J Oral Res
oral and craniofacial sciences

Conference paper

Quantitative evaluation of debris extruded apically using reciprocating *versus* continuous rotation single file with rotary and hand glide path file.

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Conflict of interests: No conflict of interests.

Ethics approval: The research has been approved by the ethical committee of the department of conservative dentistry at the session number 2 dated 7-10-2019.

Funding: The research is self-funded.

Authors' contributions: All authors contributed to the manuscript.

Acknowledgements: None.

Cite as:
Yahya EM, Al Naimi AM & Sulaiman AR. Quantitative evaluation of debris extruded apically using reciprocating *versus* continuous rotation single file with rotary and hand glide path file.
J Oral Res Special Issue. 2019;S1:32-35.
doi:10.17126/joralres.2019.088

Abstract: Chemomechanical root canal preparation (CMRCP) is an important step in root canal treatment. However, one of its negative consequences is apical extrusion of debris of the root canal system contributing to treatment failure and flare-ups. Glide path preparation (GPP) is the initial phase of CMRCP and is crucial for assessing root canal anatomy and establishing unobstructed access to the apical part of the canal. Materials and methods: Forty human mandibular permanent central and lateral incisors were selected; the debris collection apparatus was prepared and the teeth were then divided into four groups: Group 1: Rotary glide path preparation with ProGlider followed by instrumentation with Wave One files. Group 2: Rotary glide path preparation with ProGlider followed by instrumentation with One Shape files. Group 3: Hand glide path preparation with K-file followed by instrumentation with Wave One files. Group 4: Hand glide path preparation with K-file followed by instrumentation with One Shape files. The collected debris was weighed in an analytical digital balance and the collected data were statistically analyzed. Results: No significant difference was present between groups with the same method of glide path preparation or between Wave One and One Shape files. Rotary glide path preparation produced less debris than hand preparation ($p \leq 0.05$). Conclusions: Extrusion of debris was observed in all test groups. Rotary glide path preparation could be preferred in clinical practice as it is associated with less debris extrusion than the manual method.

Keywords: *Root canal preparation; root canal therapy; endodontics; comparative study.*

INTRODUCTION.

Chemomechanical root canal preparation is considered a substantial step in root canal treatment. However, one of its negative consequences is extrusion of dentinal chips, pulp tissue remnants, microorganisms and irritants into the periapical area that may lead to inflammation and delayed healing.[1] Glide path is recommended during the initial CMRCP to minimize the possibility of fracture of nickel-titanium (NiTi) instruments and root canal aberrations caused by CMRCP.[2]

Single file systems (single use) are currently regarded as a method that makes the CMRCP easier, faster and safer.[3] Single-use and single-file NiTi systems are available as reciprocating systems such as Wave One (Dentsply,

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Maillefer, Switzerland) and as rotating instruments such as One Shape (Micro-Mega Besancon Cedex, France).

The aim of this study was to quantitatively compare the amount of apical extrusion of debris (AED) using rotary and hand glide path files with reciprocating or continuous rotation single file systems.

The null hypotheses tested in this study was that first: no significant difference is present in the amount of AED between rotary and hand glide path file, and second: there is no significant difference in the amount of AED between reciprocating and continuous rotation single files.

MATERIALS AND METHODS.

A total of 40 human mandibular permanent central and lateral incisors were collected from patients aged between 40-55 years. The reasons of extraction were, as recorded by the operators, due to periodontal and prosthodontic issues.

The criteria for teeth selection were: one canal as shown by buccolingual and mesiodistal view of radiograph; the degree of curvature not more than 8ºC as determined by Schneider method (1971)[4] no evidence of internal or external resorption as shown by inspection and radiograph; no cracked roots as examined under X10 magnifying lens, and finally, size 8K file should hardly reach the apical foramen in order to confirm that the root canals needed GPP.

All teeth were stored after the extraction in glass containers with chloramine-T for sterilization and to prevent bacterial growth.

The crowns of the teeth were cut off 4±1-2mm above the cementoenamel junction (CEJ) with a carborundum disk under copious water cooling so that a total length of 17mm was obtained for all samples. Confirmation of apical patency was performed by inserting a #08 stainless steel manual K-file until it became visible at the apical foramen and the working length (WL) was determined by substracting 1mm from this length.

The debris collection apparatus was set up according to the study by Myers *et al.*[5] Each microfuge tube was weighed four times at 25ºC, 22% humidity (as measured by hygrometer in the room environment at time of study) using an electronic microbalance that is accurate to 0.0001g (Sartorius Cubis, Gottingen, Germany).

The teeth specimens were randomly divided into four groups (n=10) as follow:

Group 1: Rotary glide path preparation with the ProGlider (Dentsply, Maillefer, Switzerland) followed byinstrumentation with Wave One primary.

Group 2: Rotary glide path preparation with ProGlider followed by instrumentation with One Shape files.

Group 3: Hand glide path preparation with K-file (Dentsply, Maillefer, Switzerland) up to size 20 with watch winding motion followed by instrumentation with Wave One primary files.

