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**RESEARCH ARTICLE**

# Effect of glide path preparation on apical debris extrusion of rotary and reciprocating single-file systems: OneShape versus WaveOne

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ABSTRACT

**Objectives:** To assess the effect of glide path on the amount of apically extruded debris after instrumentation with WaveOne and OneShape.
**Materials & Methods:** Forty-eight extracted human mandibular incisors were assigned to 4 groups. In groups 1 and 2, preparation was completed with WaveOne, in groups 3 and 4 canals were prepared with OneShape. Before instrumentation, in groups 1 and 3, glide path was created with PathFile 1, 2, and 3 at working length, whereas in groups 2 and 4, glide path was not performed. The weight of the extruded debris for each group was calculated by comparing the pre- and post-instrumentation weights of the eppendorf tubes. The time required for reaching full WL was also recorded. Data were analysed by Kruskal–Wallis and Mann–Whitney *U* tests.
**Results:** There was no difference in the amount of debris extruded between the single file systems ($P$=0.234). Time required to reach full WL was significantly decreased by creating a glide path ($P$< 0.05).
**Conclusions**: Creation of a glide path does not significantly affect the apically extruded debris.

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## INTRODUCTION

Root canal shaping and irrigation are the most important steps in root canal treatment.[1] However, during chemo-mechanical preparation, dentinal chips, pulpal fragments, necrotic debris, irrigants and microorganisms may be extruded inadvertently from the root canal into periapical tissues, resulting in postoperative inflammation and pain.[2,3] Even though all instrumentation techniques and instruments are associated with extrusion of debris, the amount of debris extrusion may differ according to the preparation techniques and the design of file systems.[4-7]

The recently introduced file systems WaveOne (Dentsply Maillefer, Ballaigues, Switzerland) and OneShape (Micro Mega, Besançon, France) are claimed to be able to completely prepare root canals with a single instrument. WaveOne is designed to be used in a reciprocal motion that requires special automated devices. The file is manufactured with MWire NiTi alloy that is created by an innovative thermal treatment process,[8] whereas OneShape is made of a conventional austenite 55-NiTi alloy and used in a continuous clockwise rotation. WaveOne is characterised by a triangular or modified triangular cross-section. OneShape is characterised by different crosssectional designs over the entire length of the working part. Moreover, it has variable pitch length along the working part. This design is alleged to eliminate threading and binding of the instrument in continuous rotation.[9]

Coronal enlargement and creating a manual or mechanical glide path were shown to be the first step for safer use of NiTi rotary instrumentation because these procedures prevent fracture and torsion of instruments and shaping aberrations.[10-12] NiTi rotary PathFiles (PFs) (Dentsply Maillefer, Ballaigues, Switzerland) were marketed to improve the mechanical glide path.[10]

Numerous published articles evaluate the effect of various root canal preparation techniques and instruments on the amount of apically extruded dentinal debris and irrigant.[4,13,14] To the authors' knowledge, no data exists on the influence of glide path on the amount of apically extruded debris during instrumentation with single file systems. Hence, the purpose of this study was to compare the amount of debris extrusion and the time required for reaching full working length (WL) using WaveOne and OneShape single file systems with or without glide path.

## MATERIALS AND METHODS

Fourty-eight extracted human mandibular central incisors with single canal and similar length were collected. Insical ledge of each tooth was reduced to a standardized root length of 14 mm from the coronal aspect. All teeth were analysed with digital radiographs in buccal and proximal directions to check for single canals. After analysing the apical region of the roots using a light stereomicroscope (Olympus SZ-CTV; Olympus, Tokyo, Japan) under 20× magnification, teeth with single apical foramen and mature apices were selected. It was confirmed that all teeth had similar root curvatures of 0–10 degrees.[15] The coronal access cavity was prepared conventionally with a high-speed bur for each tooth. The canal patency was controlled with a size 10 K-file (Dentsply Maillefer, Ballaigues, Switzerland). Only teeth with intact root apices and whose root canal width near the terminus was approximately compatible with size 15 were included. Teeth with the tip of the file extruding beyond the apical foramen were excluded. WL of each canal was determined as 1 mm short of the length where a 10 K- file was visible from the major apical foramen.

The teeth were randomly divided into four groups according to the file used for the preparation of root canals (n=12/group). Each group contained teeth with similar canal length and shape.

An experimental model previously described by Myers and Montgomery[16] was used. Stoppers were separated from the eppendorf tubes. An analytic balance (Radwag, Radom, Poland) with an accuracy of $10^{-4}$ g was used to determine the initial weights of tubes. Three consecutive weights were obtained for each tube, and the mean value was calculated. A hole was created on each stopper. Each tooth was inserted up to the cementoenamel junction, and a 27-gauge needle was placed alongside the stopper to use as a drainage cannula and to balance the air pressure inside and outside the tubes. Then each stopper with the tooth and the needle was attached to its eppendorf tube, and the tubes were fitted into vials (Fig. 1).

