

## **Cleaning ability of Multiple versus Single Rotary file Systems (in-vitro study)**

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### **Introduction:**

The ultimate objective of canal preparation is the elimination of irritant and maintenance of healthy periapical tissues. Use of automated Ni-Ti instruments was a logical development to improve the efficiency of the treatment. Rotary instruments have tendency to pull the debris into their flutes, lifting them out of the root canal in the coronal direction, thus reducing extruded debris apically.

Debris is composed of dentin chips, pulp remnants, residual vital or necrotic pulp tissue attached to the root canal wall which in most cases is infected<sup>1</sup>. While the smear layer is an amorphous and irregular thin film layer is formed on root canal walls after instrumentation<sup>2</sup>, it has been suggested that the presence of smear layer may prevent bacterial penetration into the underlying dentinal tubules. On the contrary, the presence of an infected smear layer may prevent antimicrobial agents from gaining access to the infected dentinal tubules. Furthermore, the removal of the smear layer may enhance the penetration of sealers into dentinal tubules and adaptation of obturation materials to the root canal walls.

Instruments alone cannot effectively eliminate bacteria from the root canal system and modern rotary instrumentation techniques produce a large quantity of smear layer that covers root canal walls. All NiTi rotating instruments have been shown to produce moderate to heavy smear layer that need to be removed with the use of chemical solutions.

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## Aim of the study

The purpose of this study was to Evaluate the cleaning efficiency of both Race and Neolix files used for mechanical preparation of the root canal as a multiple versus single file systems, in terms of:

- (1) The amount of debris.
- (2) The presence of smear layer.

## Materials and Methods

### A-Materials :

1-RaCe endofile system; It features an anti screw-in design, an electro-chemical polish that improves resistance to fatigue and corrosion, greater flexibility and a rounded tip.

2-Neolix rotary system; they are generated using a newly developed wire-cut electrical discharge machining process. It has a rough surface and higher flexibility.

### B-METHODS:

**Selection of samples;** A total of Forty human mandibular molars with completely formed apices and straight canals were collected.

**Preparation of samples;** For decontamination all the teeth were immersed for 15 minutes in 5.25% of sodium hypochlorite. For all samples Standard access cavities were prepared by a high-speed hand-piece and Endo access bur. Size 10, 15 K-file were introduced into each root canal to confirm their patency.

**Classification of samples;** Teeth were classified equally and randomly into 2 groups (A,B) according to the file system used. All instruments were used in a 16:1 gear reduction hand-piece powered by a torque-controlled (3.0 n.m.) electric motor .

**Group A** was instrumented by **Neolix system** as follows:

C1 file was used to open the root canal orifice, Then A1 file size 0.25 and taper 6% was used reaching the full working length , canals were irrigated using 2 ml of 2.5% sodium

hypochlorite using a needle of 22 gauge.

**Group B** was instrumented by **Race system** as follows:

File sequence used were as follows: Pre-RaCe 40/0.1 and Pre-RaCe 35/0.8 were used for preparing the coronal and middle portion of the canal; the enlargement of the rest of the canal prepared by instruments of size 25/0.02, 25/0.04, 25/0.06 to the working length. The canals were finally flushed with 2.5% sodium hypochlorite.

**Method of Evaluation;** After preparation of the root canals in both main groups, Each tooth was cut into 2 halves longitudinally. Each half was then placed to be observed under the scanning electron microscope.

For smear layer, Scanning electron microscope was used to evaluate its presence qualitatively, at 3 different levels apical, middle and coronal thirds of the root canal wall under magnification power of 1000x using scoring system described by Hülsmann et al<sup>1</sup>.

For debris evaluation, Scanning electron microscope was used to evaluate its presence qualitatively, at 3 different levels apical, middle and coronal thirds of the root canal wall under magnification power of 500x using the scoring system described by Hülsmann et al<sup>1</sup>.

**Statistical analysis;** Kruskal-Wallis test was used for intergroup comparisons followed by multiple pairwise comparisons utilizing Mann Whitney U test. Friedman test was used for intragroup comparisons followed by multiple pairwise comparisons utilizing Wilcoxon signed rank test.

## Results

### Smear Layer

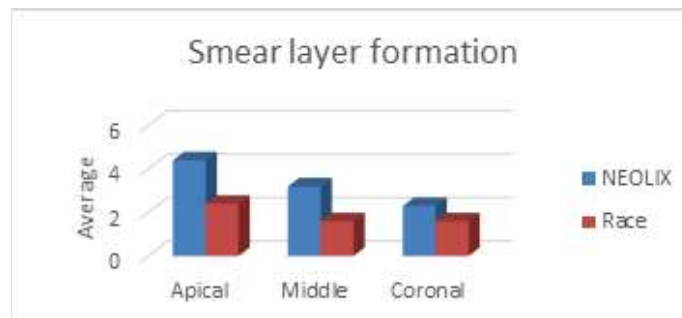
For all sections and specimens, (NEOLIX) had a higher (mean  $\pm$  SD) value than (Race) and there was a significant difference between both systems ( $P > 0.05$ ). Generally Race file system had a lower score in smear layer formation than the Neolix file system, as shown in table(I).

