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Influence of traverse and waveone gold glider glide path files on the amount of apically extruded debris

Influência das limas glide path Traverse e Wave One Gold Glider na quantidade de detritos extruídos apicalmente

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ABSTRACT

Objective: The aim of this study was to evaluate the effect of different glide path files on the amount of apically extruded debris. **Material and Methods:** Sixty single-canaled mandibular premolars were accessed and randomly divided into three groups (n= 20) according to the file used for glid path creation; group A using Traverse file, group B using WaveOne Gold Glider, group C using stainless steel K file. All teeth were then instrumented using the Reciproc system. The debris extruded apically during instrumentation were collected into pre-weighed Eppendorf tubes which were then stored in an incubator at 70 °C for 5 days. The weight of the dry extruded debris was established by subtracting the pre-instrumentation and post-instrumentation weights of the Eppendorf tubes. The data were analyzed using one-way ANOVA test, and post hoc analysis. **Results:** WaveOne Gold Glider produced the least amount of apical extruded debris (0.41±0.25) followed by the Traverse group (0.59±0.20) then the K-file group (0.64±0.16) with a statistically significant difference (p=0.003). **Conclusion:** Apical extrusion of debris is inevitable during root canal cleaning and shaping. Creation of glide path using engine-driven files produces less amount of apically extruded debris compared to hand-driven K-files.

KEYWORDS

Root canal preparation; Nickel titanium alloy; Dental instruments.

RESUMO

Objetivos: O objetivo deste estudo foi avaliar o efeito de diferentes limas glide path na quantidade de detritos extruídos apicalmente. **Metodologia:** Sessenta pré-molares inferiores com canal único foram acessados e divididos aleatoriamente em três grupos (n= 20) de acordo com a lima utilizada para criação do glid path; grupo A usando lima Traverse, grupo B usando WaveOne Gold Glider, grupo C usando lima K de aço inoxidável. Todos os dentes foram então instrumentados usando o sistema reciprocante. Os detritos extruídos apicalmente durante a instrumentação foram coletados em tubos Eppendorf pré-pesados que foram então armazenados em uma incubadora a 70°C por 5 dias. O peso dos detritos secos extruídos foi estabelecido subtraindo-se os pesos dos tubos Eppendorf antes e após instrumentação. Os dados foram analisados por meio do teste one-way ANOVA e análise post-hoc. **Resultados:** WaveOne Gold Glider produziu a menor quantidade de detritos apicais extruídos (0,41±0,25) seguido pelo grupo Traverse (0,59±0,20) e depois pelo grupo K-file (0,64±0,16) com uma diferença estatisticamente significativa (p=0,003). **Conclusão:** A extrusão apical de detritos é inevitável durante a limpeza e modelagem do canal radicular. A criação do glide path usando limas acionadas por motores produz menos quantidade de detritos extruídos apicalmente em comparação com as limas K manuais.

PALAVRAS-CHAVE

Preparo do canal radicular; Liga de niquel-titânio; Instrumentos odontológicos.

INTRODUCTION

Success of root canal treatment depends mainly upon proper debridement and disinfection of the root canal system, as well as three-dimensional obturation [1]. During root canal preparation, dentin chips, microorganisms, and pulpal tissue may be extruded beyond the apical foramen which may lead to flare-ups, postoperative pain, delayed healing, and/or periapical inflammation.

By definition, glide path is the creation of a smooth tunnel starting from the root canal orifice all the way to the apical foramen [2]. Glide path helps in decreasing stresses, preventing rotary file separation, and enhancing the performance of NiTi files in addition to the reduction of the extrusion of debris during root canal preparation [3]. Preparing a glide path is a crucial step in root canal instrumentation to avoid procedural errors during root canal treatment.

For better preservation of the root canal anatomy, the majority of the NiTi files available show improved flexibility through the use of stabilized martensite crystalline arrangement and various thermal treatments together with a noncutting tip [4]. Therefore, it can't be used for the initial negotiation of the root canal, despite the file being used in reciprocation or rotational motion. Therefore, creating a glide path is highly recommended when using any file system in order to prevent torsional failure of the shaping file [5].

