Scouting Ability of 4 Pathfinding Instruments in Moderately Curved Molar Canals

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Abstract

Introduction: Glide path preparation has been recommended as a mandatory clinical step to ensure the safe usage of nickel-titanium (NiTi) rotary instruments. This study aimed to evaluate the effectiveness and fracture rate of 4 pathfinding NiTi rotary instruments in mechanically negotiating moderately curved molar canals. **Methods:** Moderately curved maxillary (n = 120) and mandibular (n = 120) molars were randomly distributed into 4 experimental groups (n = 60, 30 maxillary and 30 mandibular molars) according to the instrument used for glide path preparation: ScoutRace 10/.02 (FKG Dentaire, La Chaux-de-Fonds, Switzerland) (800 rpm and 1-Ncm torque), ProDesign 25/.01 (Easy Equipamentos Odontológicos, Belo Horizonte, MG, Brazil) (350 rpm and 1-Ncm torque), Mtwo 10/.04 (VDW, Munich, Germany) (280 rpm and 1.2 Ncm torque), or ProGlider 16/.02 (Dentsply Maillefer, Ballaigues, Switzerland) (300 rpm and 5-Ncm torque). The instrument fracture rate and the absolute and percentage frequencies of molars in which the pathfinding instruments reached the full working length in all root canals according to tooth and canal types were recorded and statistically compared using the Pearson's chi-square test (α = 5%). **Results:** The highest and lowest frequency of reached the full working length canals were observed in the ScoutRace (68.3%) and ProDesign (38.3%) groups (P < .05), respectively, whereas the Mtwo (58.3%) and ProGlider (51.6%) groups showed intermediate results (P > .05). The ProGlider group showed the highest percentage frequency of instrument separation (11.6%) followed by the Mtwo (8.3%), ScoutRace (3.3%), and ProDesign (3.3%) groups (P < .05). **Conclusions:** ScoutRace performed more efficiently and with less instrument breakage than the other systems. ProDesign was the least efficient, and ProGlider exhibited the highest rate of instrument breakage among the systems tested. *(J Endod 2016;42:1540–1544)*

Key Words

Glide path, nickel-titanium rotary instruments, pathfinding instruments, rotary motion

> **Significance**
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> Full rotary negotiation with the tested pathfinding instruments is an unpredictable procedure in terms of efficiency and risk of file separation.

In endodontics, glide path preparation has been defined as a series of clinical procedural steps that aim to expand or preshape the root canal from its orifice to its physiological terminus before using greater tip diameter and tapered shaping files (1, 2). Glide path creation has been extensively recommended as a mandatory clinical step to improve the safety and efficiency of rotary nickel-titanium (NiTi) instruments by preventing the taper lock phenomenon, thus increasing the instrument's life span by diminishing fracture rates and preventing shaping errors (3–7). Glide path preparation usually has been performed with conventional stainless steel hand files; however, in the last years, dedicated mechanical NiTi instruments were designed exclusively for glide path preparation purposes. Compared with manual preparation, mechanical glide path technique has been shown to significantly reduce procedural chair time while decreasing postoperative pain and flare-ups (2, 6), preserving the original root canal morphology (5, 6).

Nowadays, several single- and multiple-file rotary systems are available for glide path preparation procedures. The ScoutRace system (FKG Dentaire, La Chaux-de-Fonds, Switzerland) is a sequence of 3 constant tapered instruments (0.02 mm per millimeter) with a square cross-sectional design and ISO tip diameters of 10, 15, and 20, recommended for canals with severe curvature (8). Examples of single-file glide path systems include Mtwo (VDW, Munich, Germany) and ProDesign (Easy Equipamentos Odontológicos, Belo Horizonte, MG, Brazil) instruments. The Mtwo 10/.04 instrument has an S-shaped cross-sectional design with a double cutting blade, noncutting safety tip, and positive cutting angle (9), whereas the pathfinding ProDesign 25 tip size instrument is a non-tapered instrument with a modified square cross-sectional design (10). Recently, the ProGlider instrument (Dentsply Maillefer, Ballaigues, Switzerland) was launched with the promise of enhancing mechanical glide path preparation. This instrument has an ISO 16 tip size and a variable progressive taper (2%–8%) and is made of a proprietary M-Wire NiTi alloy, which has been found to significantly improve flexibility and impart greater resistance to cyclic fatigue (11).

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0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2016.07.001

Despite the considerable amount of research conducted on root canal preparation, the literature lacks studies comparing the efficacy of different pathfinding systems in reaching the full working length (RFWL). Therefore, the purpose of this study was to compare the effectiveness and fracture rate of 4 pathfinding NiTi rotary instruments (ScoutRace 10/.02, ProDesign 25/.01, Mtwo 10/.04, and ProGlider 16/.02) in mechanically negotiating moderately curved molar canals to the full working length.

