

## Research Article



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No potential conflict of interest relevant to this  
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# Comparison of the ability of Reciproc and Reciproc Blue instruments to reach the full working length with or without glide path preparation

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## ABSTRACT

**Objectives:** The purpose of the present study was to compare the mean preparation times and frequency with which Reciproc and Reciproc Blue instruments reached the full working length in mandibular molars, with or without glide path preparation.

**Materials and Methods:** Previously untreated mesiobuccal and mesiolingual canals with completely formed apices were randomly divided into 6 groups ( $n = 50$ ) depending on the usage of Reciproc (RC; VDW), Reciproc Blue (RC Blue; VDW), C-Pilot (CP; VDW), and R-Pilot (RP; VDW) files: RC, RC Blue, RC + C-Pilot (RC-CP), RC-Blue + C-Pilot (RC Blue-CP), RC+R-Pilot (RC-RP), and RC Blue + R-Pilot (RC Blue-RP). A glide path was prepared using the hand-operated C-Pilot or the machine-operated R-Pilot instruments, respectively. The  $\chi^2$  test, analysis of variance, and the Tukey *post hoc* test were used for statistical comparisons.

**Results:** No statistically significant differences were observed in the distribution of the frequency of reaching the full working length in the RC (94%), RC Blue (88%), RC-CP (94%), RC Blue-CP (90%), RC-RP (96%), and RC Blue-RP (92%) groups ( $p > 0.05$ ).

**Conclusions:** Preparation of a glide path did not have a significant effect on reaching the full working length using these systems.

**Keywords:** C-Pilot; Glide path; R-Pilot; Reciproc; Reciproc Blue

## INTRODUCTION

Single-file nickel-titanium (NiTi) systems have gained widespread acceptance in endodontic practice [1]. Since the 2011 introduction of the Reciproc (RC; VDW, Munich, Germany) system on the market, the files of that system have been used in many cases to complete root canal preparation using only 1 instrument [2-4]. These instruments are made from heat-treated NiTi M-wires and use a reciprocating motion, which increases the life span of the instruments [1,2]. Recently, Reciproc Blue (RC Blue; VDW) systems that employ an identical reciprocating motion and kinematics as RC have been introduced. According to the manufacturer, the design, geometry, and size of RC Blue instruments are identical to those of the RC instruments. The RC Blue instrument is produced using an innovative heat treatment that transforms its molecular structure [3]. Thus, this novel system is much more flexible than its predecessor. It is also more resistant to cyclic fatigue-related fractures and has

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reduced surface microhardness [3]. Another innovation of the RC Blue system is the ability to pre-bend the instrument. The manufacturer claims that RC Blue instruments work without the creation of a glide path in cases of severe canal curvature.

The utilization of a glide path is helpful for preserving root canal anatomy and improving performance before rotary instrumentation [5-7]. The creation of a smooth glide path facilitates cleaning and shaping procedures with NiTi instrumentation. It allows canal orifices to be located and provides safe and efficient access to the apical third of the canal when using rotary systems [8,9]. Early canal enlargement can markedly decrease the risk of canal modifications and fracture of rotary instruments, primarily in curved canals [9]. Although the glide path is an important step when using rotary systems, the effect of the glide path on reciprocating systems remains unclear [9]. Instruments that are hand-operated or engine-driven are used for pathfinding purposes [10]. C-Pilot files (VDW), which are stainless steel instruments with an inactive pilot tip, have been produced for use in curved or calcified root canals. R-Pilot files (VDW), which are made of M-wire alloy, are engine-driven files for glide path preparation and designed for use with a reciprocating motion. The R-pilot is the first NiTi rotary glide path file to be used with a reciprocating motion. It has an S-shaped cross-section, a 0.125 mm tip diameter, and a constant 4% taper [11].

Previous studies have demonstrated that it was possible to enlarge straight and moderately curved molar canals using an RC instrument up to the working length (WL) without a glide path [12,13]. However, to the best of our knowledge, there are no data in the literature on the possibility of using RC Blue up to the WL without a glide path. The goal of the present study was to compare the mean preparation times and frequency of canals in mandibular molars in which RC R25 and RC Blue R25 instruments reached the full WL, with or without a glide path. The null hypothesis tested in the study was that there would be no difference between the groups.

