Effect of Glide Path Creating on Cyclic Fatigue Resistance of Reciproc and Reciproc Blue Nickel-titanium Files: A Laboratory Study

Taha Özyürek, DDS, PhD, Gülşah Uslu, DDS,* Koray Yılmaz, DDS, MSc,† and Mustafa Gündoğar, DDS, PhD‡*

Abstract

Introduction: The purpose of this article was to compare the cyclic fatigue resistance of Reciproc and Reciproc Blue files (VDW GmbH, Munich, Germany) that were used to prepare root canals of mandibular molar teeth with or without a glide path. **Methods:** Sixty Reciproc R25 and 60 Reciproc Blue R25 files were used. The Reciproc and Reciproc Blue groups were divided into 3 subgroups (ie, as received condition, used without a glide path, and used with a glide path). All the instruments were rotated in a stainless steel artificial canal with an inner diameter of 1.5 mm, a 60° angle of curvature, and a radius of curvature of 5 mm until fracture occurred. The number of cycle to fracture was calculated, and the length of the fractured segments was measured. The Kruskal-Wallis test was performed to statistically analyze the data using SPSS 21.0 software (IBM Corp, Armonk, NY) at a 5% significance level. **Results:** The cyclic fatigue resistance of as received condition Reciproc Blue files was found to be higher than as received condition Reciproc files ($P < .05$). Reciproc Blue files used for root canal preparation showed higher cyclic fatigue resistance than Reciproc files used for root canal preparation ($P < .05$). There was no statistically significant difference between Reciproc and Reciproc Blue files used with a glide path and without a glide path ($P > .05$). There was no statistically significant difference in the mean length of the fractured fragments of the instruments ($P > .05$). **Conclusions:** Within the limitations of this *in vitro* study, it was concluded that creating a glide path using ProGlider files had no effect on the cyclic fatigue resistance of RPC and RPC Blue files. *(J Endod 2018;■:1–5)*

Key Words

Cyclic fatigue, glide path, nickel-titanium, Reciproc, Reciproc Blue

Significance

The manufacturer of Reciproc instruments does not strictly recommend creating a glide path before using the reciprocating instruments. To date, the effect of creating a glide path on the cyclic fatigue resistance of novel Reciproc Blue files is unknown.

Nickel-titanium (NiTi) files are more flexible and cyclic fatigue resistant than stainless steel files, but NiTi files might unexpectedly fracture during clinical use (1, 2). NiTi file fractures occur because of torsional or cyclic fatigue. Torsional fracture occurs when the tip of the file is stuck in the root canal while its coronal segment keeps rotating (3). Cyclic fatigue fractures occur when the file is exposed to repetitive compaction and tension forces while rotating in a curved canal (4).

The manufacturers apply heat treatment before or after the production of NiTi files in order to improve the cyclic fatigue resistance of files. In previous studies, it was shown that the heat treatments applied to NiTi files increased their cyclic fatigue resistance (5–8).

For this purpose, VDW GmbH (Munich, Germany) recently updated the Reciproc (RPC) file to Reciproc Blue (RPC Blue). RPC Blue files have the same S-shaped cross section and the same number of files (R25, R40, and R50) as RPC files. Moreover, RPC Blue files have the same motion kinematics (reciprocation) as RPC files. It was reported that with the new heat treatment used in the production of RPC Blue files, which are characterized by their blue color, they have 40% higher flexibility and 2.3 times more cyclic resistance when compared with RPC files (9).

The endodontic glide path is defined as a smooth radicular tunnel from the canal orifice to the physiologic terminus, and it ensures a pathway for larger tapered NiTi rotary files in order to follow in the canal (10). The glide path can be created by using stainless steel files or NiTi files with small tip diameters (11). ProGlider (PG; Dentsply Maillefer, Ballaigues, Switzerland) is an NiTi glide path file consisting of a single file and manufactured from M-Wire alloy. PG's tip diameter is 0.16 mm, and it has a variable taper throughout its length (12).

The manufacturer of RPC instruments does not strictly recommend creating a glide path before using the reciprocating instruments. Reciprocal motion is alleged to prevent the instrument from being stuck in the canal by gradually decreasing the stress accumulating on the file and to increase the fracture resistance of the instrument. For this reason, it is argued that it is not necessary to create a glide path before using RPC files (13). It was reported that RPC files reached the apex even when no glide path was created (14).

From the *Department of Endodontics, Faculty of Dentistry, Ondokuz Mayıs University, Samsun, Turkey; †Samsun Oral and Dental Health, Samsun, Turkey; and ‡Department of Endodontics, Faculty of Dentistry, Medipol University, İstanbul, Turkey.

Address requests for reprints to Dr Koray Yılmaz, Samsun Oral and Dental Health Hospital, Samsun, Turkey. E-mail address: koray1903@hotmail.com
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In the literature, there is no study examining the effect of creating a glide path on the cyclic fatigue resistance of RPC and RPC Blue files. For this reason, in the present study, we aimed to compare the cyclic fatigue resistance of RPC and RPC Blue files that were used to prepare root canals of mandibular molar teeth with or without a glide path. The null hypothesis of the present study was that creating a glide path before preparing root canals of mandibular molar teeth would have no effect on the cyclic fatigue resistance of RPC and RPC Blue files.

Materials and Methods

In the present study, 60 RPC R25 (25/.08) and 60 RPC Blue R25 (25/.08) files were used. Before the experiment, the files were inspected using a stereomicroscope (Olympus BX43; Olympus Co, Tokyo, Japan) from the aspect of the presence of any defect. Because no defect was found, all of the files were involved in the study, and then the files were randomly divided into the following 6 groups (n = 20/each group).