Group 4: Hand glide path preparation with K-file up to size 20 with watch winding motion followed by instrumentation with One Shape files.

All the rotary files were used according to the manufacturer instructions. In order, during glide path preparation, flutes were cleaned, canals irrigated with tridistilled water using a 30-gauge side-vented needle, recapitulated with #10 file and the glide path was reconfirmed, then re-irrigated with tridistilled water to liberate loose debris; 2ml of irrigating solution was used between each step for a total of 6ml used in glide path preparation for each of the tested groups.

All the instrumentation for rotary systems was done with torque-controlled electric motor (X-Smart Plus motor, Dentsply, Maillefer, Switzerland). Each instrument was used for two canals only, and all the instrumentation was performed by one operator whereas AED was assessed by another investigator who was blinded regarding the experimental groups.

After instrumentation, the stopper of microfuge tube that housed the tooth was removed and the debris adhering to the tooth surface was collected in the tube by washing the tooth with 2ml of tridistilled water. Tubes were stored in an incubator for 5 days at 70˚C to evaporate the moisture before weighing the net dried debris.[6]

The dry weight of AED was finally obtained using the following equation:

Weight of AED: The weight of tube containing debris - The weight of the empty tube.

Statistical analysis

The amount of AED was analyzed with SPSS (IBM, SPSS, Version 24) using independent sample T-test at $p \leq 0.05$.

Table 1. Independent sample T-test for comparison of AED between groups with the same GPP method but different rotary file systems.

	N	Mean (grams)	S. Deviation	S. Error mean	*p*-value
G1	10	.00223	.000865448	.000273679	*p*=0.524
G2	10	.00191	.001293101	.000408915	
G3	10	.00396	.001604992	.000507543	*p*=0.928
G4	10	.00402	.001287375	.000407104	

Table 2. Independent sample T-test for comparison of AED between groups with different GPP method but the same rotary file systems.

	N	Mean (grams)	S. Deviation	S. Error mean	*p*-value
G1	10	.00223	.000865448	.000273679	*p*=0.008
G3	10	.00396	.001604992	.000507543	
G2	10	.00191	.001293101	.000408915	*p*=0.002
G4	10	.00402	.001287375	.000407104	

RESULTS.

Extrusion of debris was observed in all test groups. No significant difference was present between groups with the same method of glide path preparation.

Since the method of glide path preparation was the same in the groups compared in Table 1, no significant difference is present in the amount of AED between the use of Wave One and One Shape file systems. (Table 1)

However, when comparisons were made between groups 1 and 3, and between groups 2 and 4, which had the same rotary file system but different means of glide path preparation, it was found that the rotary glide path preparation produced less debris than hand preparation with the difference being statistically significant at $p \leq 0.05$. (Table 2)

According to the aforementioned results, the first hypothesis of this study was rejected as GPP with rotary ProGlider files extruded less debris than canals prepared with hand glide path.

On the other hand, the second hypothesis was accepted, since no significant difference was found in the amount of the debris extruded between Wave One and One Shape files.

DISCUSSION.

This study evaluated quantitatively the amount of AED as a result of CMRCP using rotary and hand glide path files followed by instrumentation of the canals with either Wave One or One Shape rotary files.

Based on overall clinical impression, there is an assumption that reciprocation is a forceful movement, acting as a mechanical piston, pumping irrigants and debris through the apex. Nayak *et al.*,[3] found that reciprocating Wave One and Reciproc extruded more debris compared to single use rotational sequence One Shape system.

The authors attributed this to Wave One gold file working in a large rotation angle in the cutting direction (counter clockwise) and smaller rotating angle in the disengaging direction (clockwise motion).

This unequal reciprocal motion, in and out filing motion acts like a piston causing more debris extrusion apically. However, to some extent, this assumption may not have a well-built background, since reciprocation tries to imitate the balanced force technique kinematics, which is known as being a pressureless movement pushing less material to the periapical area.[7]

This is in disagreement with the result of this study since

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no difference was found in the amount of debris extruded using both types of reciprocating and continuous rotation file systems.

In the present study, it was found that creating GPP using rotary files produced lower amounts of AED than using hand K-type files. This was in accordance with Ha *et al.,*[2] who found the rotary GPP systems produced less AED than hand instrumentation.

The results can be explained by differences in instrument geometric designs and movement kinematics between systems.[8] Baranwal & Baranwal[9] found that ProGlider removed the coronal dentin restriction, followed and expanded original anatomy, improving shaping results, reducing chair time and decreasing postoperative pain which was also in accordance with Ha *et al.,*[2] who explained that ProGlider resulted in major debris removal from the coronal third of the canal

On the other hand, the filing motion of K-file creates a greater pressure apically which may tend to push irrigant and debris through the foramen, with less space available to push it coronally. This was in agreement with Abdallah *et al.,*[10] who found that action of linear filing packs more AED tightly into the foramen apically.

CONCLUSION.

Extrusion of debris may be an unavoidable consequence of rotary root canal preparation procedures.

Rotary glide path preparation could be preferable in clinical practice since it provided less apical debris extrusion than the manual method.

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