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Cyclic fatigue resistance of WaveOne Gold Glider and TruNatomy Glider glide path instruments in double curvature canals

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Purpose: This study aims to compare the cyclic fatigue resistance of the WaveOne Gold Glider and TruNatomy Glider files in artificial double curvature canals.

Methods: This study includes 12 WaveOne Gold Glider (15.02 v) and 12 TruNatomy Glider (17.02 v) nickel–titanium files (Ni-Ti), which were all used according to the manufacturer's instructions until they were broken in artificial double curvature canals. The artificial double curvature canals used in the study were made of stainless steel. The fracture time was recorded using a digital stopwatch. The rotation number until fracture was also calculated. Moreover, the lengths of the broken pieces were recorded. Data were statistically analyzed using an independent sample t-test.

Results: The number of rotations until fracture for the WaveOne Gold Glider file was noted to be higher when compared to that of the TruNatomy Glider file. Statistically significant difference was found between the two groups ($p< 0.05$). No statistically significant difference was determined between the two groups in terms of the lengths of the fragments ($p> 0.05$).

Conclusion: As per our findings, the resistance of the WaveOne Gold Glider Ni–Ti file to cyclic fatigue in double curved canals was found to be higher than that of the TruNatomy Glider Ni–Ti file.

Keywords: Cyclic fatigue, double curvature, TruNatomy Glider, WaveOne Gold Glider.

Introduction

Removing bacteria from the root canals, eliminating debris, and hermetically filling the root canals in three dimensions are identified as the main objectives of root canal procedures, which are among the most significant stages of endodontic treatment (1). The most common complications in root canal preparation are as follows: perforations, ledge formation, root canal transportation, and fracture of handpieces (2–5).

New-generation Ni–Ti rotary handpieces are used to minimize the complications that might occur during the preparation procedure. A glide path smoothly centered from the canal orifices to the physiological terminus facilitates root canal preparation with Ni–Ti instruments by monitoring the tip of the first rotating instrument (6). During root canal preparation, complications such as taper lock, instrument fracture, and shaping aberrations can be prevented by creating a glide path (7). It is recommended to create a glide path to use these handpieces safely. A lot of rotary instruments have been developed to create glide paths (8).

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TruNatomy (Dentsply Sirona, Ballaigues, Switzerland) is a recently produced innovative single file rotary system that is made up of superflex alloy by a post-manufacturing thermal process. This new file system is aimed to shape canals into a continued tapering preparation, significantly preserving peri-cervical dentine, which is achieved by a regressive variable taper of the shafts. TruNatomy Glider (TNG) (Dentsply Sirona, Ballaigues, Switzerland) has an ISO tip size #17, a centered cross-sectional parallelogram design, and a taper that averages 2%. The maximum flute diameter is 0.8 mm when compared to the 1.1 mm of all the other conventional glide path instruments.

Working with a reciprocating motion, the WaveOne Gold Glider (Dentsply Sirona; Ballaigues, Switzerland) is a single-use file that is produced from gold-wire. 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.

There were no studies that compared the cyclic fatigue resistance of the TruNatomy Glider and WaveOne Gold Glider in double curvature artificial canals in our broad literature review. Thus, this study aims to compare the cyclic fatigue resistance of the TruNatomy Glider and WaveOne Gold Glider files in double curvature artificial (S-shaped) canals under a static model. The null hypothesis was that there would be no statistical difference in terms of cyclic fatigue resistance between the files under a static model in double curvature canals.

Materials and Methods

Twenty-four Ni–Ti files were used in this study, including 12 TruNatomy Glider and 12 WaveOne Gold Glider files. All of the files were examined by stereomicroscope (Olympus BX43, Olympus Co., Tokyo, Japan) with a magnification of 20x to detect deformation and manufacturing failures before they were used in the test mechanism.

A stainless steel mechanism having a stainless steel artificial canal in which files could freely rotate was fabricated or the cyclic fatigue tests (diameter 1.5 mm, length 18 mm). The angle of the first curvature in the coronal area was 60 degrees. The diameter of the curvature was 5 mm in a double curvature artificial canal. The distance between the center location of the coronal curvature and the tip of the canal was found to be 8 mm. The apical curvature angle

Fig. 1. A stainless steel artificial canal with double curvature canal.

was 70 degrees, while its diameter was 2 mm. The distance between the center location of the curvature was found as 2 mm (Fig. 1).