To avoid variables and eliminate biases, cleaning, shaping and irrigation of all samples were completed by the same trained operator. The operator was shielded from seeing the root apex during instrumentation by an aluminum leaf that covered the vials. The assessment of extruded debris was performed by a second examiner who was blind with respect to all experimental groups. In each sample, a total of 4 mL of distilled water was used as irrigation solution between pecking sequences to avoid the possible crystallisation of sodium hypochlorite**.**

**Figure 1.** The debris after evaporation of the distilled water.

In the glide path test groups, glide path was performed by using Ni-Ti rotary instruments PFs #1, #2, and #3 taper 0.02, tip size, ISO 13, 16, and 19, respectively, using an endodontic engine (X-Smart, Dentsply Maillefer) with a 16:1 contra angle at the suggested setting (300 rpm on display, 5 Ncm) at full WL. The manufacturer suggests using the first PFs immediately after a #10 hand K file has been used to scout the root canal to the full WL, and then #2 and #3 are used at the WL.

**Group 1:** A WaveOne Primary reciprocating file with a #25 tip was used in a reciprocating in-and-out pecking motion, according to the manufacturer's instructions after creating a glide path. The flutes of the instrument were cleaned after three in-and-out movements (pecks).

**Group 2**: A glide path was not created prior to instrumentation. Each canal was shaped with WaveOne Primary reciprocating files, used with a pecking motion until reaching full WL. The flutes of the instrument were cleaned after three pecks.

**Group 3:** An OneShape file with a #25 tip was used according to the manufacturer's instructions after creating a glide path.

**Group 4:** A glide path was not created prior to instrumentation. Each canal was shaped with a #25 tip OneShape file.

Each instrument was used for the preparation of four root canals for both groups and then discarded. Time for canal preparation was recorded which included total active instrumentation of single files, cleaning of the flutes of the instruments, and irrigation. Elapsed time while using PFs in groups 1 and 3, were not included in the total preparation time. Because it was aimed to record only the preparation time required to reach full WL with WaveOne and OneShape files. After instrumentation was completed, the debris adhering to the root surface was collected from the root surface by washing the root with 1 mL of distilled water and added to debris extruded apically during preparation in the tube (Fig 2.). The tubes were then stored in an incubator at 70 °C for 5 days to evaporate the distilled water before weighing the amount of dry debris (Fig 3.). Weights were calculated by a second examiner who was blinded to group assignment. The eppendorf tubes were weighed using the same analytic balance to obtain the final weight of the tubes, including the extruded debris. Three consecutive weights were obtained for each tube. The dry weight of the extruded debris was calculated by subtracting the weight of the empty tube from the weight of the tube containing debris.

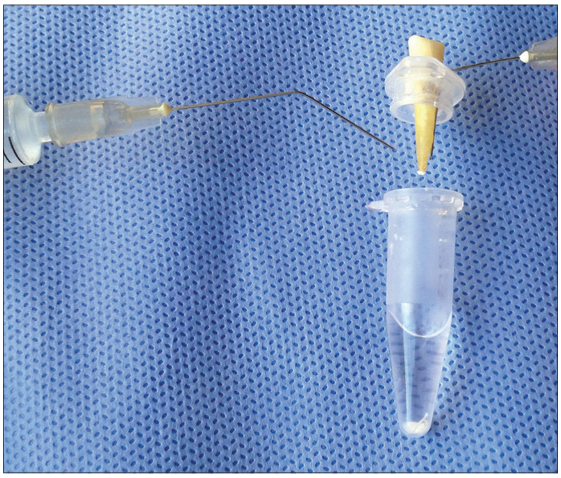

**Figure 2.** The apparatus used to evaluate the collection of apically extruded debris.

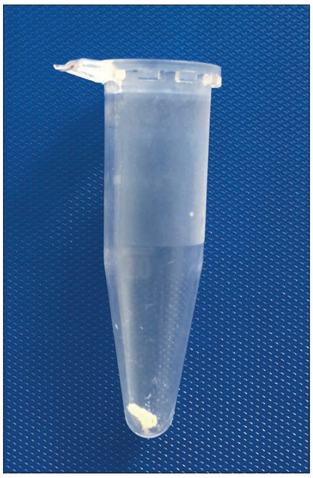

**Figure 3.** The debris on the root surface was collected to the Eppendorf tubes.

Differences among the groups were analysed by the Kruskal–Wallis test. Dual comparisons among groups with significant values were evaluated with the Bonferroni adjusted Mann–Whitney U-test.

## RESULTS

The mean values and standard deviations of all groups are shown in Table 1 and 2. There were no statistically significant difference was between the groups ($P$=0.234). Time required to reach full WL was significantly decreased by creating a glide path ($P$=0.001). In OneShape group, time required for reaching WL was significantly less than the other groups ($P < 0.05$).

