The influence of glide path preparation on the failure rate of WaveOne reciprocating instruments

SADJ July 2014, Vol 69 no 6 p266 - p269

CH Jonker[1], PJ van der Vyver[2], FA de Wet[3]

ABSTRACT

Introduction: The aim of this study was to determine the influence of two different glide path preparation methods on the fracture rate of the Primary 25/08 WaveOne reciprocating instrument. Preparation times for different glide path methods and total time for root canal preparation, with and without prior glide path preparation, were also calculated.

Materials and Methods: ISO 15, 0.02 taper Endo-Training-Blocks (n = 300) were selected and randomly divided into three main groups (n = 100): Group 1: no glide path (control); Group 2: glide path preparation with stainless-steel hand files; and Group 3: glide path preparation with rotary PathFiles. The time taken to prepare each glide path was recorded. The specimens in each main group were then randomly assigned into five subgroups (n=20). New Primary 25/08 WaveOne files were used for canal preparation in each subgroup. The outcome was measured by recording how many simulated canals could be shaped with one WaveOne reciprocating file in each subgroup before instrument breakage occurred. The average time it took to prepare each of the simulated canals was calculated and recorded. The data were collected and statistically analysed using the ANOVA / Bonferroni test.

Results: Glide path preparation with PathFiles was significantly faster than with hand files (P<0.001). After the glide path preparation had been performed with PathFiles, a greater number of simulated canals could be prepared before failure of the WaveOne file (P<0.001). Root canal preparation time was significantly shorter (P<0.001) when an initial glide path had been prepared with PathFiles.

Conclusion: Initial glide path preparation with PathFiles resulted in shorter preparation times and allowed a higher number of simulated canals to be prepared before failure of the WaveOne instruments.

ACRONYM

DOM: Dental Operating Microscope

INTRODUCTION

Numerous studies have sought to eliminate instrument failure during root canal preparation.[1,2,3] The creation of a glide path has been recognised as being centrally important in the reduction of the incidence of instrument fracture.[4,5]

A recent study showed that WaveOne (Dentsply/Maillefer, Ballaigues, Switzerland) and Reciproc (VDW, Munich, Germany), operated in a reciprocating motion, have significantly higher resistance to cyclic fatigue compared with Mtwo (VDW, Munich, Germany), and Twisted File (TF; SybronEndo, Orange, CA), used in full rotation.[6] That study also showed that instruments manufactured with M-wire (Reciproc and WaveOne) have higher resistance to fatigue than traditional nickel-titanium instruments (Mtwo) and instruments of R-phase nickel-titanium alloy (Twisted File).

The main purpose of the glide path is to reduce torsional and flexural stress on the root canal instrument.[5] The introduction of an instrument with a high taper into an unprepared root canal with a low taper will cause a rapid increase in torsional stress. The manufacturer does not recommend creating a glide path when using Reciproc reciprocating instruments.[7] A study demonstrated that Reciproc R25 can reach full working length in straight and moderately-curved mandibular molars without a preceding glide path.[8] Traditional nickel-titanium files are more likely to fracture at lower cyclic fatigue levels once exposed to torsional stress. Previously used nickel-titanium files are at higher risk because of their already reduced resistance to torsional stresses.[9,10] A few studies have shown that pre-flaring the root canal prior to instrumentation with rotary files can reduce the rate of instrument failure.[4,11]

The WaveOne endodontic system consists of a selection of three files: small (ISO tip 21, yellow), primary (ISO tip 25, red)

1. **C H Jonker:** *BChD.* Division of Endodontics, Department of Odontology, School of Dentistry, Faculty of Health Sciences, University of Pretoria, Gauteng, South Africa.
2. **P J van der Vyver:** *BChD, MSc.* Division of Endodontics, Department of Odontology, School of Dentistry, Faculty of Health Sciences, University of Pretoria, Gauteng, South Africa.
3. **F A De Wet:** *BChD, Hons, MDent, UED, DSc. (Odont).* Head: Department of Odontology, School of Dentistry, Faculty of Health Sciences, University of Pretoria, Gauteng, South Africa.