Materials and Methods

Sample Size Estimation

A priori calculation using the goodness-of-fit model from the chi-square test family was adopted to determine the ideal sample size for this study with the following parameters: medium value (w = 0.3) for the effect size, an alpha-type error of 0.05, power statistics of 0.95, and degrees of freedom of 3. The output indicated a minimal sample size of 191 teeth, and a critical chi-square of 7.81 as the limit for accepting H0.

Tooth Specimen Selection and Groups

After approval by the institutional research ethics committee, extracted maxillary (n = 120) and mandibular (n = 120) first and second molars with moderately curved roots (ranging from 10°–20°) (12) were selected and stored in 0.1% thymol solution at 5°C. Preoperative digital radiographs were taken from different angles for each tooth. Only mandibular molars with a single distal canal were included, whereas any existing second canal in the mesiobuccal root of maxillary molars was excluded from the experimental procedures. The teeth were then randomly distributed (www.random.org) into 4 experimental groups (n = 60, 30 maxillary and 30 mandibular molars) according to the instrument used for glide path preparation (ScoutRace [10/.02], ProDesign [25/.01], Mtwo [10/.04], and ProGlider [16/.02]).

Experimental Procedures

After gaining root canal access, each tooth was mounted on a specific apparatus (IM do Brasil, São Paulo, SP, Brazil) that simulated the alveolar socket and allowed connection of the metal lip clip of an apex locator (Root ZX; J Morita USA Inc, Irvine, CA) to enable the electronic measurement of the working length (Fig. 1*A*). Initial scouting of the root canals was performed with an ISO size 08 K-file (Dentsply Maillefer) to determine the appropriate insertion angle for the instruments at the orifice level. Then, the apex locator file holder (Root ZX) was clipped to the upper part of the pathfinding instrument mounted on a contra-angle handpiece (Sirona, Bensheim, Germany) powered by an electric motor (VDW Silver, VDW) (Fig. 1*B*). Glide path preparation was then performed in each group using ScoutRace (10/.02, 800 rpm and 1-Ncm torque), ProDesign (25/.01, 350 rpm and 1-Ncm torque), Mtwo (10/.04, 280 rpm and 1.2-Ncm torque), or ProGlider (16/.02, 300 rpm and 5-Ncm torque) instruments according to the manufacturers' instructions.

Pathfinding instruments were used in full clockwise rotation with a gentle in-and-out motion of about 2-mm amplitude to the full working length, which was established when the apex locator emitted a continuous sound alert indicating that the tip of the instrument had reached the foramen. The instruments were cleaned after 3 pecking motions, and the root canals were then irrigated with 2 mL of 5.25% sodium hypochlorite between each preparation step. RFWL was attempted in all the groups until resistance was encountered and the autoreverse mode of the motor was triggered automatically, preventing the instrument from being introduced any further. In all the groups, the glide path preparation procedures were performed

