



Comparative Evaluation of Cleaning Efficacy of Three Different Single File Systems: An *In Vitro* Study

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

Aim: The aim of this study was to evaluate the canal cleaning efficacy of these three file systems using scanning electron microscopy.

Place and Duration of Study: The study was conducted in the Department of Conservative dentistry and Endodontics, Institute of Dental Sciences Sehora, between October 2020 and December 2020.

Materials and Methods: Access cavity preparation was performed on sixty extracted human mandibular premolar teeth and working length was determined. The samples were randomly divided into three groups (n=20) depending upon the file system used i.e. Group 1 (Reciproc Blue), Group 2 (Waveone Gold) and Group 3 (F360). Samples were split into two halves by creating longitudinal grooves on the buccal and lingual surfaces. The samples were sputter-coated with gold and examined under scanning electron microscope at 5000X. The dentinal wall of root canal at coronal, middle and apical thirds of each sample were evaluated for the presence of determining the canal cleanliness and then analyzed using a five-score index.

Results: The results of this study revealed that Group 1 (Reciproc Blue) exhibited better cleaning efficacy than samples of Group 2 (WaveOne Gold) and Group 3 (F360) at different locations in the canal i.e. coronal, middle and apical. The mean debris present was highest in coronal area for both

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group 2 and group 3 i.e. 2.1 and least was seen in apical area of group 1 i.e. 0.3. ($p < 0.05$)
Conclusion: Reciproc Blue single-file showed highest cleaning efficacy followed by Waveone Gold and F360. Reciproc file also showed effective cleaning in the apical third of the canal.

Keywords: Reciproc blue; scanning electron microscope; debris; waveone gold.

1. INTRODUCTION

A root canal treatment requires complete removal of microbes in order to prevent reinfection of the canal. Proper shaping of the canal prevents both damage to the root canal and also reduces the apical tissue irritation [1]. Various advances in the field of dentistry have led to development of wide range of nickel-titanium (NiTi) rotary file systems, which have been a boom in the clinical endodontic procedural success. These rotary files have properties like super elasticity, shape memory and flexibility which leads to a clean three dimensional obturation [2]. Several manufactures have developed rotary files in varied tapers and designs.

Single-file nickel titanium systems have obtained worldwide popularity in endodontics [3]. These single file system is a combination of novel metallurgy and reciprocating motion. They are based on balanced force technique, which was introduced by Ghassan Yared [4]. These reciprocating motion reduces the stress on the file during instrumentation thus minimizing the risk of breakage [5]. The major drawback of these files was there was a marked tendency for debris generation along the walls of root canal [6].

Reciproc series (VDW GmbH, Munich, Germany) was introduced in 2008 with reciprocating motion having unequal forward and reverse movement [4]. Reciproc blue (VDW GmbH, Munich, Germany) is a thermal treated nickel-titanium instrument, with a improved resistance to cyclic fatigue and increased flexibility [7]. The instrumentation requires only one file to enlarge the canal to optimum size and taper even in cases with high degree of curvature or canal calcification.

Another file system which is based on continuous clockwise rotation is F360 (Komet, Brasseler GmbH & Co., Lemgo, Germany). It is based on two files with tip diameter of 25 and 35 and taper 0.04, also other files for apical shaping are available with a tip diameter of 45 or 55. The files a S-shaped cross section along the whole length

and is made up of conventional austenite Ni-Ti alloy.

In 2015, Waveone Gold (WOG, Dentsply Maillefer) was introduced having a parallelogram cross-sectional design. It has a enhanced cyclic resistance due to advanced metallurgy and heat treatment technology [8]. The gold color which has been produced due to thermocyclic procedure is said to increase the flexibility of file [9].

Since new file system are being developed to increase the cleaning efficacy of the root canal, so a few studies have investigated about the cleaning ability of Reciproc Blue, F360 and Waveone gold. Therefore, the aim of this study was to compare the canal cleaning efficacy of these three file systems using scanning electron microscopy.