Corresponding author

C H Jonker:
Division of Endodontics, Department of Odontology, School of Dentistry, Faculty of Health Sciences, University of Pretoria, Gauteng, South Africa. Tel: 012 319 2434, E-mail: casper.jonker@up.ac.za

and large (ISO tip 40, black). All are manufactured from the highly resistant M-Wire nickel-titanium alloy and are operated in a reciprocating action. In some cases a root canal can be adequately prepared using only a single WaveOne file.[12]

The WaveOne Primary reciprocating file produces less modification of canal curvature when used following glide path preparation.[12] WaveOne instruments in general maintain original canal anatomy better than does the ProTaper system (Dentsply/Maillefer), consisting of a minimum of four instruments.[13]

Several methods have been proposed to create a glide path prior to root canal preparation.[11,14,15] It has been shown to be more time consuming to manually prepare a glide path with K-files.[16] Park *et al*. in 2013 compared Reciproc instruments with WaveOne files after glide path preparation to a #15 K-file.[17] They found that the WaveOne primary file required significantly less working time to prepare a root canal than did the Reciproc R25 file, regardless of canal anatomy.[17]

Lim and co-workers, also in 2013, concluded that if no glide path is present prior to WaveOne 25/08 instrumentation, the preparations will be less centered, with an increased risk of canal aberrations.[7] This particular study advocated that a glide path larger than a #15 K-file be prepared prior to the use of the WaveOne 25/08 instrument. At present there is no research data available on the influence of a glide path or of the different methods of glide path preparation, on the fracture rate of WaveOne instruments.[12] The influence of different glide path preparation methods on the working time to prepare a root canal with WaveOne has also not being investigated.

The aim of this study, therefore, was to determine the influence of two different glide path preparation methods on the fracture rate of WaveOne reciprocating instruments. In addition, the times required for different glide path preparation methods – as well as total time for root canal preparation, with or without glide path preparation, were calculated.

MATERIALS AND METHODS

The principles and techniques outlined by Berutti *et al*. were used in this study.[4] Three-hundred ISO 15, 0.02 taper, Endo-Training-Blocks (Dentsply/Maillefer, Ballaigues, Switzerland) were selected. A working length of 16.5mm for each training block was confirmed with a #10 K-File (Dentsply/Maillefer) under 10X magnification using a Dental Operating Microscope (DOM) (Global, St. Louis, USA). Specimens were randomly assigned to three different groups (n=100) and treated as follows:

Group 1: No glide path preparation (control)

The Endo-Training-Blocks were not modified in any way.

Group 2: Initial glide path preparation using stainless-steel hand K- files

Manual pre-flaring with new stainless-steel K-files #10-15-20 was performed to working length. Glyde (Dentsply/Maillefer) was used as a lubricating agent.

Group 3 Glide path preparation using a stainless-steel K-file followed by PathFiles

A reproducible glide path was manually established with a #10 K-file using the same technique as described in group 2. The glide path was then enlarged using a sequential series of PathFiles (Dentsply/Maillefer), #1 (ISO tip 13), #2 (ISO tip 16) and #3 (ISO tip 19), driven by the WaveOne Endodontic Motor (Dentsply/Maillefer) and a 16:1 contra angle hand piece at 300 rpm, at a torque of 4 Ncm. The total time it took to produce and to enlarge the glide paths in groups 2 and 3 was recorded by means of an electronic stop watch. The time it took to change instruments was not recorded.

The specimens in each group were then randomly assigned into five subgroups (n=20). A new Primary 25/08 WaveOne file was allocated to each subgroup. Root canal preparation was done with the Primary 25/08 WaveOne instruments using the WaveOne Endodontic Motor (Dentsply/Maillefer) in the "Reciprocating WaveOne All" mode, using Glyde as a lubricant.