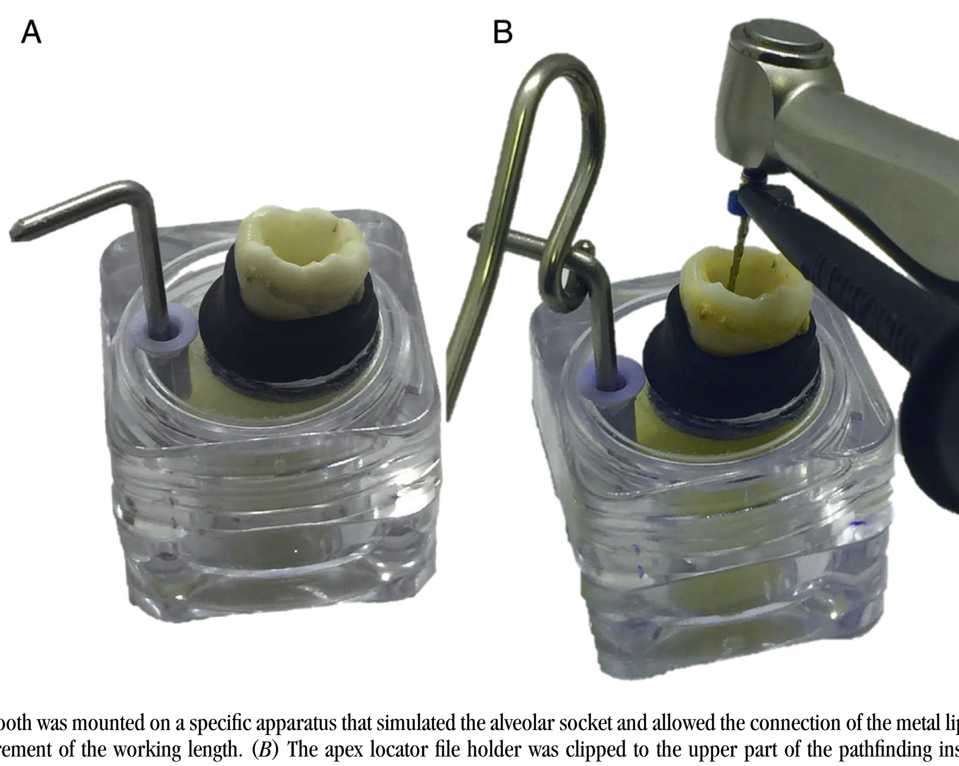

Figure 1. (*A*) Each tooth was mounted on a specific apparatus that simulated the alveolar socket and allowed the connection of the metal lip clip of an apex locator for electronic measurement of the working length. (*B*) The apex locator file holder was clipped to the upper part of the pathfinding instrument mounted on a contra-angle handpiece to perform the glide path preparation procedure.

TABLE 1. Absolute and Percentage Frequencies of Pathfinding Instruments That Reached the Full Working Length (RFWL) according to the Variables Studied

Tooth types and root canals	ScoutRace, *n* (%)	ProDesign, *n* (%)	Mtwo, *n* (%)	ProGlider, *n* (%)
Teeth with all canals classified as RFWL	41 (68.3)[a]	23 (38.3)[b]	35 (58.3)[c]	31 (51.6)[c]
Tooth type				
Maxillary molars	18 (60.0)	9 (30.0)	16 (53.3)	12 (40.0)
Mandibular molars	23 (76.7)	14 (46.7)	19 (63.3)	19 (63.3)
Root canals (maxillary molars)				
Mesiobuccal	25 (83.3)	15 (50.0)	23 (76.7)	21 (70.0)
Distobuccal	24 (80.0)	20 (66.7)	23 (76.7)	19 (63.3)
Palatal	29 (96.7)	27 (90.0)	26 (86.7)	28 (93.3)
Root canals (mandibular molars)				
Mesiobuccal	27 (90.0)	23 (76.7)	21 (70.0)	25 (83.3)
Mesiolingual	26 (86.7)	17 (56.7)	22 (73.7)	26 (86.7)
Distal	27 (90.0)	19 (63.3)	26 (86.7)	25 (83.3)

Different superscript letters indicate a statistically significant difference (Pearson χ^2 test, $P < .05$).

by a previously trained endodontist with 4 years of clinical experience using rotary instruments. Each instrument was used in only 1 tooth and then discarded.

Statistical Analysis

The instrument fracture rate and the absolute and percentage frequencies of molars in which the pathfinding instruments RFWL in all root canals according to tooth (maxillary or mandibular molar) and canal (mesiobuccal, distobuccal, mesiolingual, palatal, or distal) types were recorded and statistically compared using the Pearson's chi-square test with an alpha-type error and critical chi-square set at 0.05 and 7.81, respectively, as indicated by the sample power calculation.

Results

The absolute and percentage frequencies of pathfinding instruments that RFWL as well as the fracture rates according to the studied variables are summarized in Tables 1 and 2. Figure 2*A–L* shows representative images of molars in which the pathfinding instruments were able to RFWL in all the canals as well as images of instrument separation that occurred in the apical third after glide path preparation with all tested systems. Pearson's chi-square test showed that the instrument fracture rate and the frequency of teeth with all root canals classified as RFWL were influenced by the pathfinding system ($P < .05$, $\chi^2 > 7.81$), whereas tooth and canal types did not influence the results ($P > .05$, $\chi^2 < 7.81$). The highest and lowest frequency of canals classified as RFWL were observed in the ScoutRace (68.3%) and ProDesign (38.3%) groups ($P < .05$), respectively, whereas the Mtwo (58.3%) and ProGlider (51.6%) groups showed intermediate results ($P > .05$). The highest percentage frequency of instrument separation was observed in the ProGlider group (11.6%) followed by the Mtwo (8.3%), ScoutRace (3.3%), and ProDesign (3.3%) groups ($P < .05$).

Discussion

In the current study, the tested pathfinding system exerted a significant impact on the frequency of teeth with all root canals classified as RFWL, whereas either tooth (maxillary or mandibular) or canal (mesiobuccal, distobuccal, mesiolingual, palatal, or distal) types had no influence on the performance of the instruments. ScoutRace appeared as the most effective pathfinding instrument, producing the highest frequency of canals classified as RFWL (68.3%). This outcome may be the result of its file's design, which has a small tip size (ISO #10) and a continuous low taper (.02) compared with the other tested systems. This design has been found to minimize the contact area between the shaft and the dentinal walls, reducing torque (13); this, in turn, can render the advance of the instrument toward the apex easier.

