ORIGINAL ARTICLE

Effect of Multiple Glide Path Files on Apical Debris Extrusion in Severely Curved Mesial Roots of Mandibular Molars: An *In Vitro* Study

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Abstract

Introduction: A glide path preparation prevents the fracture of endodontic files and maintains a centered root canal configuration. This study aimed to evaluate and compare the amount of apically extruded debris following the use of various glide path files in severely curved root canals.

Materials and methods: Of the 112 extracted human mandibular molar teeth collected, 40 teeth with severely curved mesial roots were selected. The mesial roots of the teeth were sheared off at the cementoenamel junction and pre-weighed Eppendorf tubes were attached to the roots. The specimens were randomly divided into four experimental groups according to canal preparation (n = 10): Group I- HyFlex GPF glide path files; group II- Rotary pathfile; group III- Manual K File glide path; group IV– No glide path preparation. HyFlex CM rotary file system was used to complete the biomechanical preparation of all the specimens up to size 25/06. using 8 mL of distilled water as an irrigant. Eppendorf tubes were then stored in an incubator to calculate the weight of extruded debris, after evaporation. Data comparison was done by applying ANOVA followed by *post hoc* Tukey's test ($p < 0.05$).

Results: There was no statistically significant difference between the rotary glide path groups, but there was a significant difference between debris extruded using rotary glide path file groups as compared to the manual glide path and without glide path file groups.

Conclusion: Rotary glide path files caused less debris extrusion than glide path preparation with manual K-files and without glide path preparation in severely curved canals.

Keywords: Debris extrusion, Glide path, HyFlex GPF, PathFile.

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Introduction

Endodontic therapy has made rapid strides in new approaches and advancements in cleaning and shaping. The design of NiTi instruments has evolved with different designs, kinematics, and metallurgy.[1] However, post-operative pain and discomfort following endodontic therapy still remain unpredictable for the patient. The severity of postoperative pain has been explained categorically between having mild symptoms to severely affected ones. Postoperative pain ranging from moderate to severe has adverse effects patient's overall well-being, requiring emergency dental visits, invasive endodontic treatments, and analgesic medicines.

Moderate to severe postoperative pain can hurt a patient's well-being, necessitating emergency dental appointments, analgesic and antibiotic drugs, and further recuperative measures.[2]

The basic reason behind post-endodontic pain is apical organic debris purging that gives rise to inflammatory responses in that area and disturbs the equilibrium between host microbiota and root canal during procedural instrumentation giving rise to severe discomforts.[3]

Dislodgement of organic debris and inflammatory agents after the apical foramen is a cumbersome process. However, novel strategies in framing root canal preparation and irrigation exist.

It is established that balanced force (Reciprocal) and crown down techniques (rotary) cause less extrusion of debris as compared to the filing motion used with hand instrumentation.[4] However, a few elements are governed by the operator to reduce post-operative pain and discomfort. These influences include the lineup of endodontic architectural systems and root canal procedure that can reduce the extrusion of debris.[5]

The manifestation of smooth radicular patency can be made from the root canal opening until the apical stenosis at the start of the biochemical makeup of the root canal scheme.[6] Preparing the hand filing steel grade glide paths is cumbersome and requires a lot of time during the making procedure, especially in root canals that are severely curved, double curved, or have narrow canals.[3,7] Glide path files can be single file systems like the ProGlider system or multiple file systems such as PathFile.[5] Apical extrusion of debris using these glide path systems before using single file shaping systems has shown that single glide path files generate less debris than multiple glide path file systems.[3] However, curved

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canals present challenges in biomechanical preparation and are best prepared using multiple file systems.[5] There are no studies in the literature evaluating the apical debris extrusion in acutely curved canals post-usage of multiple glide path file arrangements and full sequence rotary file systems. Hence, this study evaluated and compared the values of apical extrusion of organic debris by application of rotary mixed glide path files systems namely PathFiles and HyFlex Glide path files as compared to the use of manual K-files before preparing severely curved root canals with full sequence HyFlex CM rotary file system in canals with severe curvatures of 25–35°.[8]

Materials and Methods

After the attainment of ethical clearance from the Institutional Ethical Committee, 112 (*n*) human mandibular molar teeth having aged apices were extracted for periodontal reason having due courses in periodontal areas.

Forty teeth with severely curved mesial root canals with curvatures ranging between 25 and 35 (Schneider's method) were selected for the study.[8] The mesial roots of these teeth were shaved from the cementoenamel junction by employing a high-speed diamond disc, using water as coolant to achieve a uniform root length of 13 mm.[3]

A pre-curved #08 K-file was inserted in the root canal till the tip of the file was seen at the apical foramen apical foramen and working length length is calculated after subtracting 1 mm from this length under the microscope at 8× magnification (Moller-Wedel International, Germany).

