Comparison of preparation times of three different rotary glide path instrument systems

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Introduction: This study aimed to compare the preparation times of three different glide path preparation methods using nickel-titanium files in a rotary motion with those achieved by manual stainless-steel K-files.

Materials and methods: ISO 15, 0.02 taper Endo-Training-Blocks (n = 80) were selected and randomly divided into four main groups (n = 20) for glide path preparations: Group 1: with the rotary ProGlider instrument; Group 2: with stainless-steel hand K-files; Group 3: with rotary PathFiles; Group 4: with rotary X-Plorer Navigation Files. The total time taken to prepare the glide paths was recorded. The times required to change instruments, irrigate, clean instruments, and for recapitulation and re-irrigation were not recorded. The data were statistically analysed using the ANOVA / Bonferroni test.

Results: Stainless-steel hand K-files recorded the longest preparation time (24.3s) (P<0.001). The ProGlider instrument was significantly faster at the task at 11.3 seconds compared with all the other test groups (P<0.001). There was no statistically significant difference between the mean glide path preparation times recorded for PathFiles and X-Plorer Canal Navigation Files (P>0.001).

Conclusion: PathFiles and X-Plorer Canal Navigation Files were more efficient than hand K-files. The ProGlider instrument achieved overall significantly shorter glide path preparation times.

INTRODUCTION

The preparation of a glide path prior to the introduction of rotary nickel-titanium instruments is a standard adjunct to ensure more safety during root canal instrumentation.[1] A glide path can be defined as a smooth, radicular tunnel from the canal orifice to the physiologic terminus of the root canal.[2] The purpose of a glide path in root canal preparation is to create a root canal diameter the same size as, or ideally a size bigger than, the first rotary instrument introduced.[3,4,5] Varela-Patiño *et al.* (2005) found that fewer instrument fractures occurred when a wide and smooth-walled glide path was created and the canal was pre-flared before canal preparation with rotary files.[4]

The preparation of a glide path not only reduces the risk of instrument separation, but also conveys to the clinician an intimate knowledge of the tortuous anatomy of the root canal system. Various methods to create a glide path have been advocated. Initially, authors recommended the use of stainless-steel K-files for the task to reduce the failure rate of nickel-titanium instruments.[3,6,7,8,9]

Other authors advocate the use of a reciprocating hand piece in combination with stainless-steel K-files.[10] This combination method reduces hand fatigue and cuts down considerably on clinical chair time, especially in cases with multiple, narrow root canal systems.[10,11,12]

The most recent development in glide path preparation is the use of stainless-steel hand files in combination with rotary nickel-titanium instruments eg. PathFiles (Dentsply/Maillefer), G-Files (Micro-Mega), EndoWave Mechanical Glide Path Kit (MGP)(J Morita), Scout-RaCe Files (FKG), Race ISO 10 (FKG) and X-Plorer Canal Navigation NiTi Files (Clinician's Choice Dental Products Inc.).

The PathFile system consists of three instruments with square cross sections and 2% taper. PathFile no.1 (purple) has an ISO 13 tip size, PathFile no.2 (white), an ISO 16 tip size and PathFile no.3 (yellow) an ISO 19 tip size. The gradual increase in tip size facilitates progression of the files apically. The manufacturer suggests using the PathFile no.1 only after a size 0.10 K-file has been used to explore the root canal to working length.[5,13]

ACRONYMS

DOM: Dental Operating Microscope
MGP: Mechanical Glide Path

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Berutti *et al.* (2009) showed that the preparation of a glide path with hand files resulted in more irregularities and an over-enlargement of the canal curvature compared with the use of rotary PathFiles.[5] They also demonstrated that PathFiles could be safely used by inexperienced operators, who obtained superior results in creating a glide path with far fewer canal alterations than did expert operators using hand files. In a recent study it was demonstrated that glide path preparation with PathFiles increased the longevity of 25/08 WaveOne instruments when used to prepare simulated canals compared with how those instruments lasted when no glide path preparation had been effected or glide path preparation had been completed with stainless-steel hand K-files.[14] The X-Plorer Canal Navigation NiTi File system (Clinician'sChoice Dental Products Inc., New Milford, USA) also consists of three instruments. The first X-Plorer file has an ISO 15 tip size and a 1% taper with a triangular cross section. The second X-Plorer file has an ISO 20 tip size with a 1% taper and a square cross section. The third X-Plorer file has an ISO 20 tip size with a 2% taper and a square cross section. The reduced taper increases flexibility and facilitates apical progression of the files.[15,16]