Different studies have already shown that a previous glide path preparation procedure is able to reduce the frequency of separation of NiTi instrumentation systems (3, 4, 14). However, to date there is no study demonstrating the difference in separation rates of pathfinding instruments. In this study, the frequency of file separation was not similar among the pathfinding systems. The highest percentage frequency of fracture was observed with ProGlider (11.6%), whereas Mtwo presented intermediate fracture rates (8.3%), and both ScoutRace and ProDesign were the safest files (3.3%). These high fracture rates may be explained by the experimental design of this study. It is important to emphasize that no glide path was prepared manually before using the pathfinding rotary instruments, contrary to all manufacturers' recommendations.

TABLE 2. Absolute and Percentage Frequencies of Pathfinding Instruments That Fractured after Reaching the Full Working Length (RFWL) according to the Variables Studied

Tooth types and root canals	ScoutRace, *n* (%)	ProDesign, *n* (%)	Mtwo, *n* (%)	ProGlider, *n* (%)
Instrument fracture	2 (3.3)[a]	2 (3.3)[a]	5 (8.3)[b]	7 (11.6)[c]
Tooth type				
Maxillary molars	1	—	3	4
Mandibular molars	1	2	—	—
Root canals (maxillary molars)				
Mesiobuccal	—	—	2	2
Distobuccal	1	—	—	2
Palatal	—	—	1	—
Root canals (mandibular molars)				
Mesiobuccal	1	—	—	3
Mesiolingual	—	2	1	—
Distal	—	—	1	—

Different superscript bold letters indicate a statistically significant difference (Pearson χ^2 test, $P < .05$).

Figure 2. Radiographic images of (*A–D*) 2 maxillary and (*E–H*) 2 mandibular molars with root canals classified as RFWL. (*I–L*) Representative images of instrument separation occurring in the apical third of the root canal after glide path preparation with (*I*) ProDesign, (*J*) ProGlider, (*K*) Mtwo, and (*L*) ScoutRace instruments.

This data may evidence that using these pathfinding rotary instruments without previous manual glide path preparation is not recommended.

While mechanically advancing a pathfinding instrument to the working length, the file is largely subjected to stress as a consequence of 2 factors: the taper lock phenomenon (torsional stress) and cyclic fatigue. Because pathfinding instruments are usually extremely flexible, because of the small tip size and low taper, cyclic fatigue appears to be less relevant than torsional stress on the causality of instrument separation. The present results are consistent with the theoretical assumption that fracture rate increases significantly as a function of instrument taper. The larger the instrument taper, the stronger the taper lock phenomenon; therefore, a higher risk of torsional failure. The variable taper of ProGlider results in a coronal flute diameter of 0.99 mm, which certainly increased the contact area of the instrument with the canal walls (taper lock). Arias et al (15) reported an increased peak torque and force during glide path preparation with ProGlider compared with a constant 2% taper file (PathFile, Dentsply Maillefer). The authors questioned whether these features of the ProGlider could result in an increased chance of torsional fracture. The ProGlider fracture rate showed herein tends to confirm this assumption. It seems that the M-Wire technology and the superior ability of ProGlider to withstand *in vitro* cycles to fracture compared with ScoutRace (16) or PathFile (11) do not suffice to prevent the highest fracture rate of ProGlider observed in this study.

In addition, the low taper size of ScoutRace and and the absence of taper in the ProDesign instrument could be the reason for the lower fracture rates observed in these groups, whereas the .04 taper of the Mtwo instrument could explain its intermediate separation frequencies. Despite the low taper and tip size of ScoutRace (17), the instrument is electropolished, which may increase its ability to withstand fatigue (13, 18). The ProDesign file receives no special treatment, and although its safety level was similar to that of ScoutRace, the percentage of canals classified as RFWL related to its use was the lowest (38.3%) among the tested instruments. It is likely that the large tip size (25) of ProDesign prevented the free advance of the file to the working length in the majority of cases.

To the best of the authors' knowledge, there is no peer-reviewed *in vitro* or clinical study regarding the influence of these tested variables on the scouting ability of pathfinding instruments. Although several previous studies have indeed evaluated the use of glide path instruments, most of them evaluated variables such as apical transportation and canal aberrations (7, 8, 16).

Curved canals have been commonly used in these types of studies because they represent a well-known clinical challenge to achieving proper mechanical instrumentation (9). In the present study, molar teeth with canals with moderate curvature were chosen because they represent the type of root canal configuration most commonly observed in clinics (19).

Conclusions

Within the conditions of this study, ScoutRace performed more efficiently and with less instrument breakage than the other tested systems. In contrast, ProDesign was the least efficient instrument, and ProGlider exhibited the highest rate of instrument breakage.

Acknowledgments

The authors deny any conflicts of interest related to this study.

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