Debris Collection Assembly

Apically dislodged organic debris was gathered in Eppendorf tubes attached to the teeth according to Myers and Montgomery.[9] Each of the apical debris was weighted using an electronic scale (Citizen CY-204 Analytical Balance, India) with an accuracy of 10^{-4}gm. The pre-weighed Eppendorf tubes were placed in separate glass vials. A spherical incision was made in the silicone rubber cover.

A silicon rubber cap was used to keep teeth and was fixed using cyanoacrylate as a fixative to restrain the seeping of irrigating liquid solution.

A 26-G needle was injected within the rubber to serve as a drainage cannula to establish an equilibrium between the internal and external air pressures.

Preparation of Root Canals

Four experimental groups ($n = 10$) were categorized from 40 teeth being randomly segregated and further glide path for mesiobuccal and mesiolingual canals of each specimen in the groups was prepared as follows:

Group-I: HyFlex GPF: (#15/.01, #15/.02 and #20/.02 files at speed 300 rpm and torque 1.8Ncm (Coltene, Switzerland).

Group-II: PathFile: #13/.02, #16/.02 and #19/.02 files at speed 300 rpm and torque 5 Ncm (Dentsply, Maillefer).

Group-III: K File: Glide path procedure was made using pre-curved ISO #10, #15, and #20 manual K-files (Mani, Japan).

Group-IV: Not having any pre-glide path procedure made. Served as control.

Later, the root canals of all specimens were prepared using 25/.06 HyFlex CM rotary file system at speed 500 rpm and torque 2.5 Ncm to complete the biomechanical preparation.

Table 1: The Mean and standard deviation (SD) values of apically extruded debris in grams

Groups	*N*	*Mean ± Standard deviation*
Group I		
PathFile	10	0.0011700 ± 0.00040565
Group II		
HyFlex GPF	10	0.0008300 ± 0.00033015
Group III		
K File	10	0.0025900 ± 0.00096315
Group IV		
Without glide path	10	0.0036100 ± 0.00128102

To prevent the occurrence of false positive results, every instrument is made in the procedural application for a single time and is not used otherwise.

A total volume of 8 ml irrigating distilled water was made to use in the making procedure of root canal process per single sample. A side-vented irrigation needle of 30 gauge was used within 2 mm of the working length with an in and out motion. Irrigation was performed after every 3 pecks of instrumentation and after each file sequence change. Apical patency was measured using an #8 K-file beyond every filing procedure till final irrigation. Post-procedure, the root canal of each specimen was drenched in 2 mL of distilled water. All root canals in the four groups were processed by one operator, whilst the purged organic debris was measured by another examiner blinded to the tested groups. When the preparation was completed, the apical parts of the roots were washed with 1 mL of distilled water to collect the apically extruded debris that remained affixed to the root apex. After collection of the extruded debris, the Eppendorf tubes were removed from the experimental model and stored in an incubator at 68°C for 5 days to allow the distilled water to evaporate. After evaporation, the experimental Eppendorf tubes measured the number of purged debris. The total weight of the remaining debris was measured by subtracting the pre-weight of the Eppendorf tube from the following weights.

Method of Data Analysis

In the present study to enumerate statistical significance, analysis was made with a 95% confidence interval and at 80% power of the study using IBM SPSS Statistic for Windows (v 21.0.). Mean debris extrusion was calculated in all the experimental groups. One-way ANOVA performed with *post hoc* Tukey's test was tested to investigate statistically significant alterations in the debris extrusion between groups.

Results and Analysis

The standard deviation (SD) and mean values of all the experimental groups are depicted in Table 1 and Figure 1. One-way ANOVA test demonstrated statistically significant alterations among Group I, II, III, and IV respectively ($F = 23.400$; $p < 0.001$). Tukey's *post hoc* test presented that there was a statistically significant variation between group I and group III ($p = 0.003$) and in-between group I and group IV ($p < 0.05$). There were no statistically significant differences between group I and group II ($p > 0.05$). Group II when compared with group III and group IV showed a statistically significant difference in the total amount of debris extruded ($p < 0.05$). Group III and group IV also exhibited statistically significant differences in the values of apically extruded debris ($p = 0.049$) (Table 2).

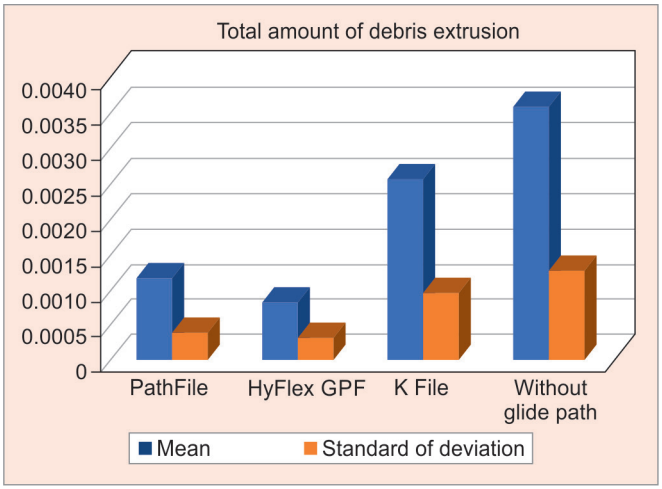

Fig. 1: The mean and standard deviation (SD) values of apically extruded debris in grams