## MATERIALS AND METHODS

### Specimen preparation

After obtaining approval from the Ethics Committee of Hatay Mustafa Kemal University (2017/169), 150 extracted human mandibular molars were selected. The teeth, 19–21 mm in length, were radiographed to determine which teeth met the selection criteria using the Schneider technique [14]. After preoperative buccolingual radiography, separate foramina for the mesiobuccal and mesiolingual canals with curvatures ranging from 25° to 39° were included. In addition, only teeth in which the root canals were completely visible on the radiograph were included. Additionally, 300 previously untreated mesial canals with completely formed apices were selected, and the canals were randomly divided into 6 groups ( $n = 50$ ), according to the use of Reciproc (RC), Reciproc Blue (RC Blue), Reciproc + C-Pilot (RC-CP), Reciproc Blue + C-Pilot (RC Blue-CP), Reciproc + R-Pilot (RC-RP), or Reciproc Blue + R-Pilot (RC Blue-RP) (all VDW). Standard endodontic access cavities were prepared. No instruments had previously been used in root canals. After orifice opening, all the root canals were initially irrigated with 1 mL of 5.25% NaOCl. All procedures were performed by the same experienced researcher.

In the RC and RC Blue groups, no glide path was created, and no instrument was used earlier in the root canal. The RC R25 (size 25/0.08) and RC Blue R25 (size 25/0.08) instruments were used with a torque-controlled motor (Silver; VDW) in the “Reciproc ALL” mode. Each instrument was used for a maximum of 3 canals and inspected under a dental operating microscope (Opmi-Pico, Karl Zeiss, Jena, Germany) to detect defects or deformities after each preparation. The instrument was advanced in the canal until reaching two-thirds of the previously estimated WL. The preparation was carried out using a reciprocating in-and-out motion, not exceeding an amplitude of 3–4 mm, with gentle apical pressure. After 3 motions, the instrument was removed from the root canal, and its flutes were cleaned with gauze. At this point, the root canal was irrigated with 1 mL of 5.25% NaOCl. A size 10 hand K-file was gently inserted into the root canal until the tip of the file was just visible at the apical foramen. The WL was established 0.5 mm short of this measurement. No instrumentation movement was performed with the hand file up to this point. Both the RC and RC Blue instruments were able to reach the established WL and were classified as reaching the full working length (RFL). If the instrument could not proceed and failed to reach the established WL, the preparation was stopped, and the instrument was classified as not reaching the full working length (NFWL). All the teeth were radiographed postoperatively to examine the root canals.

A glide path was prepared in the RC-CP and RC Blue-CP groups using a hand-operated pathfinding file (C-pilot; size 12.5/0.02 along the entire shaft). The file was advanced apically until it met the root canal walls. A quarter-turn/pull movement was applied, with slight apical pressure when the file was loose inside the canal. After 3 repetitions, the file was cleaned, and the root canal was irrigated with 1 mL of 5.25% NaOCl. The instrument was used until the tip of the file was just visible at the apical foramen. The WL was determined. The same reciprocating procedures as in the RC and RC Blue groups were then performed.

In the RC-RP and RC Blue-RP groups, a glide path was created in the canal using engine-driven pathfinding files (R-Pilot file; size 12.5/0.04). The R-Pilot instrument was used with the same endodontic motor in the same mode as in the reciprocating procedures. The instrument was moved using a slow in-and-out pecking motion, not exceeding an amplitude of 2–3 mm, with light apical pressure. After 3 motions, the file was cleaned, and the root canal was irrigated with 1 mL of 5.25% NaOCl. The instrument was stopped by the operator. Then, the rubber stop on the instrument was adjusted to the coronal reference point. After the rubber stop was fixed to the instrument with a flowable light cure resin, the instrument was removed and the distance between the rubber stop and the file tip was measured. The WL was established 0.5 mm short of this measurement. The procedures were repeated until the full WL was reached, and then the same reciprocating procedures in the RC and RC Blue were performed.

