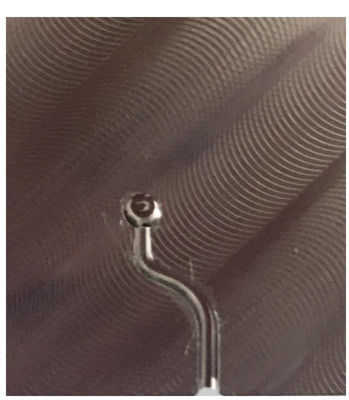

Figure 1. A stainless steel artificial canal with a double curvature.

Synthetic lubricant (WD-40 Company, Milton Keynes, England) was used to minimize the friction and to enable the files to rotate freely in the canals. The OneG and ProGlider files were used with a VDW Silver Reciproc endodontic engine (VDW, Munich, Germany) at 300 rpm and 2 N of torque, in accordance with the manufacturer's instructions. The WaveOne Gold Glider files were used with the same engine and the WaveOne All program. According to the manufacturer, the speed in the WaveOne All mode is 350 rpm [7]. All the files were used in artificial canals, and the time to fracture was recorded by a digital stopwatch. All of the procedures of the experiment were carried out by a single expert.

The following formula was used to calculate the number of cycles to fracture (NCF) of the files ($NCF = \frac{rpm \times duration}{60}$, where NCF is NCF of the files, rpm is revolutions of the files per minute, and duration is measured in seconds). The length of each broken end was measured with a digital meter (WT 20130 Digital Power Meter, Yokogawa Electric Corp., Tokyo, Japan). Broken surface images of 2 files from each group were examined by scanning electron microscopy (SEM) (Quanta 450, FEI, Hillsboro, OR, USA) in order to confirm that the fracture was due to cyclic fatigue.

Statistical analysis

Differences between groups in the average NCF and the length of the broken pieces were analyzed by the Kruskal-Wallis test and 1-way analysis of variance using SPSS version 21.0 (IBM Corp., Armonk, NY, USA).

RESULTS

The average values and standard deviations of the NCF of the ProGlider, One G, and WaveOne Gold Glider Ni-Ti files are shown in **Table 1**. The WaveOne Gold Glider showed the most resistance to cyclic fatigue, to a statistically significant extent ($p < 0.05$). The ProGlider file showed significantly greater resistance to fatigue than the One G file. All files initially broke in the apical area and then in the coronal area of the artificial double-curvature canals.

Photos of the broken surfaces of the files were taken by SEM and were evaluated. Fatigue lines, which are typically seen in fractures due to fatigue, were observed in all groups (**Figure 2**).

DISCUSSION

Several studies have shown the importance of creating a glide path in order to efficiently and safely flare curved root canals. In addition to curved canals with a single curvature, there are canals with S-shaped curvatures. S-shaped curvatures in root canals cause more stress to accumulate on the file than in single-curvature canals [8]. Additionally, forming a glide

Table 1. Number of cycles to fracture (NCF; mean ± standard deviation) and fragment length (FL; mm) of 3 instruments

Groups	Coronal curvature		Apical curvature	
	NCF	FL	NCF	FL
One G	778.3 ± 124.62[a]	6.99 ± 0.19	487.92 ± 76.11[a]	2.16 ± 0.7
ProGlider	1,331.75 ± 65.41[b]	6.98 ± 0.13	666.25 ± 34.97[b]	2.14 ± 0.1
WaveOne Gold Glider	1,868.08 ± 55.16[c]	7.02 ± 0.09	1,482 ± 57.54[c]	2.15 ± 0.11

[a,b,c]Different superscript letters indicate significant differences between groups ($p < 0.05$).