It was found that without any glide path preparation the Primary 25/08 WaveOne instrument was able to penetrate into the canal to an average depth of 7.5mm, and for the groups where glide path preparation was done, to an average of 9mm (Figure 1) into the canal (leaving 9mm and 7.5mm of unprepared canal space, respectively). The complete canal preparation was done in 2.5mm increments with the instruments being removed for cleaning before the next phase of use. Cutting debris was cleaned from the instrument flutes using EndoFoam (Australian Dental Manufacturing, Kenmore Hills, Australia), the canal irrigated with water, recapitulated with a size 08 K-File and the canal re-irrigated to remove cutting debris from the canal. Final root canal preparation was checked by ensuring that a Primary WaveOne Gutta-Percha cone (25/08) (Dentsply/Maillefer) could be fitted to full working length, ascertained under 10X magnification.

The outcome was measured by recording how many simulated canals could be shaped with one WaveOne recipro-

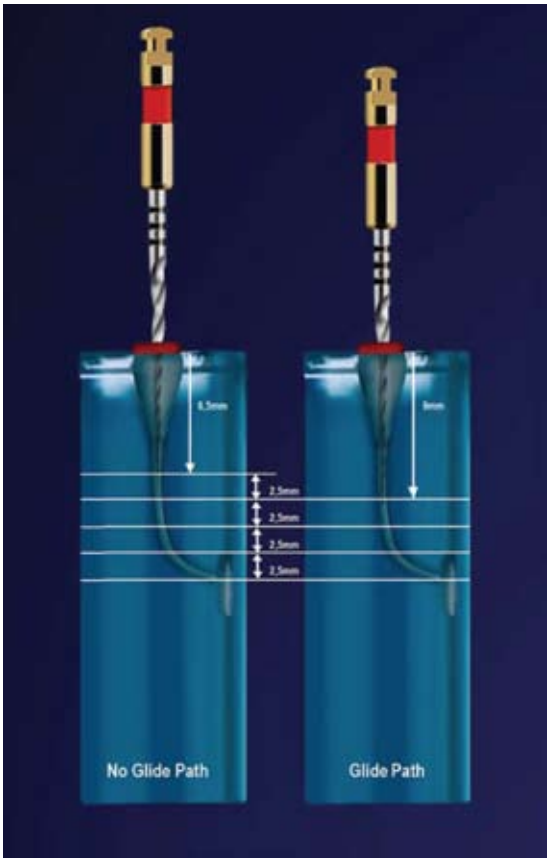

Figure 1: Preparation increments for the no glide path and glide path groups

Table 1: Descriptive statistics for the glide path preparation times when using hand files and PathFiles (seconds).

Group	Mean (s)	Standard Deviation	Coefficient of Variation (%)	95% Confidence Interval
Hand files	25.1[a]	2.60	5.2	(23.4; 26.8)
PathFiles	13.3[b]	1.70	6.4	(12.0; 14,1)

Values with the different superscript letters were statistically different at P<0.001

Table 2: Descriptive statistics for the number of simulated canals prepared before the WaveOne instrument fractured in the different test groups.

Group	Mean	Standard Deviation	Coefficient of Variation (%)	95% Confidence Interval
No Glide Path	7.4[b]	0.89	12.0	(6.3; 8.5)
Hand files	17.6[a]	1.14	6.5	(16.2; 19.0)
PathFiles	19.2[a]	0.84	4.3	(18.2; 20.2)

Values with the same superscript letters were not statistically different at P < 0.001

Table 3: Descriptive statistics for the total preparation times for the different test groups (seconds).

Group	Mean (seconds)	Standard Deviation	Coefficient of Variation (%)	95% Confidence Interval
No Glide Path	21.2[c]	0.20	1.0	(21.0; 21.5)
Hand files	15.0[b]	0.47	3.1	(14.4; 15.6)
PathFiles	12.7[a]	0.22	1.7	(12.6; 13.1)

Values with different superscript letters were statistically different at P < 0.001

cating instrument in each subgroup before instrument breakage occurred. The average working time it took to prepare each of the artificial canals for the different subgroups was also recorded with an electronic stop watch.

In addition, canal preparation time for each 2,5mm increment was recorded by commencing timing at the instant of entry into the canal and stopping the clock at the moment of instrument retrieval. Total preparation time for each block was calculated by adding together the times recorded for all increments. The time it took to clean debris from the instrument flutes, irrigate, recapitulate and to re-irrigate the canal was not recorded.