### **Preparation time**

For all instruments, the preparation time was recorded in seconds using a chronometer. The total time included the initial 1 mL irrigation with 5.25% NaOCl solution, patency exploration with a size 10 K-file, glide path formation (in groups with a glide path), and reciprocating instrumentation. The reciprocating time was recorded from the beginning of preparation with the RC or RC Blue instruments until the WL was reached. The chronometer was continued if further instrumentation was considered necessary after the 3 initial motions, including the time required for cleaning the instrument, further irrigation, and patency confirmation.

**Table 1.** Frequency (%) of cases evaluated as reaching the full working length (RFL) or not reaching the full working length (NFWL) and mean ( $\pm$  standard deviation) of total time required for canal preparation

Group	No.	RFL	NFWL	Fracture	Total preparation time (sec)
Reciproc	50	47 (94%) <sup>a</sup>	3 (6%)	2	91.96 $\pm$ 10.05 <sup>a</sup>
Reciproc Blue	50	44 (88%) <sup>a</sup>	6 (12%)	0	99.92 $\pm$ 12.38 <sup>a</sup>
Reciproc + C-pilot	50	47 (94%) <sup>a</sup>	3 (6%)	1 + 0	122.20 $\pm$ 14.74 <sup>b</sup>
Reciproc Blue + C-Pilot	50	45 (90%) <sup>a</sup>	5 (10%)	0 + 0	126.96 $\pm$ 15.60 <sup>b</sup>
Reciproc + R-pilot	50	48 (96%) <sup>a</sup>	2 (4%)	1 + 1	139.02 $\pm$ 17.74 <sup>c</sup>
Reciproc Blue + R-Pilot	50	46 (92%) <sup>a</sup>	4 (8%)	0 + 1	145.90 $\pm$ 19.61 <sup>c</sup>

Different superscript letters show a significant difference between groups ( $p < 0.05$ ).

### Statistical analysis

The collected data were analysed with SPSS version 21.0 (SPSS Inc., Chicago, IL, USA). The normal distribution of the variables was tested using the Shapiro-Wilk test. Homogeneity of the variances was analysed with the Levene test. One-way analysis of variance and the Tukey honest significant difference test were used to compare the total time required for canal preparation, and the  $\chi^2$  test was applied to compare the distribution of the frequency of cases evaluated as RFL or NFWL. Statistical significance was set at  $p < 0.05$ .

## RESULTS

The mean times for total preparation and the distribution of the frequency of RFL are presented in **Table 1**. No statistically significant differences in RFL were found among groups (RC: 94%; RC Blue: 88%; RC-CP: 94%; RC Blue-CP: 90%; RC-RP: 96%; RC Blue-RP: 92%;  $p > 0.05$ ). The RC instruments tended to perform better in RFL than the RC Blue group. Although fractures occurred in the RC group, there were no fractures in the RC Blue group. The total preparation times of groups with a glide path were significantly longer than those without a glide path. The preparation times in the groups without a glide path (RC: 91.96  $\pm$  10.05 seconds; RC Blue: 99.92  $\pm$  12.38 seconds) were statistically significantly shorter than those in groups with a glide path ( $p < 0.05$ ). The mean preparation times of the RC-RP (139.02  $\pm$  17.74 seconds) and RC Blue-RP (145.90  $\pm$  19.61 seconds) groups, with an engine-driven glide path, were longer than those of the RC-CP (122.20  $\pm$  14.74) and RC Blue-CP (126.96  $\pm$  15.60) groups, with a manual glide path.

## DISCUSSION

Single-instrument root canal preparation is time-saving and comfortable for both the patient and clinician. RC and RC Blue are single-file systems that utilize reciprocal motion, which rotates 150° counterclockwise and 30° clockwise. In these systems, glide path use is not recommended by the manufacturer [4,15].

The present study compared the frequency of canals in which RC and RC Blue instruments reached the full WL, with or without a glide path. The findings of this study found no apparent difference between the RC and RC Blue instruments as regards RFL, with or without a glide path. The RC and RC Blue instruments reached the full WL in the absence of a glide path at a high frequency. Therefore, there was no significant between-group difference in RFL, irrespective of the presence or absence of a glide path. Previously, several researchers reported the ability to use an RC instrument up to the WL without a glide path [13,16]. Bartols *et al.* [13] reported that 95.6% of root canals could be prepared to the full WL using RC instruments.