Traverse file (Kerr, Michigan, USA) is a glide path file with an advanced technology that helps creating a more tarped glide path reducing the stresses upon the shaping files used thereafter. Traverse file consists of one file that comes in 21 mm, 25 mm, 31 mm with a 0.06 taper, and a 0.13 and a 0.18 tip size. Traverse file possesses a non-cutting tip and a triangular cross-section. It is claimed to have high torsional resistance, preserve the canal anatomy, and have high cutting efficiency. Traverse file is used in continuous rotational motion [6].

WaveOne Gold Glider (WGG) (Dentsply Sirona, Ballaigues, Switzerland) is a path file manufactured using the heat-treated Gold-wire which has been shown to significantly improve the flexibility and cyclic fatigue resistance compared to non-heat-treated files [7]. It shows a progressive taper over the active portion reducing the taper lock and screw-in effect. The WGG file has a parallelogram cross-section with two cutting edges and a 0.15 mm tip diameter. The WGG shows a progressive taper ranging from 0.02 to 0.06. WGG is available in three lengths 21 mm, 25 mm, and 31 mm, used in reciprocation motion [8].

Traverse file is relatively a novel file, up to our knowledge no studies have been performed to assess its effect on apical debris extrusion. Therefore, the aim of the current study was to assess the effect of Traverse and WGG files on the amount of apically extruded debris. The null hypothesis tested is that there is no statistically significant difference between both files in the amount of apically extruded debris.

METHODOLOGY

Ethical approval

This study was approved by the Institutional Review Board with approval number IRB/COD/STD/41/Apr-2021.

Sample size calculation

A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there is no difference would be found between tested groups. By adopting an alpha and beta levels of (0.05) (i.e. power=95%), and an effect size (f) of (0.521) calculated based on the results of a previous study [9], the predicted sample size (n) was a total of (60) samples (i.e. 20 samples per group). Sample size calculation was performed using G*Power version 3.1 [10].

Sample selection

Mandibular premolars with complete root development, one canal with one apical foramen, and root canal curvature of less than 5° according to the Schneider [11] method were selected. Teeth with previous root canal treatment, apical foramen diameter larger than #25, external or internal root resorption, calcified canals, root caries, and root cracks were excluded.

Samples preparation

Soft and hard deposits attached to the external root surfaces were gently removed using a sharp periodontal curette. The teeth were stored in saline solution. Decoronation was performed using a diamond disk 19 mm from the root apex

in a 90-degree angulation relative to the long axis of the root creating a relatively standard root canal length [12]. Working length was then determined at 0.5 mm short from the apical foramen using a #10 K-file.

Sample classification

The samples were randomly allocated into three groups (n=20) using a computer algorithm (www.random.org) according to the glid path file used; group A using Traverse, group B using WGG and group C using K-files.

Apparatus setup and initial weighing

Myers and Montgomery's [13] model was followed for the current study (Figure 1). An Eppendorf tube was marked and weighed separately for each sample in the study using an analytical weighing scale with a precision of 10^{-4} g. The average of three subsequent weights was used to determine and record the mean weight of each tube.

A total of 60 glass vials with rubber caps were used to fix the sample teeth at the level of the cementoenamel junction using cyanoacrylate. Eppendorf tubes were then placed inside the glass vials. Equalization of the air pressure was achieved by inserting a needle along the rubber cap. To eliminate operator bias, all vials were covered using aluminum foil.

Glide path preparation

Group A: traverse glide path file

A stainless-steel K-file #10 was used to negotiate the canal to the working length with increasing amplitudes of 1–3 mm. Traverse file 0.18/06 was used in continuous rotation of 500 rpm and 150 g/cm torque according to the manufacturer recommendations until the full working length was achieved. After every 1-2 mm of apical advancement, the file was removed and cleaned from debris and reconfirmed patency.

Figure 1 - Experimental model for AED evaluation.