The data for the different parts of the project were collected and statistically analysed using the ANOVA and Bonferroni tests.

RESULTS

The descriptive and comparative data are shown in Tables 1, 2 and 3. A one-way analysis of variance (ANOVA) (P<0.001) showed that glide path preparation with PathFiles was significantly faster at 13.3 seconds compared with the 25.1 seconds required when using hand files (Table 1). Group 3, in which the glide path preparation was performed with PathFiles, recorded the highest number of simulated canals (19.2) which could prepared with the Primary 25/08 WaveOne instrument before it fractured (Table 2). When no glide path had been prepared, the instrument achieved only 7.4 canal preparations. Pairwise comparisons at the Bonferroni adjusted significance level of 0.017 demonstrated statistically significant differences (P < 0.001) between the data of both PathFiles (19.2 canals) and hand files (17.6 canals) compared with that of the no glide path (7.4 canals) group. The same test also demonstrated that the total mean time to prepare a simulated canal with the WaveOne 25/08 instrument was significantly shorter when an initial glide path had been prepared with PathFiles (12.7 seconds) compared with the mean time spent on preparation when a glide path had been instrumented with hand files (15.0 seconds) (P<0.001) and when no glide path (21.2 seconds) had been prepared (P<0.001). There was also a statistically significant difference between the mean preparation times of the hand file and no glide path groups (P<0.001) (Table 3).

DISCUSSION

Endo-Training-Blocks are often used to evaluate the performance of endodontic instruments and to standardize experimental conditions.[18,19,20] This study used these blocks in determining the mean number of simulated canals prepared with the Primary 25/08 WaveOne file, with or without glide path preparation, before instrument fracture.

It is clear that the preparation of a glide path contributes to the efficacy of the instrument. When no initial glide path was created, a mean of only 7,4 simulated canals could be prepared before the instrument fractured. However, when a glide path was prepared by means of hand files or with rotary PathFiles, respectively, 17.6 and 19.2 simulated canals could be prepared (not a statistically significant difference). Similar observations were made in other studies that used different types of instruments.[4,5,21,22]

Whilst the Primary WaveOne file removes debris along the length of the instrument, the main area of work load is the apical portion with the greater taper (8% in the last 4mm). The WaveOne file is therefore subjected to more loading along its apical portion especially when no glide path preparation is done. Hence a greater failure rate would be expected in the group in which no prior glide path had been prepared. This study also demonstrated that the preparation times to prepare a glide path with PathFiles (13.3 seconds) were statistically shorter than preparation times required with hand files (25.1 seconds). A previous study undertook a comparative analysis of the times taken to perform pre-flaring with hand files and with PathFiles by an expert group and by an inexpert group of operators. The times were significantly shorter in the groups using PathFiles (expert = 7.79 seconds; inexpert = 7.74 seconds) versus the hand files groups (expert = 28.08 seconds; inexpert = 38.58 seconds).[23]

In light of the above, clearly there are advantages in using PathFiles to create a glide path before using the WaveOne system. Chair time and operator fatigue are effectively reduced. A hand piece and electric motor are used to create the glide path instead of manual filing by hand motions. In addition there are also fewer canal irregularities and aberrations present after glide path preparation with PathFiles.[20,23,24,25]

Within the limits of this study it can be concluded that glide path preparation increased the longevity of the 25/08 WaveOne instrument and enabled more simulated canals to be prepared before instrument fracture. However, although the results of this study indicated that a high number of simulated canals can be prepared with the Primary 25/08 WaveOne instrument after initial glide path

preparation, it must be taken into account that the length of canal preparation on the simulated canals was only 7.5mm (Figure 1). It could be expected that this number of prepared canals will reduce drastically in clinical situations where the length of canal preparation will often be longer. It was also significantly faster to prepare a glide path with PathFiles than with hand files. The total preparation time is reduced when hand files or PathFiles are used for glide path preparation prior to root canal preparation with the Primary 25/08 WaveOne instrument.

Declaration: No conflict of interest declared.

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