Comparative Evaluation of the Effect of Glide Path Creation with Nitiflex Hand K- file, Proglider and Path File on Canal Transportation and Concentricity in Apically Curved Canals - An In- Vitro study.

Abstract:

Aim: To compare and evaluate the effect of glide path creation with Nitiflex hand K- file, Proglider and Path file on canal transportation and concentricity in apically curved canals.

Objectives: To compare the degree of canal transportation and concentricity between:

1) Glide path preparation with Nitiflex hand-K file vs Proglider file followed by combination of Hyflex EDM and CM file instrumentation
2) Glide path preparation with Proglider file vs Path file followed by combination of Hyflex EDM and CM file instrumentation
3) Glide path preparation with Nitiflex hand- K file vs Path file followed by combination of Hyflex EDM and CM file instrumentation

Materials and methods: Forty ISO 20, 0.02 taper, Endo Training Blocks (Dentsply Maillefer) were acquired and divided into following four groups (n = 10): group A, Control group without glide path preparation; group B, Glide path preparation with Nitiflex hand-K file; Group C: Glide path preparation with Proglider file; Group D: Glide path preparation with Path files. In all the groups, combination of Hyflex EDM and CM file instrumentation was done after glide path creation. Pre- and post-instrumentation digital images were processed with Image J Version 1.8.0 software to identify the center of the canal, and then superimposed using Adobe Photoshop 7.0 software. Unpaired/independent t test and One Way ANOVA were used for intergroup comparison of difference of mean scores.

Results: In comparison to other groups, training blocks instrumented with Proglider files and a combination of Hyflex EDM and CM files had reduced deviation in canal axis.

Conclusion: Following the combination of Hyflex EDM and CM file instrumentation with an earlier glide path created with Proglider file, canal concentricity and canal geometry are better preserved.

Key-words: Glide path, canal transportation, proglider, path files, Hyflex EDM

Introduction:

One of the most crucial phases of endodontic therapy is biomechanical preparation for root canal therapy.[1] In order to prepare the canal for 3D root filling, it is a crucial step to remove pulp remnants, necrotic tissues, germs, and debris. The apical patency is put at risk by the anatomic complexity of root canals, which have irregular noncircular cross sections, apical ramifications, and iatrogenic errors such apical ledges,

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canal transportations, and instrument separation.[2] Therefore, the root canal system needs to be cleansed and moulded in three dimensions for a successful 3D obturation.[3]

The establishment and maintenance of a glide path is one guiding technique that has come to be recognised as essential to successful endodontic treatment.[2] From the coronal orifice of the canal to the radiographic terminal or electronically determined portal of escape, a glide path is described as a smooth, albeit potentially constrained, tunnel or route.[4] Maintaining a glide path entails having a smooth path that can be reproduced by files utilised repeatedly in the canal.[5] A rotary tool shouldn't be used to prepare a root canal unless a hand instrument has already been inserted since it can cause taper lock.[6] Therefore, it is important to execute coronal expansion and make a glide path, either manually or mechanically, before using NiTi rotary instrumentation.[7]

Niti files with the shape memory effect and increased flexibility have been introduced to combat the canal straightening issue related to stainless steel files. With Niti files, glide path is easier to achieve.

The manufacturers have suggested a cutting-edge and efficient pairing of Hyflex CM (Controlled Memory) and Hyflex EDM (Electric Discharge Machining, single file system) for rotary instrumentation in curved canals in particular. Spark erosion is a manufacturing process used to create Hyflex EDM.[8] Compared to traditional Niti files, the EDM manufacturing process appears to increase the instruments' fracture strength, cutting efficiency, and cyclic fatigue resistance.[9]

Due to the dearth of information on the effects of numerous novel manual and mechanical glide path files, the study was undertaken to look into fresh angles on the subject.

Materials and Methodology:

Forty transparent acrylic endo training blocks containing a simulated curved root canal (iDentical, Inc., India) were used in this experimental study. The diameter and the taper of all simulated canals was equivalent to an ISO standard size#20 (2% taper) root canal instrument. After confirming the patency in the simulated canals with stainless steel hand K - file (ISO 10, 0.02 taper; DentsplyMaillefer, Switzerland) just beyond the apex, the canals were injected with a red ink (Kokuyo Camlin Limited, India) by a syringe. Five landmarks were placed in each block: at the canal orifice (A), half-way to the orifice in the straight section (B), the beginning of the curve (C), the apex of the curve (D), and the end point (E), (Figure 1).