Cassim and van der Vyver (2013) compared the efficiency of modification of canal curvature and the incidence of canal aberrations after glide path preparation with stainless-steel K-files used manually, stainless-steel K-files used in a reciprocating hand piece, rotary NiTi PathFiles and X-Plorer Navigation Files.[16] They concluded that there were no differences in efficacy between PathFiles and X-Plorer files for glide path preparation. Both these rotary systems performed better than stainless-steel K-files in the reciprocating hand piece, which again, performed better than stainless-steel K-files used manually.

Recently, a new single rotary glide path instrument, the ProGlider (Dentsply/Maillefer), was launched. This instrument is manufactured using M-wire technology, making it more resistant to cyclic fatigue.[17] The M-wire alloy may also decrease the potential for file fracture and increase the flexibility of the instrument. Manufacturers claim that it allows for a smoother "glide path" transition by making use of a controlled, smooth, inward cutting action. The ProGlider instrument has a tip diameter of 0.16mm at D0 and 0.82mm at D16. The instrument has a progressive taper from 2% to 8% over the cutting flute length.

The aim of this *in vitro* study was to compare the preparation times associated with the use of three different rotary glide path instruments systems and with the conventional, manual, stainless-steel K-file system.

Table 1: Mean glide path preparation time(s), standard deviation and coeffficient of variance for the different methods

Preparation Method	Mean Preparation Time (s)	Standard Deviation	Coefficient of Variance (%)
Stainless-steel hand files	24.3[a]	3.6	14.8
ProGlider Instrument	11.3[b]	2.2	19.5
PathFiles	17.2[c]	2.6	15.1
X-Plorer Canal Navigation Files	18.5[c]	2.7	14.5

Values with the same letter were not statistically significant different at P<0.001

MATERIALS AND METHODS

Eighty ISO 15, 0.02-tapered, Endo-Training-Blocks (Dentsply/Maillefer, Baillaigues, Switzerland) were selected for this study. A working length of 16.5mm for each training block was confirmed with a size 10 K-File (VDW, Munich, Germany) under 10X magnification using a Dental Operating Microscope (DOM) (Global, St Louis, USA). Specimens were randomly assigned to four different groups (n=20) and treated as follows:

Group 1: Stainless-steel K-files by hand (control)

Manual pre-flaring with stainless-steel K-files (VDW), in the following sequence: 0.10, 0.15 and then 0.20 to working length, using a quarter clockwise "turn and pull" motion.

Group 2: Hand K-files followed by the ProGlider instrument

A reproducible glide path was manually established with a size 10 stainless-steel hand K-file (VDW), before the glide paths were enlarged using the ProGlider instrument.

Group 3: Hand K-files followed by rotary PathFile instruments

A reproducible glide path was manually established with a size 10 stainless-steel hand K-file (VDW), before the glide paths were enlarged using the three rotary PathFiles.

Group 4: Hand K-files followed by rotary X-Plorer instruments

A reproducible glide path was manually established with a size 10 stainless-steel hand K-file (VDW), before the glide paths were enlarged using the three X-Plorer files (Clinician's Choice Dental Products Inc).

The rotary ProGlider, PathFiles and X-Plorer files were used in an endodontic hand piece (X-Smart Plus, Dentsply/Maillefer) operating at 300 rpm, and 4 Ncm torque. Glyde root canal lubricating gel (Dentsply/Maillefer) was used between the different instruments.

The time it took to prepare each of the twenty glide paths for each group was recorded with an electronic stop watch. The time it took to change instruments was not recorded. The data of the different parts of the project were collected and statistically analysed using the ANOVA / Bonferroni tests.