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A
B
C

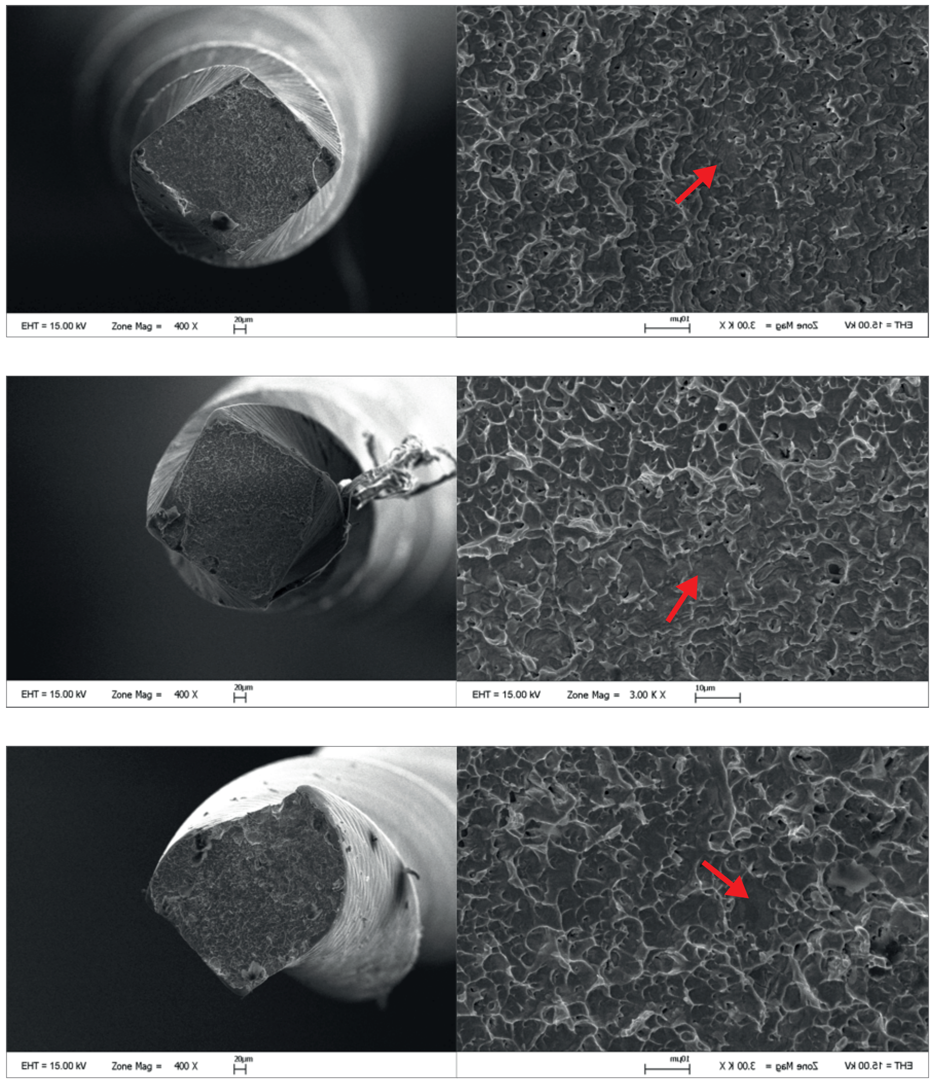

Figure 2. Scanning electron microscopic appearances of (A) the WaveOne Gold Glider; (B) the ProGlider; and (C) the One G after cyclic fatigue testing.
EHT, electron high tension.

path in S-shaped canals can be more difficult. Recently, file systems have been produced with different technologies in order to create glide paths. The aim of this study was to compare the cyclic fatigue resistance of the ProGlider, One G, and WaveOne Gold Glider single-file systems, which were produced in order to create glide paths.

Studies have revealed that the kinematic and alloy features of the files are efficient with regard to cyclic fatigue resistance [9]. In 2008, Yared [10] stated that Ni-Ti instruments that are used with a reciprocating motion are more resistant to cyclic fatigue than instruments with a rotating motion. Varela-Patiño *et al.* [11] found that angular movement of the files in a reciprocating motion caused less stress on the files than a rotating motion, which increased their resistance to cyclic fatigue. Evaluating the cyclic fatigue of R-Pilot, HyFlex EDM, and PathFile files in artificial double-curvature canals, Uslu *et al.* [12] concluded that the R-pilot reciprocating glide path file was more resistant to fatigue than other files. In studies that were carried out in artificial single-curvature canals with 45°, 60°, and 90° curves, the

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WaveOne Gold Glider glide path file, which uses a reciprocating motion, was more resistant to cyclic fatigue than files that work with a rotating motion [13-15]. Moreover, the WaveOne Gold Glider file is produced with gold-wire technology, and recent studies have shown that alloy properties are very important for cyclic fatigue resistance in Ni-Ti instruments [14,16]. The NCF values in the results of our study also demonstrate that the WaveOne Gold Glider file is more resistant to fracture due to cyclic fatigue in both the apical and the coronal curvatures than the ProGlider and One G files. For this reason, the null hypothesis was rejected.

The present study also found that the ProGlider file was more resistant to cyclic fatigue than the One G file. Other studies that evaluated the cyclic fatigue resistance of the ProGlider and One G files found that the ProGlider file was significantly more resistant to cyclic fatigue in curved and S-shaped canals [16,17]. As noted above, alloy properties can influence cyclic fatigue resistance. The fact that the Ni-Ti ProGlider file is produced with M-wire technology, while the One G file is made of a traditional Ni-Ti alloy, could explain the results of our study [18,19].

According the results of our study, fractures on the files initially formed in the apical area and then in the coronal area. The results of similar studies are consistent with the outcomes of our study [8,20]. A smaller radius in the apical curvature means a sharper curve, which causes files to fracture in this area first [21,22]. The average lengths of the pieces that were broken in the apical and coronal areas were similar.

CONCLUSIONS

Our study showed that the WaveOne Gold Glider, which uses a reciprocating motion and is produced with gold-wire technology, is the most resistant glide path file in S-shaped artificial canals in terms of cyclic fatigue. Further studies are warranted to test the torsional fatigue resistance of reciprocating glide path instruments.

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