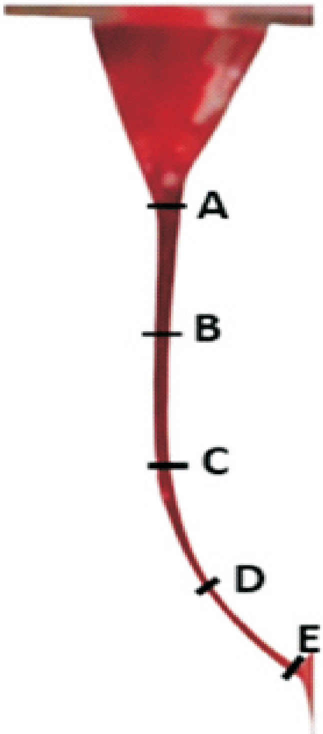


Figure: 1 Five landmarks in simulated canal:

Preinstrumentation images were captured using a digital camera (Canon, Tokyo Japan) positioned centrally and at 90° to the specimen and saved as Jpeg format images. Specimens were then randomly assigned to four different groups (n=10). A new instrument was used for each canal in all the groups. 15% EDTA (RC Help; Prime Dental Products Pvt. Ltd, India) was used as a lubricant before the utilization of each instrument, and normal saline was used for irrigation during preparation. Glide path was prepared using Proglider file (DentsplySirona, USA), Pathfiles (ISO size 13, 0.02 taper, ISO size 16, 0.02 taper, ISO size 19, 0.02 taper; DentsplyMaillefer, Switzerland) and Niti Flex hand K files (ISO size 20, 0.02 taper; DentsplyMaillefer, Switzerland) before rotary instrumentation with combination of Hyflex EDM (ColteneWhaledent, Inc., USA) and CM file (20/.04; ColteneWhaledent, Inc., USA). A rotary endo motor (Guilin Woodpecker Medical Instrument Co., Ltd., China) was used at 300 rpm speed and at a torque of 1.5 Ncm for mechanical glide path preparation in groups C and D and for rotary instrumentation at 400 rpm speed and at 2.5 Ncm torque in all the 4 groups. The 4 groups were divided as:

Group A: Control group: all the simulated canals were instrumented with combination of Hyflex EDM and CM file without glide path preparation.

Group B: Glide path preparation with Nitiflex hand-K file in all the simulated canals

Group C: Glide path preparation with Proglider file in all the simulated canals

Group D: Glide path preparation with Path files in all the simulated canals

In groups B,C and D, combination of Hyflex EDM and CM file instrumentation was done after glide path creation.

After the completion of instrumentation of both the groups, black ink (Kokuyo Camlin Limited, India) was injected in the instrumented training blocks, and postoperative images were acquired.

To highlight the canal geometry, the pre- and post-instrumented photos were enlarged and cropped.These images were imported into a mathematical computing software (Image J Version 1.8.0; National Institutes of Health, Bethesda, Maryland, USA) for processing, where the centre of each canal was identified. These images were then saved in.jpeg format with a pixel size of 1080×1080. Using digital imaging software (Adobe Photoshop 7.0 software, Adobe Inc., Michigan, USA), the preinstrumentation digital images were superimposed on the post-instrumentation images, taking the landmarks as reference points and measurements in millimetres were carried out at those five landmarks.

Data presentation and analysis:

This analyzed the deviation of the instrumented simulated canals (Figure 2). Microsoft Excel 2007 was used to enter the data for this study, and SPSS statistical software 19.0 Version was used to analyse it (IBM Corp., Armonk, NY, USA). The mean and standard deviation were among the descriptive statistics. For this investigation, the level of significance was set at 5%. The unpaired/independent t test and One Way ANOVA were used for the intergroup comparison for the difference in mean scores between independent groups.

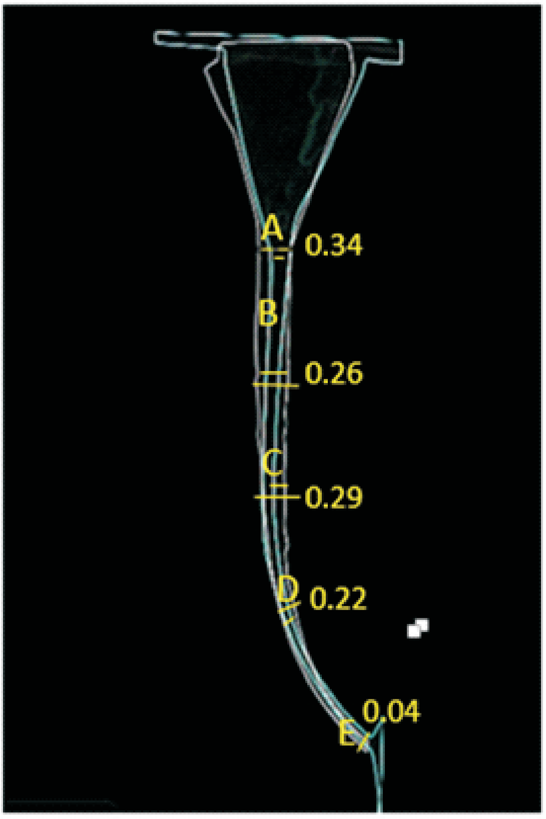


Figure 2: Measurement of canal deviation in mm at five landmarks

Results:

Findings are summarized in Table 1. At every measurement point, Group 1 (Control group with instrumentation but no glide path preparation) displayed a greater deviation in the canal axis. Group 3 (Proglider file group) displayed reduced deviation in the canal axis at all five landmarks (Graph 1). There was a substantial difference in P values among the 4 groups at all points except point E (Table 2).