RESULTS

The descriptive and comparative data are shown in Table 1. A one-way analysis of variance (ANOVA) showed that glide path preparation with the ProGlider instrument was significantly faster at 11.3 ± 2.2 seconds compared with all the other groups tested (P<0.001). The slowest preparation time was recorded with stainless-steel hand K-files (24.3 ±3.6 seconds) (P<0.001). ANOVA testing also showed that there were no statistically significant differences between the mean glide path preparation times of PathFiles and X-Plorer Canal Navigation Files (17.2 ± 2.6 and 18.5 ± 2.7 seconds respectively) (P>0.001), as is also suggested by the relative closeness of the respective coefficients of variation. Pairwise comparisons at the Bonferroni adjusted significance level of 0.017 demonstrated a statistically significant difference (P<0.001) in times between the group where the glide paths were prepared with stainless-steel hand K-files (control) compared with those prepared with PathFiles and X-Plorer Canal Navigation Files.

DISCUSSION

This study used Endo-Training-Blocks in tests designed to compare the preparation times achieved when using three different rotary glide path instruments systems with the times associated with manual glide path preparation using stainless-steel hand K-files. Simulated canals in Endo-Training-Blocks are often used to standardize experimental conditions for the evaluation of endodontic instruments.[5,18,19]

It is evident that manual glide path preparation by means of stainless-steel hand K-files resulted in the longest preparation time compared with the efficacy of the rotary glide path preparation instruments. A similar observation was noted in previous studies where glide path preparation with stainless-steel hand K-files was compared with rotary PathFiles preparation times.[14,20]

This is the first study to compare the mean preparation times achieved by the use of three different rotary glide path instruments. No comparative data for the X-Plorer Canal Navigation File and the ProGlider instrument was found in the literature. The PathFile and X-Plorer Canal Navigation File systems both make use of three rotary instruments, in contrast to the single ProGlider instrument, to enlarge the glide path, after a reproducible glide path has been established with a size 10 stainless-steel hand K-file. The fact that three different instruments had to be used to enlarge the glide path with PathFiles and X-Plorer Canal Navigation Files resulted in the statistically significant longer glide path preparation times for these two systems, when compared with the performance of the single ProGlider instrument. There were no statistically significant differences in the glide path preparation times for PathFiles and X-Plorer Canal Navigation Files.

It is relevant to note that this study did not record the time it took to change between the different instruments used for each group. Taking this into account, the single ProGlider instrument (after using the size 10 K-file) enlarges a glide path significantly faster compared with the multiple instruments used with the stainless-steel hand K-files (three instruments), PathFiles (four instruments) and the X-Plorer Canal Navigation Files (four instruments). Clinically, the use of the ProGlider instrument for glide path enlargement may result in a substantial reduction in clinical chairtime compared with the times required by the other systems tested in this study.

However, one should also consider the final apical preparation size and the taper of the simulated canals that were prepared by using the different glide path instruments. Several authors recommend creating a glide path to the same size, or ideally a size bigger than, the first rotary instrument introduced for root canal preparation.[3,4,5] The final apical preparation sizes of the stainless-steel hand K-file group and the X-Plorer Canal Navigation Files were approximately ISO 0.2mm, followed by ISO 0.19 and ISO 0.16 for PathFiles and the ProGlider instrument, repectively. Stainless-steel hand K-files, PathFiles and the X-Plorer Canal Navigation Files will result in an approximately average canal taper of 2%. The ProGlider instrument entered the canal to its full length of 16mm (cutting flutes) and it can be expected that it left the simulated canal with a progressive taper ranging from 2% at the apex to 8.2% at the canal orifice. Although the ProGlider instrument showed the fastest mean glide path preparation time, it also resulted in the smallest apical preparation diameter and in the maximum coronal canal diameter. Although these parameters were not evaluated in this study, they could have an impact on further canal preparation with different sizes of rotary nickel-titanium preparation instruments.

CONCLUSIONS

Within the limits of this study, it can be concluded that the slowest glide path preparation time was recorded with stainless-steel hand K-files. Glide path preparation times with Pathfiles and X-Plorer Canal Navigation Files were significantly faster compared with preparation with hand files. The single ProGlider instrument resulted in significantly shorter glide path preparation times compared with all the other methods evaluated.

Declaration: No conflict of interest declared

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