2. MATERIALS AND METHODS

In the present study, sixty freshly extracted single-rooted human mandibular premolars were selected. These teeth were extracted for orthodontic reasons and placed in saline at room temperature immediately after extraction. Teeth with two canals, fractures, calcification and internal resorption are not included in the study. The root canal curvature was determine by Schneider's method. The study included those teeth which had straight root canal $< 5^\circ$ angle.

Standardized access cavities were prepared and working length was determined using a 15 K file under a radiograph. The samples were randomly divided into three groups ($n = 20$ for each group).

Group 1 (Reciproc Blue): The samples were directly instrumented by RC Blue R25 (size 25/0.08) instrument, without creating any glide path previously. The file was used along with x-smart plus endodontic motor (Dentsply Maillefer, Germany), according to manufacture's instructions. The file was changed after instrumenting 3 canals.

Group 2 (WaveOne Gold): The samples were instrumented with WaveOne Gold 25 (0.07)

using x-smart plus endodontic motor according to manufacturer's instructions.

Group 3 (F360): The samples were prepared using red instrument (25/04) followed by green instrument (35/04) using x-smart plus in a continuous rotary motion at 300 rpm and 1.8 N/cm torque. The set of files were change for every 3 canals.

All the file systems were instrumented by crown-down technique. Samples were prepared by the same trained operator. Canals were irrigated by 3 ml of 3.0% sodium hypochlorite followed by 1ml of 17% EDTA, after each instrumentation. A final rinse was done with NaOCl for each tooth.

On the buccal and lingual surfaces of each tooth parallel longitudinal grooves were created with the help of a diamond disk. The specimens were then split into two halves using pliers taking grooves as reference areas. The samples were sputter-coated with gold and examined under scanning electron microscope (EVO MA 10 Carl Zeiss SMT AG, Germany) at 5000X. The dentinal wall of root canal at coronal, middle and apical thirds of each sample were evaluated for the presence of determining the canal cleanliness.

The SEM images were analyzed using Hulsmann scoring criteria [10]:

Score 1: Clean root canal, only a few small debris particles

Score 2: Few agglomerations of debris
Score 3: Many agglomerations of debris coving <50% of the root canal wall

Score 4: More than 50% of the root canal walls were covered with debris

Score 5: Complete or nearly complete root canal wall covered by debris

2.1 Statistical Analysis

Statistical software SPSS with version 21.0 (SPSS Inc., Chicago II, USA) and Microsoft Excel were used to carry out the statistical analysis of data. Descriptive statistics of data including mean and standard deviation. Analysis of variance (ANOVA) test was used for analysis of data. A P-value of less than 0.05 was considered statistically significant.

3. RESULTS

The results of this study revealed that Group 1 (Reciproc Blue) exhibited better cleaning efficacy than samples of Group 2 (WaveOne Gold) and Group 3 (F360) at different locations in the canal i.e. coronal, middle and apical. The mean debris present was highest in coronal area for both group 2 and group 3 i.e. 2.1 and least was seen in apical area of group 1 i.e. 0.3 Fig. 1.

Statistical significant difference was seen at coronal ($p = 0.043$) and apical ($p = 0.001$) thirds of root canal in different groups ($p < 0.05$) Table 1.