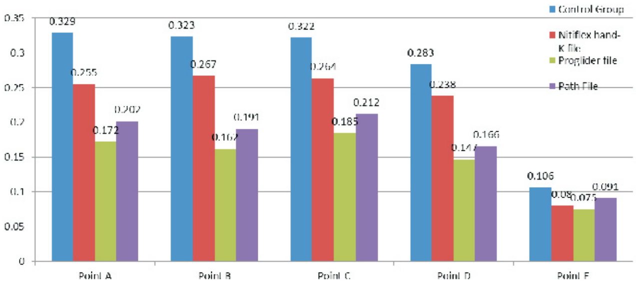
Table 1: The mean, standard deviations, and the P values of the deviation of the central canals for all the groups

		Mean	Std. Deviation	Std. Error	P value
Point A	Control Group	0.329	0.018	0.005	0.001 (Sig)
	Nitiflex handK file	0.255	0.019	0.006	
	Proglider file	0.172	0.014	0.004	
	Path File	0.202	0.009	0.002	
Point B	Control Group	0.323	0.031	0.009	0.001 (Sig)
	Nitiflex handK file	0.267	0.009	0.002	
	Proglider file	0.162	0.011	0.003	
	Path File	0.191	0.024	0.007	
Point C	Control Group	0.322	0.038	0.012	0.001 (Sig)
	Nitiflex handK file	0.264	0.030	0.009	
	Proglider file	0.185	0.016	0.005	
	Path File	0.212	0.023	0.007	
Point D	Control Group	0.283	0.051	0.016	0.001 (Sig)
	Nitiflex handK file	0.238	0.059	0.018	
	Proglider file	0.147	0.027	0.008	
	Path File	0.166	0.021	0.006	
Point E	Control Group	0.106	0.077	0.024	0.543 (NonSig)
	Nitiflex handK file	0.080	0.041	0.013	
	Proglider file	0.075	0.043	0.013	
	Path File	0.091	0.043	0.013	

Table 2: Pairwise comparison of difference of mean scores (Post Hoc Analysis)

	Group	Mean Difference	Std. Error	Sig.
Point A	Control vs Nitiflex file	0.073	0.007	0.001 (Sig)
	Control vs Proglider file	0.157	0.007	0.001 (Sig)
	Control vs Path File	0.127	0.007	0.001 (Sig)
Point B	Control vs Nitiflex file	0.056	0.009	0.001 (Sig)
	Control vs Proglider file	0.161	0.009	0.001 (Sig)
	Control vs Path File	0.132	0.009	0.001 (Sig)
Point C	Control vs Nitiflex file	0.058	0.012	0.001 (Sig)
	Control vs Proglider file	0.136	0.012	0.001 (Sig)
	Control vs Path File	0.110	0.012	0.001 (Sig)
Point D	Control vs Nitiflex file	0.044	0.019	0.026 (Sig)
	Control vs Proglider file	0.136	0.019	0.001 (Sig)
	Control vs Path File	0.116	0.019	0.001 (Sig)
Point E	Control vs Nitiflex file	0.026	0.024	0.282 (NS)
	Control vs Progliderfile	0.031	0.024	0.201 (NS)
	Control vs Path File	0.015	0.024	0.529 (NS)

Graph 1: Mean canal deviation values (in mm) of all 4 groups



Discussion:

The possibility of complications such deviation, canal transportation, ledge creation, zipping occurrence, and tool refraction make root canals with anatomical curves challenging for practising dentists.[10] Root canal instrumentation starts with canal scouting and preflaring.[11] Glide path ensures that the root canal is sufficiently widened to take the first shaping instrument and enables efficient and secure root canal shaping.[7] The endodontic glide path is essential for both quality control and achieving the endodontics' rationale.[12]

The intrinsic heterogeneity of extracted teeth makes their use in such investigations problematic. The first to recognise this issue was Weine et al., who employed clear casting resin models of simulated root canals that could be created in any size, shape, or curvature to evaluate the impact of root canal preparation.[13] Such standardisation would eliminate the variations caused by the vast array of factors involved in removing teeth, enabling accurate evaluation of a certain technique or file type.[14] Resin blocks have been proven to be a reliable experimental model for studying endodontic preparation methods.[15]

Because curved canals present a greater challenge to equipment, they are frequently employed as specimens in research studies. As a result, the ability of various instrument systems to shape curved canals and their capacity to preserve the original anatomy of the canal to confirm its curvatures have been linked to assessments of their performance.[16] When preparing these curves, stainless steel files frequently return to their original straight shape. In contrast, nickel titanium files have a high degree of elasticity and controlled memory, which minimises the lateral stresses and effort placed on the canal walls in curved canals.

