

ORIGINAL RESEARCH

Quantitative Evaluation of Apically Extruded Debris of Different Single File Systems: WaveOne Gold, One Shape, F360, and Reciproc: An *in vitro* Study

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ABSTRACT

Introduction: Root canal therapy comprises three main steps, namely access preparation, biomechanical preparation, and three-dimensional obturation. During the process, the debris of the root canal system is pushed out from the canals, leading to treatment failure and flare-ups.

Materials and methods: Eighty extracted human teeth with straight single canal were selected; the sample tubes were preweighted before instrumentation and were then allocated into four groups along with the sample teeth. All the samples were instrumented and debris was collected in the collector tubes. The debris collected was weighted in an analytical balance to determine the extruded debris.

Results: The results of our study showed that WaveOne Gold resulted in least amount of periapical debris extrusion. However, there was no statically significant difference between One Shape and F360, while Reciproc extruded maximum amount of debris as compared with all other file systems.

Conclusion: The WaveOne Gold extruded less amount of periapical debris than the other file systems.

Keywords: One shape, Reciproc, WaveOne.

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INTRODUCTION

Root canal therapy comprises three main steps, namely access preparation, biomechanical preparation, and three-

dimensional obturation. During the process, the debris of the root canal system is pushed out from the canals, leading to treatment failure and flare-ups.¹

Many factors contribute to debris extrusion. According,² irrigation of the root canal space during instrumentation is one of the factors that led to an increased amount of debris extrusion. Teeth with necrotic pulp permitted more irrigant extrusion compared with vital teeth. The depth of file insertion into the root canal is another factor affecting debris extrusion. Studies conducted^{3,4} showed that instrumentation short of apical foramen decreased the amount of debris extrusion with both endosonic and k-files.

Canal preparation done with step-back techniques showed greater amount of periapical extrusion, whereas canal preparation having special design of nickel-titanium files with crown-down technique decreases the amount of extrusion periapically.² The amount of apical extrusion can also vary according to the technique used. It is generally accepted that instrumentation techniques that incorporate rotational action generate less debris than push/pull instrumentation, and the crown-down technique has been associated with the least amount of debris extrusion, compared with techniques involving a linear filing motion. Thus, engine-driven rotary systems have tended to extrude less debris than hand techniques.

Recently, newer file system WaveOne Gold has been introduced, which was compared with F360, One Shape, and Reciproc.

The Reciproc files are composed of M-Wire nickel-titanium, which offers increased flexibility. The reciprocating movement of the instrument reduces the risk of cyclic fatigue.

One Shape files, on the contrary, employ traditional continuous rotation. They have a triangle-shaped cutting edge and two additional cutting edges, in the apical and coronal parts, as well as a cross-section that progressively changes from three to two cutting edges between the apical and coronal parts. This design offers optimal cutting action.^{1,3}

F360 has a double S-shaped cutting edges and a lower bending ability increasing the flexibility of file. It has a

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large chip space and dynamic file design, which flush out debris.¹

WaveOne Gold is a single-file technique having a unique design feature of alternating offset parallelogram-shaped cross-section. This design limits the engagement between the file and dentin to only one or two points of contact at any given cross-section, subsequently reducing taperlock and the screw effect.²

The aim of our *in vitro* study was to quantitatively analyze the amount of periapical debris extrusion of WaveOne Gold, F360, Reciproc, and One Shape file system.

MATERIALS AND METHODS

Eighty extracted human teeth with straight single canal were selected. The degree of curvature was calculated using methodology described.¹

The coronal access was achieved using Endo Access and Endo Z bur and the canal patency was ensured with 15 k-file. The working length was established by ensuring file to extrude beyond apex and subtracting 1 mm from that length.

The sample tubes were preweighted before instrumentation and were then allocated into four groups:

1. *Group I*: A R25 Reciproc file having size 25 at the tip and a taper of 0.08 over the first 3 mm to be used in reciprocating motion.
2. *Group II*: A WaveOne Gold file having size 25 at the tip was used in reciprocating motion,
3. *Group III*: A F360 file having a size 25 at the tip and taper of 0.04 was used with a rotational speed of 300 rpm.
4. *Group IV*: One Shape file having a size 25 at the tip and a taper of 0.06 was used with a rotational speed of 400 rpm and torque was adjusted to 4 N cm.

DEBRIS EXTRUSION

Receptor tubes were prepared as per guidelines of Montgomery setup¹ and covered using rubberdam sheets. These tubes were used to house the teeth.

Thick rubberdam sheet was made using double layer of sheets and the sheet was used to cover the tube mouth ligated using an elastic string. A preweight of these tubes was done using a milligram balance.

Postweight was done after instrumentation and drying of receptor tube to quantitatively assess extruded debris.