## DISCUSSION

The amount of material extruded from the apical foramen is one of the main concerns related to an instrumentation technique. Extrusion of these materials may potentially cause postoperative complications, such as induction of inflammation, pain and delay of periapical healing.[3] Although all instrumentation techniques apically extrude some amount of debris, there are notable differences among the techniques.[4, 17]

According to the results of this study, apical debris extrusion occurred independently of the type of instrument used. There was no statistically significant difference between the groups on the amount of extruded debris. However, when evaluated only in terms of glide path creation, OneShape with a glide path is the group showing the least amount of debris

**Table 1.** Amount of apically extruded debris after the use of the different instruments.

| Groups | Amount of debris extrusion (g) | | *p* value |
|---|---|---|---|
| | Mean | SD | |
| Group 1 WaveOne with glide path | ,000425[a] | ,0004115 | 0.234 |
| Group 2 WaveOne without glide path | ,000733[a] | ,0005944 | |
| Group 3 OneShape with glide path | ,000358[a] | ,0001676 | |
| Group 4 OneShape without glide path | ,000467[a] | ,0002871 | |

Values with the same letters were not statistically different at P=0.05

**Table 2.** Preparation time with the different instruments.

| Groups | Preperation time (s) | | *p* value |
|---|---|---|---|
| | Mean | SD | |
| Group 1 WaveOne with glide path | 27,33[a] | 14,816 | 0.001 |
| Group2 WaveOne without glide path | 45,25[b] | 17,661 | |
| Group 3 OneShape with glide path | 18,42[c] | 10,638 | |
| Group 4 OneShape without glide path | 34,92[d] | 24,172 | |

Values with the different letters were statistically different at P=0.05

extrusion, hence it can be the most favorable result from a clinical point of view.

Similarly, Bürklein and Schäfer[18] recently reported that the reciprocating systems occurred more debris compared with the rotational systems. The result of present study is in accordance with results of a recent report that rotary instrumentation was associated with a reduced amount of debris extrusion.[19]

The differences between the instruments obtained in the present study may be due to the preparation technique, the cross-sectional design of the instruments and the different tapers of the instruments. WaveOne was used in a reciprocal motion whereas OneShape was used in rotation. It may be concluded that a reciprocal motion enhances debris transportation toward the apex, contrarily, continuous rotation may improve coronal transportation of debris by acting like a screw conveyor.[18] For each system size 25 files were selected. WaveOne Primary file apical diameter of #25 with. 08 taper and OneShape has a #25 apical diameter with. 06 taper. The larger apical taper of WaveOne at the tip may cause more aggressive preparation of the root canals, and this could be another reason for greater apically extruded debris by WaveOne.

The file design of OneShape is unique: the instrument presents a variable cross section along the blade with three different cross-section zones. The apical zone presents a variable three cutting-edge design. The middle position of the file prior to the transition, offers a cross section that progressively changes from three to two cutting edges and the coronal part is provided with two cutting edges that facilitate coronal debris transportation consequence. WaveOne is characterized by a triangular or modified triangular cross-section resulting in a lower cutting efficiency and smaller chip space.[18] Thus; it seems unlikely that the differences in debris extrusion can be explained by the minor differences in the cross-sectional design of the instruments.

Early coronal enlargement and development of a glide path using hand or mechanical instruments are recommended to reduce frictional forces to the canal walls and to maintain the original canal curvature and guarantee uniform dentin removal to reduce apical debris extrusion.[11,12,20] The use of PathFile is recommended to maintain the original canal curvature and guarantee uniform dentin removal with reduced apical debris extrusion, as demonstrated by several authors.[18,20,21] Our results showed that when single file systems were used after creating a glide path with PFs, relatively less apical debris extrusion was produced. In addition, for both systems the time required to reach WL is decreased by use of PFs before instrumentation. It was observed that fewer pecking motions were needed to reach full WL with WaveOne single files, when a glide path was created previously. Similarly, Berutti et al.[20] reported that less pecking motion was required to reach the WL with the WaveOne when a glide path had been created.

In the present study, an experimental model was used for debris collection, and this model has been described and discussed previously.[16] Periapical tissues and the pressure at the apex that act as a barrier against apical extrusion were not mimicked with this experimental model. Because of this shortcoming of the methodology, numerical comparisons could not reflect the clinical situations they should be transferred to clinical situations with caution. However, standardization of methodology could provide information to compare the tested instruments in terms of apical extrusion. A simulation of back-pressure of the periapical tissues using floral foam has been suggested,[22, 23] but foam suffers from several disadvantages, such as absorption of irrigant and debris. Therefore, no attempt was made to simulate periapical resistance in the present study like the the other studies.[18,19,24]

## CONCLUSION

Within the limitations of the present study, it can be concluded that creation of a glide path before using any NiTi rotational or reciprocal instrument, does not affect the apically extruded debris. However creation a glide path provides a decreased working time for reaching WL.

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