Group B: WaveOne gold glider file

A stainless-steel K-file #10 was used to negotiate the canal to the working length with increasing amplitudes of 1–3 mm. Glide path preparation using WGG size 0.15 mm and 0.2 tapers using "WAVE ONE ALL" mode according to the manufacturer recommendations with gentle inward pressure. The file was passively progressed until the full working length was reached.

Group C: stainless steel K-file

The glide path was initially established using a stainless-steel K-file # 10 until the hand file was loosely fitted in the canal followed by K-file # 15 and 20. K-file # 20 reaching the working length was pulled coronoally 4 mm, then pushed with light finger pressure to the working length again to confirm a glide path.

Root canal preparation

Single file, Reciproc R40 (40/.06) was used to prepare all canals in a reciprocating motion with vertical strokes of 3 mm. After three strokes, the blades were cleaned with a gauze. Patency was maintained using K-file #15 file to the working length. Instrumentation was performed till the R40 reached the working length easily.

After the preparation, wash with 1 mL of distilled water was performed for collection of the adherend AED. Finally, patency was checked using a #10 K-file after irrigation with distilled water.

Irrigation protocol

Each canal was irrigated with 10 mL of distilled water using Navi Tip 29 G irrigation needle (Navi Tip, Ultradent Products, Utah, USA) 2 mm shorter than the working length. A final flush was then performed with 2 mL of distilled water as well.

Final weighing of eppendorf tubes

After preparation, the Eppendorf tubes were incubated for 5 days at 70°C to evaporate

water remnants [14]. Weight calculation was performed by the second author who was blinded to the group assignment. The mean of three readings was calculated.

Statistical analysis

Numerical data were represented as mean and standard deviation (SD) values. Intraclass correlation coefficient was calculated to test for intra-rater reliability and yielded a value of 0.99 which indicates highly correlated measurements of each sample. Shapiro-Wilk's test was used to test for normality. Homogeneity of variances was tested using Levene's test. Data showed parametric distribution and variance homogeneity, so they were presented as mean and standard deviation values and were analyzed using one-way ANOVA followed by Tukey's post hoc test. The significance level was set at $p \leq 0.05$ for all tests. Statistical analysis was performed with R statistical analysis software version 4.1.2 for Windows.

RESULTS

Mean, standard deviation values, and results of intergroup comparisons for extruded debris was presented in Table I and Figure 2.

Results of post hoc pairwise comparisons showed WGG (0.41±0.25) to have a significantly lower value than K-file (0.64±0.16) and Traverse file (0.59±0.20) (p=0.004 and 0.027), respectively. However, the difference between groups Traverse and K-file was not statistically significant (p=0.771).

DISCUSSION

Glide path creation is recommended when using rotary NiTi file systems [15]. Creating a patent channel from the coronal access cavity to the apical terminus will help enhancing the performance of the rotary NiTi files and reduces the extrusion of debris.

As preparation of curved root canals shows a great challenge, straight single-rooted premolars were preferred in the current study to avoid cleaning and shaping mishaps and allow for better standardization [16,17]. Natural teeth were chosen to better simulate *in vivo* situations because resin blocks lack natural tooth properties, such as dentin hardness, canal irregularities, and natural apical constriction [18].

Myers & Montgomery's experimental model was used in the current study [13] despite its limitations including lack of simulation of the apical pressure of the periodontium, inability to standardize the dentin surface hardness and the very small amount of debris measured [19]. This technique allows for differentiation between the extruded debris and the irrigant [20].

Distal water was used as an irrigant for two reasons; first to avoid any impurities of different irrigants which may affect the weight of dry debris, second is to avoid sodium hypochlorite crystallization [21,22]. Several factors affect the amount of apically extruded debris. One of which is the single versus multi-file shaping. Tanalp et al. [23] has concluded that single file systems yield less amount of apically extruded debris and therefore, Reciproc R40 was used as a single file for the root canal preparation.