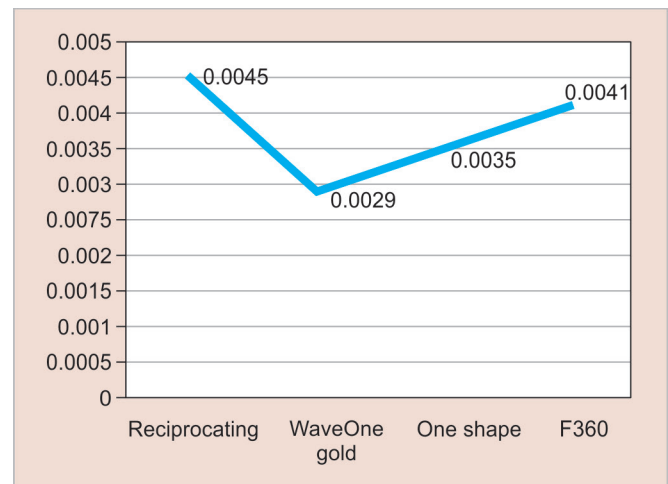
The samples were mounted over the tubes and housed in a second tube to prevent external contamination. Then biomechanical preparation was performed along with irrigation, and the debris extruded was then collected in a receptor tube.

The collected irrigant was dried in a hot air oven and residue was left behind. The receptor tube was weighted again in an analytical scale for debris collected.

Table 1: The mean values from different file systems

Groups	Mean \pm SD	F-value	p-value	Significance
Reciprocating	0.0045 \pm 0.00041	73.300	0.001	Significant
WaveOne gold	0.0029 \pm 0.00032			
One shape	0.0035 \pm 0.00035			
F360	0.0041 \pm 0.00034			

SD: Standard deviation



Graph 1: Comparison of apical extrusion in different groups

Statistical Analysis

Statistical analysis of all samples was done using analysis of variance and *post hoc* Tukey's test (Graph 1 and Table 1).

RESULTS

Our *in vitro* study showed that all file systems used extruded debris apically. The result of our study showed that WaveOne Gold resulted in least amount of periapical debris extrusion. However, there was no statically significant difference between One Shape and F360, while Reciproc extruded maximum amount of debris as compared with all other file systems.

DISCUSSION

The apical extrusion of intracanal materials has been investigated in many studies because of its clinical relevance. Apical extrusion of intracanal materials can delay periapical healing and cause inflammation and postoperative pain. Therefore, the main objective of this study was to evaluate the apical extrusion of debris and irrigant as a result of root canal preparation by different instrumentation systems.³

The present study revealed that all of the instrumentation systems caused apical extrusion of debris and irrigants. The results were consistent with previous studies, which demonstrated that no method could completely prevent debris extrusion. The results of our study showed

that WaveOne Gold resulted in least amount of periapical debris extrusion. However, there was no statically significant difference between One Shape and F360, while Reciproc extruded maximum amount of debris as compared with all other file systems. The obtained differences between the instruments might have been caused by the different tapers and the cross-sectional design of the instruments.

In our study, WaveOne Gold performed significantly better. There are three major clinical advantages to WaveOne Gold's unique movement. One, compared with continuous rotation, there is improved safety, as the CCW engaging angle is designed to be less than the elastic limit of file. Two, opposed to equal clockwise (CW)/ counter clockwise (CCW) angles, unequal CW/CCW angles enable a file to more readily advance toward the desired working length without using excessive and potentially dangerous inward pressure. Three, compared with equal CW/CCW angles, unequal angles strategically enhance auguring debris out of the canal.²

While Reciproc has an S-shaped, cross-sectional design with sharp cutting edges, One Shape is characterized by a changing triangular cross-section, and F360 has a double S-shaped cutting edges and a lower bending ability increasing the flexibility of file. WaveOne Gold has a parallel cutting edge.^{5,6}

Uzun et al,⁷ and Hussein and Al-Zaka⁶ studied apical extrusion among different file systems. They concluded that Reciproc file system extruded lesser debris than WaveOne file system. WaveOne is a single-file root canal preparation system that also produced more debris than the Reciproc. The larger apical taper of the WaveOne instrument may cause more aggressive preparation of the canals, which could explain the larger quantity of debris apically extruded by the WaveOne. Since the above-mentioned features were modified in WaveOne Gold, it must have led to better results with this newer file system.^{8,9}

There are different techniques available to measure the apically extruded debris and irrigant. In the current

study, the generally accepted method of Myers and Montgomery, which is more standardized and repeatable than other methods, was used to collect the intracanal materials. Thus, it was selected for study.

CONCLUSION

Within the limitation of our study, WaveOne Gold extruded least amount of debris as compared with F360, One Shape, and Reciproc.

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