1. Group 1, RPC (as received condition): 20 RPC R25 files were directly subjected to the static cyclic fatigue test without being used in any teeth (as received condition).
2. Group 2, RPC (used without a glide path): 20 RPC R25 files were firstly used for the preparation of 3 root canals of mandibular molar teeth in which no glide path was created before and then subjected to the static cyclic fatigue test.
3. Group 3, RPC (used with a glide path): 20 RPC R25 files were firstly used for the preparation of 3 root canals of mandibular molar teeth in which a glide path was created using a PG file and then subjected to the static cyclic fatigue test.
4. Group 4, RPC Blue (as received condition): 20 RPC Blue R25 files were directly subjected to the static cyclic fatigue test without being used in any teeth (as received condition).
5. Group 5, RPC Blue (used without a glide path): 20 RPC Blue R25 files were firstly used for the preparation of 3 root canals of mandibular molar teeth in which no glide path was created before and then subjected to the static cyclic fatigue test.
6. Group 6, RPC Blue (used with a glide path): 20 RPC Blue R25 files in this group were firstly used for the preparation of 3 root canals of mandibular molar teeth in which a glide path was created using a PG file and then subjected to the static cyclic fatigue test.

Selection of Teeth

To examine the effect of creating a glide path on the cyclic fatigue resistance of RPC R25 and RPC Blue R25 files, 80 first mandibular molar teeth, which were extracted and have 2 separate mesial canals and 1 distal canal, were involved in the present study. As in the study of Kosti et al (15), the inclusion criteria were as follows: having a severe root curvature (angle 60° ± 10°, radius 2 ± 1 mm), having completed root formation, having no internal/external root resorption or calcification, having no crack or fracture, and having no history of previous endodontic treatment. The mesial canals of the teeth were scouted with a #15 K-file (VDW), and the distal canals were scouted with a #20 K-file (VDW). Teeth with a diameter >0.15 mm in the mesial canals and >0.20 mm in the distal canals were removed from the study and replaced with new ones. The selected teeth were then randomly divided into 4 groups (n = 20) to be used for preparation (www.random.org).

Glide Path Creation and Root Canal Preparation

After preparing the endodontic access cavities, the canals were checked using #10 K-files (VDW), and the working length was set to 1 mm shorter than the apex. A glide path was created in the root canals of a total of 40 teeth (groups 3 and 6) using PG (16/.02) NiTi files at 300-rpm speed and 500-g/cm torque with an endodontic motor (X-Smart, Dentsply Maillefer) in accordance with the manufacturer's instructions.

In total, 80 teeth in groups 2 and 5 (no glide path) and groups 3 and 6 (with glide path) were shaped using RPC R25 and RPC Blue R25 files. The RPC R25 and RPC Blue R25 instruments were used with the VDW.Gold Reciproc (VDW) endodontic motor in the "RECIPROC ALL" program until reaching the working length. According to the manufacturer's instructions, RPC and RPC Blue instruments were used with an in-and-out pecking motion and gentle apical pressure. A total of 30 mL 5.25% sodium hypochlorite was used in each tooth for irrigation during root canal preparation.

Static Cyclic Fatigue Test

All of the RPC R25 and RPC Blue R25 files were subjected to the cyclic fatigue test using stainless steel artificial canals. Artificial canals had a 1.5-mm inner diameter, a 60° angle of curvature, and a 5-mm radii of curvature; the center of curvature was located at 5 mm coronal to the end of the artificial canal. All of the files were operated in artificial canals using the VDW.Reciproc Gold endodontic motor with "RECIPROC ALL" software until the files fractured, and the time to fracture was recorded using a digital chronometer. In order to minimize the friction between the file and the artificial canal, a synthetic lubricant (WD-40 Company, Milton Keynes, UK) was used. The number of cycle to fracture was calculated as follows: number of cycle to fracture = revolution per minute × time to fracture (in seconds)/60. Moreover, the length of the fractured segments was measured using calipers. Twelve randomly selected files (n = 2/group) were investigated using a scanning electron microscope (JSM-7001F; JEOL, Tokyo, Japan) in order to determine the type of fracture (Fig. 1*A–D*).

Statistical Analysis

The data were first analyzed using the Shapiro-Wilk test to verify the assumption of normality. The Kruskal-Wallis test was performed to statistically analyze the data using SPSS 21.0 software (IBM Corp, Armonk, NY). The statistical significance level was set at $P < .05$.

Results

The number of cycle to fracture values of the RPC R25 and RPC Blue R25 files and the mean lengths of the fractured segment are presented in Figure 2. The cyclic fatigue resistance of the RPC Blue R25 files in group 4 (as received condition) was found to be higher than that of the RPC R25 files in group 1 (as received condition) ($P < .05$). The RPC Blue R25 files used for root canal preparation (groups 5 and 6) showed higher cyclic fatigue resistance than the RPC R25 files used for root canal preparation (groups 2 and 3) ($P < .05$).

There was no statistically significant difference between RPC R25 files in group 1 (as received condition) and the RPC R25 files in group 3 (used with a glide path) and group 2 (used without a glide path) ($P > .05$).

In the RPC Blue R25 files, although no statistically significant difference was found between files used without a glide path (group 5) and those used with a glide path (group 6) ($P > .05$), a statistically significant difference was found between the files in group 5 (used without a glide path) and group 4 (as received condition) ($P < .05$).

The mean length of the fractured segments was recorded to evaluate the correct positioning of the tested instrument inside the canal curvature. There was no statistically significant difference in the mean