Table 2: ANOVA and *post hoc* Tukey's test between groups

Groups	*p-value*	*F*	*p-value*
PathFile			
HyFlex GPF	0.804	23.400	<0.001*
K File	0.003*		
Without glide path	<0.001*		
HyFlex GPF			
K File	<0.001*		
Without glide path	<0.001*		
K File			
Without glide path	0.049*		

*The mean difference is significant at $p < 0.05$

Discussion

The primary objective of this study was to evaluate debris extrusion from canals with severe curvatures using and compare various glide path systems followed by a full sequence rotary file system. Maneuvering the glide path making with K-files is presently a realistic choice to date, but recent advances in endodontic instruments offer novel alternatives that significantly limit the values of apical debris extrusion.[10] The coronal framework of each tooth was shaved off and flattened to deliver a benchmark step for stable research environments. Moreover, the working length was calibrated to 13 mm to minimize confounders like irrigation penetration and shaping depth. The commonly used methods of myers and montgomery allowed the analogy of the file networks even though a physical back-pressure generated from periapical tissues shall not be replicated.[9] Other methods that could be used for debris comparison and analysis include cube-shaped parts of foam mimicking periapical tissue, evaluation of neuropeptide expression, and real-time measurement of extrusion volumes using point-conductivity-probes.[11–15] Due course some inherent shortcomings in the methodology suggested by Myers and Montgomery, it was appointed as a way to decipher debris, as it is practical and permits comparison between the amounts of debris purged by each file.[9,16]

In the aforesaid study, to reduce the number of variables; curvature angles of the mesial root canals were standardized at 25–35° (Schneider technique).[8] Because the root canals mesial and mandibular first molars are often narrow and have an accentuated curvature, increasing the challenges to centered instrumentation, they were selected for this study.[17] Moreover, debris extrusion is more in curved root canals as compared to straight canals as the former is more challenging to clean and shape. In this present study, the counter repercussions of cyclic rotary glide path files and manual K-files on apical debris extrusion were comparably evaluated. Comparing our results with the results of other studies a multiple glide path file system and a full sequence rotary file system generated lesser weight of extruded debris.[5]

As per the literature of previous workers, De-Deus et al. and Abdallah Mai et al. preferred using rotary glide path files in mandibular molar mesial roots and hence we selected the mandibular molars as our study.[18,19] Though in most of the formerly done studies, single canals were employed in the measurement of evicted debris, in this study, mesiobuccal and mesiolingual canals were used to assess extruded debris.[3] Moreover, distilled water was used instead of hypochlorite to facilitate complete evaporation of the extruded irritant.[3] Findings of the present study showed that hand instrumentation gives rise to more debris extrusion when compared to rotary shaping files; similarly, hand glide path preparation led to more debris than multiple rotary glide path file preparation when all other parameters in the study remained the same.[16] Since the amount of debris extruded is co-related to post-operative pain, the use of glide path files may subsequently reduce the postoperative discomfort and pain in patients undergoing endodontic therapy.[20]

A possible limitation of our study was that we did not compare the multiple rotary glide path file systems with single file rotary glide path systems. It is established that complete sequence rotary equipment results in lesser debris extrusion as correlated with single file schemes in curved canals.[4,21] Since our study design included severely curved roots, we chose and compared the two multiple glide file systems with different speed and torque settings.

Although the findings demonstrated that there were no statistically significant alterations among HyFlex GPF files and PathFiles, HyFlex GPF generated lesser debris than PathFiles. HyFlex GPF has different cross-sectional shapes like quadratic in the apical portion and trapezoidal in the coronal part of the file in contrast PathFiles has square cross-sectional shape. This may be the contributing factor to lesser apical debris extrusion in the HyFlex GPF group.[22] HyFlex GPF was manufactured with CM wire technology and PathFile was manufactured with conventional NiTi so according to the results CM wire technology file shows less debris extrusion than the conventional NiTi file but the difference was not significant. HyFlex GPF files has less torque than PathFiles so higher torque on the instrument leads to more strain and crack propagation in the dentin and thus more debris generation.[15,23]

Conclusion

Within the limitations of this *in vitro* study, samples prepared without glide path preparation showed maximum debris extrusion, followed by manual K-files for glide path makeup and then PathFiles and HyFlex GPF files. The shortcomings of the present study, are rotary glide path files resulted in less debris extrusion than glide path preparation with manual K-files. Rotary glide path files may provide greater ease in glide path preparation also less debris extrusion, eventually causing less post-operative pain or flare-ups.

Further *in vivo* studies with the parameter of post-operative pain may be required to correlate the results obtained in our study.

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