Due to their great flexibility, all NiTi rotary tools on the market have noncutting tips and are not intended for the first negotiation of the root canal.[17] Hyflex EDM is a third-generation single file that was introduced with a new production technique using electric discharge machining (EDM), followed by CM treatment, even though Niti files contain shape memory and flexibility properties. A metallurgical thermal process called CM increases instrument flexibility and tolerance to cyclic fatigue while lowering the shape memory of NiTi files. In contrast to conventional NiTi files, HyFlex EDM files are up to 700% more resistant to cyclic fatigue.[18]

Although earlier research has demonstrated that the Hyflex EDM one file system has superior centering and shaping capabilities when compared to other rotary file systems, precise data about the impact of glide path preparation with this cutting-edge rotary file system is lacking.

In this work, a quantitative analysis was carried out by comparing the curvature before and after instrumentation.

Previous research has proven the validity of the experimental approach, as well as how effectively it represents changes in canal curvature and yields reliable outcomes.[19]

In contrast to the other examined groups, the Hyflex rotary instrumentation without a glide path group in the current investigation displayed a greater mean canal transportation. Because they give the files a more direct path to the apical end of the canal and reduce coronal resistance or redirection of the files apically, coronal expansion and preflaring have been shown to be essential techniques for safer use of NiTi rotary instrumentation in curved canals.[20]

When Elnaghy AM et al. compared the transportation and centering capabilities of rotary instrumentation with and without glide path preparation, they came to the conclusion that the glide path/rotary instrumentation method indicated less canal aberrations. The outcomes agreed with those of the current study.[21]

The Proglider/Hyflex group in the current investigation displayed the lowest mean transportation values overall. Compared to instruments made of normal superelastic wire, the proglider system's manufacturing process, which uses M-Wire technology, offers higher flexibility and resistance to cyclic fatigue.[22] Using the Proglider technology to create a glide path relieves some of the instrumentation burden on Hyflex.[7] Because of the Proglider's increased amount of expansion in the coronal and middle thirds of the root canal and gradual taper, accessing the apex takes less time when it is utilised for preparation. Additionally, it has been claimed that Proglider files' progressive taper structure gives them greater volume than files with a constant 2% taper, such rotational Path files and hand K files.[23]

The Proglider and Wave One Gold Glider groups produced less transportation and curvature straightening than the Pathfile and no glide path preparation groups, according to a research by Shi L et al. using 80 endo training blocks. The results were consistent with those of the current investigation.[24]

In a study, Paleker F et al. found that Proglider displayed a substantially more centred enlargement than both G files and K files, which were significantly similar, at the point of maximal root curvature. There were no notable variations between G files and K files and Proglider was substantially more centred than K files.[25]

In the current investigation, Proglider and Route files glide path systems produced more centred canals than nitiflex hand tools. In a study, Zheng L. et al. found that hand K files and ProGlider files resulted in less canal transportation than hand K files. This could be explained by the fact that, when a glide path has already been mechanically generated, rotating instruments require relatively fewer "pecking" actions to reach their maximum working length. The ProGlider file's enlargement of the coronal and middle regions may have decreased the torsional stress during the subsequent root canal preparation, making it simpler for the Hyflex file to reach a working length. One could anticipate that doing so would reduce the likelihood of instrumentation being misdirected and subsequent root canal transportation.[26]

Thus, it is evident from this study that NiTi rotary instruments, as opposed to Nitiflex hand files, may safely and successfully provide a predictable glide route since the former better preserves the original canal morphology with less transportation in the apically bent canals.

This investigation's intrinsic restriction stems from the fact that it is an in vitro study. Simulated resin blocks are unable to accurately capture the anatomic diversity of a human root canal system. Because of this, conclusions cannot be immediately generalised to the clinical situation. The selection of files for glide path construction in the management of apically curved canals must thus be supported by additional research in this area.

Conclusion:

When compared to groups where nitiflex hand files and Path files were used to create glide paths and where no glide paths were prepared, the Proglider file used for creating a glide path, followed by a combination of Hyflex EDM and CM file instrumentation, maintains the original root canal anatomy with less deviation and better canal concentricity.

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