Synthetic lubricant (WD-40 Company, Milton Keynes, England) was used to decrease friction and enable the files to rotate freely in the artificial canals. TruNatomy Glider files (17.02 v) were used with a VDW Silver Reciprocal endodontic engine (VDW, Munich, Germany) at 500 rpm and 2 N torque values, following the manufacturer's instructions. WaveOne Gold Glider files (15.02 v) were used with the same engine in WaveOne All mode. The speed in WaveOne All mode is 350 rpm according to the manufacturer (9). All of the files were used in artificial canals, and time to fracture was recorded via a digital stopwatch. A single specialist carried out all of the procedures of the test.

The following formula was used to calculate the number of cycles to fracture (NCF) (NCF 60, where NCF is the number of cycles to fracture, rpm is the number of rotation of the files per minute, and duration is measured in seconds). NCF = rotation of the files per minute (rpm) x duration (second)/60. The length of each broken end was measured using a digital meter (WT 20130 Digital power meter, Yokogawa, Tokyo, Japan).

Statistical Analysis

Differences between the average NCF and the length of the broken pieces were analyzed using the independent t-test and one-way analysis of variance tests using IBM

Table 1. The means of the number of cycles to failure (NCF) and length of fractured fragments

Groups	NCF	SD	Fracture length (mm)
TruNatomy Glider	1485.5[a]	57.54	2.15
WaveOne Gold Glider	1877.5[b]	55.16	2.12

There is no statistically significant difference between the values with the same superscript letters.

SPSS Statistics 21.0 (Released 2012. Armonk, NY: IBM Corp.) (Table 1).

Results

The average and standard deviations of the NCF of TruNatomy Glider and WaveOne Gold Glider Ni–Ti files are shown in Table 1. Statistically, the WaveOne Gold Glider was found to be more resistant to cyclic fatigue than TruNatomy Glider ($p< 0.05$). All files initially broke in the apical area and then in the coronal area of double curvature artificial canals.

Discussion

Many studies have pointed out the significance of efficiently and safely creating a glide path for flare curved root canals. In addition to the curved canals with a single curvature, there are also S-shaped canals with curvatures. S-shaped curvatures in root canals result in more stress accumulation on the file when compared to single curvature canals (10). Furthermore, creating a glide path in S-shaped canals can be more difficult when compared to curved canals with a single curvature. Recently, various file systems have been produced using different technologies to create glide paths. This study aimed to compare cyclic fatigue resistance of the TruNatomy Glider and WaveOne Gold Glider single glide path files, which were produced to create glide paths.

Studies have highlighted the fact that the kinematic and alloy features of the files are efficient in terms of cyclic fatigue resistance (11,12). In 2008, Yared stated that Ni–Ti files, which are used with a reciprocating motion, are more resistant to cyclic fatigue than files with a rotating motion (12). Varela-Patiño et al. (13) found that angular movement of the files in a reciprocating motion causes not only less stress on the files but also increases their resistance to cyclic fatigue when compared to a rotating motion. Evaluating the cyclic fatigue of R-Pilot, HyFlex EDM, and PathFile files in double curvature artificial canals, Uslu et al. (14) concluded that the R-pilot reciprocating single glide path file is more resistant to fatigue compared to the other files. The studies which were carried out in single curvature artificial canals with 45, 60, and 90-degree curves showed that the 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 (15–17). Moreover, the WaveOne Gold Glider file is produced with gold-wire technology, and recent studies have shown that alloy properties are of high significance for cyclic fatigue resistance in Ni–Ti instruments (17,19). NCF results of our study also show that the WaveOne Gold Glider file is more resistant to fracture due to cyclic fatigue in the apical curvature when compared to the TruNatomy files; therefore, the null hypothesis was rejected.

In the literature, there are yet no studies that compare the cyclic fatigue resistance of WaveOne Gold Glider and TruNatomy Glider files, so the results of the present study cannot be directly compared with other studies in the literature. Previous studies stated that the different heat treatment applications and manufacturing methods might affect the fatigue resistance of endodontic instruments (18). Thus, the heat treatment which was applied to WaveOne Gold Glider files may have contributed to their superior fatigue resistance. On the other hand, TruNatomy Glider files work with a rotation motion. Previous studies demonstrated that reciprocation motion provided higher cyclic fatigue resistance when compared to rotation motion (17,19), which is a shred of evidence that shows why TruNatomy Glider files have less cyclic fatigue resistance than WaveOne Gold Glider.

According to the results of our study, fractures on the files initially formed in the apical and then in the coronal. The results of similar studies are consistent with the outcomes of our study (20). A smaller radius in the apical curvature is a sign of a sharper curve, which causes files to have fractures in this area first. The average lengths of the pieces that were broken in the apical were found to be similar.

Conclusion

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

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