De-Deus *et al.* [12] reported that the full WL was reached in 90.7%–96.4% of cases using RC instruments in root canals of lower molars. The findings of those studies are compatible with the results of the present study. To the best of our knowledge, no previous comparisons have been made of the ability of RC Blue file systems to reach the full WL without a glide path. Thus, a direct comparison of the findings of the present study with the results in the literature is not possible. In the present study, the RC instruments tended to perform better in RFWL than the RC Blue instruments. The RC Blue file systems have the same size, design, cross-section, and alloy type as the RC file systems. Moreover, in both groups, the files were used with the same kinematics (reciprocal speed and torque) and with the same motor [1,2]. The features of RC Blue made it possible to use that system to prepare the majority of root canals without a glide path. The only difference between the RC and RC Blue systems is the thermal treatment procedure of the RC Blue instruments. The heat treatment used in the manufacturing process of the RC Blue instruments is responsible for the distinct characteristics of RC Blue instrument system. The manufacturing process turns the colour of the instrument blue. The proprietary blue heat treatment, which modifies the molecular structure, gives the RC Blue instruments more strength and flexibility than the RC instrument system [4]. Many previous studies reported that this thermal treatment technology increased the life span of the instruments [17,18]. In the present study, no fractures were observed in the RC Blue group, although some fractures did occur in the RC group. It is possible that the thermal treatment procedure may affect the ability of RC Blue file systems to reach the full WL without a glide path. Based on our findings, we conclude that the ability of RC Blue to reach the full WL is not as good as that of RC, although the difference was not statistically significant.

The glide path procedure reduces the incidence of taper locking, which refers to a phenomenon in which a file binds against the canal wall over the length of its cutting blades [16,19]. Taper locking usually occurs when the instrument tip is larger than the canal cross-section. Without a glide path, the contact area between the instrument and canal walls increases, which may result in torsional stress [16]. Glide path preparation is well established as an important step before rotary instrumentation. It is thought to prevent instrument wear and to reduce the instrument fracture rate [7]. However, the effect of the glide path on reciprocating systems remains unclear [9]. No previous studies have evaluated the effect of using different glide path instruments on the ability of RC and RC-Blue systems to reach the full WL. In this study, R-pilot engine-driven instruments were used with reciprocal motion for glide path preparation. The use of R-pilot engine-driven instruments rather than hand-operated instruments for glide path preparation did not result in significant differences in the ability of RC and RC-Blue to reach the full WL.

The creation of a glide path is an additional procedure that increases the total preparation time [9]. Thus, in the present study, the total preparation times in the RC and RC Blue groups without a glide path were significantly shorter than those in the groups in which a glide path was prepared. There was also a statistically significant difference between the mean preparation times of the manual and engine-driven glide path groups, with shorter preparation times in the RC-CP and RC Blue-CP groups (manual glide path) than in the RC-RP and RC Blue-RP groups (engine-driven glide path). It is important to take into account the final apical preparation size and taper of canals prepared using different glide path instruments [8]. In the present study, the glide path was prepared in the RC-CP and RC Blue-CP groups with a C-Pilot instrument, whereas an R-Pilot instrument was used in the RC-RP and RC Blue-RP groups. The same apical preparation size was used in both systems. Although the ideal size of an apical file for creating a glide path is not clear, a small size hand

file is usually used for enlargement of the root canal [20]. In this study, an intermediate-sized file (ISO 12.5) was selected. However, the canals in the groups in which the C-Pilot was used had an average canal taper of 2% (along the entire shaft), as compared with an average taper of 4% in the groups in which the R-Pilot was used. Although the mean glide path preparation times were shorter in the RC-CP and RC Blue-CP groups than in the other groups, the canal taper in these groups was smaller than in the RC-RP and RC Blue-RP groups. We conclude that the total preparation time was increased by the use of larger taper files in the RC-RP and RC Blue-RP groups.

## CONCLUSIONS

Using RC and RC Blue instruments, the vast majority of root canal cases can be prepared without glide path preparation. The use of a glide path was not associated with an improvement in the ability of the tested systems to reach the full WL.

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