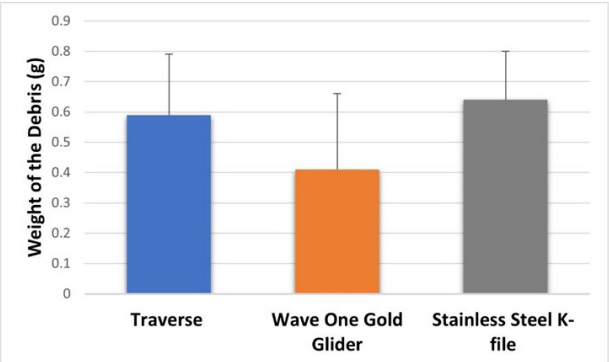

Figure 2 - Bar chart showing mean and standard deviation values for extruded debris for different glide path files.

Table I - Mean, standard deviation values, confidence bounds and results of intergroup comparisons for extruded debris

Group			f-value	p-value
Traverse	*WGG*	K file		
0.59±0.20 ^{A}	*0.41±0.25* ^{B}	0.64±0.16 ^{A}	***6.34***	***0.003****

Means with different superscript letters within the same horizontal row are significantly different. *significant (p<0.05).

In the present study, all groups showed AED with a statistical significance of ($p=0.003$); therefore, the null hypothesis is rejected.

K-files produced significantly more AED than both rotary glide path files tested. This comes in full agreement with numerous studies [2,12,24-27] who concluded that the engine-driven glide path files yielded less amount of AED than hand-driven ones. This can be mainly attributed to two main factors; first is the file's design features and second is the kinematics applied [28]. The push-and-pull action of the hand-driven files will result in more pressure in the apical direction. Hence, more AED will form. This push-and-pull action of the hand-driven files will pack more debris in the apical third of the root canal [22,29].

WGG showed the minimal amount of AED. This can be also attributed to the file design and kinematics applied. WGG shows a progressive taper and a 0.15 mm tip diameter allowing for minimal contact with the dentin surface to be cut, minimizing the screw-in effect. In addition to the parallelogram-shaped cross-sectional design that allows for a considerable clearance space. WGG is a reciprocating file that works with a 150/30 reciprocating angle. This motion allows for better cutting efficiency, less screw-in effect and more clearance of debris coronally [27,30].

Less AED with reciprocating motion compared to continuous rotation has been highlighted by many studies [16,31,32] in agreement with the current study. This could be attributed to the enhanced debris extrusion control for reciprocating kinematics instruments in comparison to rotational systems due to their balanced force movement, expelling lower apical pressure. Reciprocating glide path instruments have higher cutting efficiency, advanced root canal shaping efficiency, and lower apically extruded debris amounts in comparison to continuous rotation instruments. Fontana et al. [32] has shown that clockwise-counterclockwise reciprocating motion allows for better preparation centralization, thus minimizing pressure towards the apical direction in comparison to continuous rotation systems hence lowering debris extrusion.

Traverse results could not be directly compared to other studies as none could be identified in the literature till now evaluating its effect on AED. In this study, Traverse file resulted in less debris than the K-files; however, this difference was not statistically significant, and it was statistically significantly greater than the WGG. This could be attributed to the differences in instrument geometric designs and movement kinematics between systems. Traverses file shows a triangular cross-sectional design with sharp cutting angles offering increased cutting efficiency and more AED. Traverse file operates in continuous rotational motion which will result in more screw-in effect and less clearance of debris during cutting.

CONCLUSION

Based on the results of the current study, it can be concluded that apical extrusion of debris is inevitable during root canal cleaning and shaping. Creation of a glide path using engine-driven files produce lower amounts of AED than hand-driven K-type files. Reciprocation motion results in lower amount of apically extruded debris when compared to rotational motion. The file design also has a significant effect on the amount of debris extruded.

Author's Contributions

ARSAA: Samples preparation, instrumentation, manuscript preparation. TE: Statistical analysis, manuscript preparation and revision. BE: Study design, manuscript preparation and revision.

Conflict of Interest

No conflicts of interest declared concerning the publication of this article.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of Gulf Medical University's Institutional Review Board. The approval code for this study is: IRB/ COD/ STD/41/Apr-2021.

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