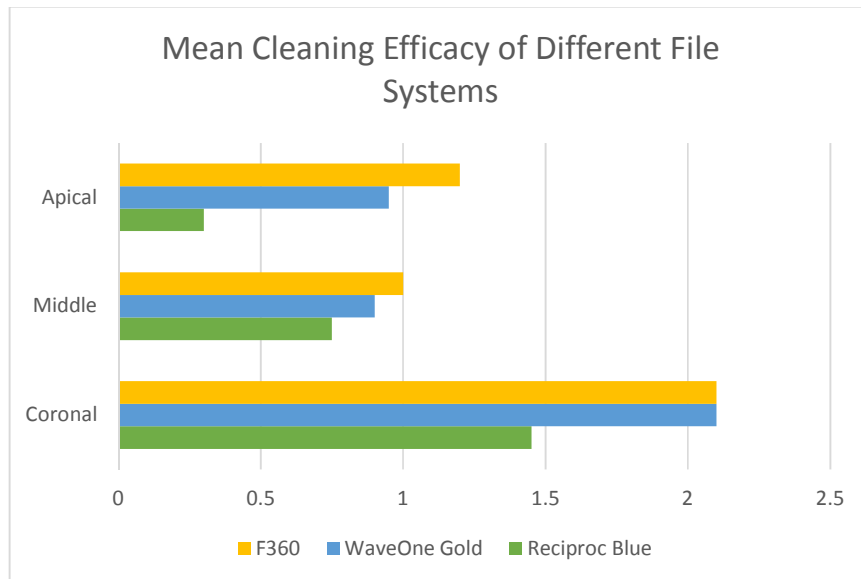


Fig. 1. Graphical representation of mean cleanliness in each group

Table 1. Canal cleanliness for each group and summarization of statistics between three groups at different locations in the canal

Groups	Total no. of Samples	Coronal		Middle		Apical	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Group 1 (Reciproc Blue)	20	1.45	0.9445	0.75	0.7164	0.3	0.4702
Group 2 (WaveOne Gold)	20	2.1	0.8522	0.9	0.7182	0.95	0.7592
Group 3 (F360)	20	2.1	0.9679	1	0.7255	1.2	0.9515
f-ratio		3.3069		0.61083		7.60587	
p-value		0.043774*		0.546416		0.001181*	

p<0.05 shows significant difference

4. DISCUSSION

Instrumentation aims at continuous taper of the canal, without any alterations in original anatomy of the root canal. Due to varying designs of the endodontic instruments, the cleaning efficacy is different for different file systems [11]. Ni-Ti were introduced in endodontics in order to provide the best mechanical properties to the root canal preparation. The Ni-Ti files earlier had a continuous rotation and also required multiple instrumentation for canal preparation. Advancements in these files have led to development of reciprocation and establishment of single file systems [10]. Single file systems preparation of the root canal is time saving and is pleasant for both the patient and the dentist.

In the present study, the canal cleaning ability of Reciproc Blue, Waveone Gold and F360 were evaluated under a scanning electron microscope. The SEM was chosen as it is more sensitive and specific in evaluating the cleaning ability [12-14]. It was observed that Reciproc Blue instrumentation group showed a more cleaning ability than other two groups (WaveOne Gold and F360). The result of our study can be compared to study done by Bartols et al. [15] who reported that Reciproc Blue file can be used to prepare the root canals to full working length in 95.6% cases. Another study done by De-Deus et al. [16] also stated that Reciproc instruments can reach to full working length in 90.7%-96.4% cases of lower molars. The reason behind this may be attributed to thermal treatment used in the manufacturing process of Reciproc Blue. The heat treatment modifies the molecular structure and provides more strength and flexibility to the file system [17].

Waveone Gold is another file system which showed less cleaning efficacy as compared to Reciproc Blue file. The result of our study was in accordance to study conducted which stated that Reciproc files had a better cleaning ability when compared to Waveone Gold which may be due to different cross-sectional designs of the file systems [18]. F360 file system showed the least cleaning efficacy among the three file systems due to the less taper of the file (0.04), thus reducing the effective shaping of the root canal and also through debridement of the canal [2].

Various studies revealed that reciprocating rotary files demonstrated relatively cleaner root canals [19-21].

5. CONCLUSION

Within the limitations of the study, it was concluded that none of the instrumentation file system thoroughly cleaned the root canals. Reciproc Blue single-file showed highest cleaning efficacy followed by Waveone Gold and F360. Reciproc file also showed effective cleaning in the apical third of the canal.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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