**A-Effect of file system:** Neolix file system showed more smear layer formation than the Race file system among the whole specimen.

**B-Effect on section:** Neolix file system showed most smear layer formation at the apical third, less smear layer formation at the middle third and the least smear layer formation was at the coronal section of the tooth. While Race file system showed better results on the coronal and middle thirds of the specimen than on the apical one third.

**Tables(I);** Mean, Standard deviation (SD) values of smear layer formation scores for different groups at different sections

Sections	Smear layer formation (mean±SD)		P-value
	NEOLIX	Race	
Apical	4.40±0.96 <sup>Aa</sup>	2.40±0.51 <sup>Ab</sup>	<0.001***
Middle	3.20±0.42 <sup>ABa</sup>	1.60±0.51 <sup>Bb</sup>	<0.001***
Coronal	2.30±0.48 <sup>Ba</sup>	1.60±0.51 <sup>Bb</sup>	0.029*
P-value	<0.001***	0.009**	



**Figure (I):** Bar chart showing average smear layer removal scores for different groups at different sections

## Debris

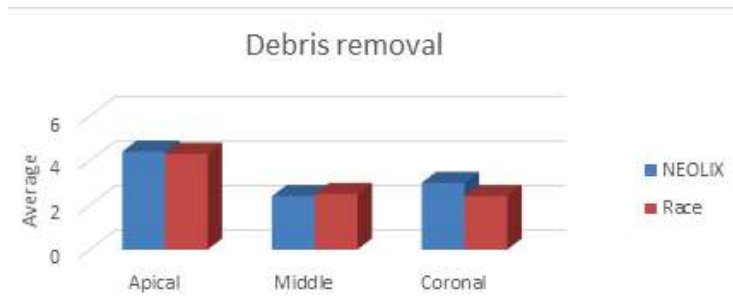
Generally, Race file system had a higher score at debris removal than the Neolix file system.

**Effect of file system:** Neolix file system showed less debris removal than the Race file system among the whole specimen.

**Effect on section:** Neolix file system showed least debris removal at the apical third, better debris removal at the coronal third and the best debris removal action was at the middle third. While Race files showed better debris removal on the coronal and middle two thirds of the specimen than on the apical one third.

**Table (II):** showing more debris removal using race file system than using the neolix file system.

Sections	Debris removal (mean±SD)		P-value
	NEOLIX	Race	
Apical	4.40±0.51 <sup>Aa</sup>	4.30±0.67 <sup>Aa</sup>	0.853ns
Middle	2.40±0.51 <sup>Ba</sup>	2.50±0.52 <sup>Ba</sup>	0.739ns
Coronal	3.00±0.81 <sup>ABa</sup>	2.40±0.51 <sup>Ba</sup>	0.123ns
P-value	0.001**	<0.001***	



**Figure (III): Bar chart showing average debris removal scores for different groups at different sections**

## Discussion

During chemo mechanical preparation root canals, the cutting action of the endodontic instruments within the root canals dentinal walls, causes formation of debris and smear layer<sup>3</sup>, which may harbour microorganisms and deteriorate the sealing of the root canal filling materials<sup>4</sup>.

In the current study, the cleaning ability of Race (multiple) versus Neolix (single) endodontic rotary files were evaluated and compared in terms of debris removal and smear layer formation.

Previous study stated that rotating single file system produced less debris and smear layer formation<sup>5</sup>.while another previous study stated that the use of Race files resulted in significantly more residual debris in the apical third of the canals<sup>6</sup>Race and Medin Nickel-Titanium (NiTi, moreover Schafer et al. also reported that Race files resulted in more debris compared with Mtwo files<sup>7</sup>.

In the current study, during chemo-mechanical preparation all the root canals were thoroughly irrigated with 2.5% NaOCl due to its antibacterial effect <sup>8</sup>, and was used alone as it has no effect on smear layer so preventing interference of other factors in removing debris and smear layer<sup>6</sup>Race and Medin Nickel-Titanium (NiTi).

A disadvantage of using higher magnification is the small size of the area of evaluation, so In the current study, magnifications used during this study was x500 for debris evaluation and x1000 for smear layer evaluation<sup>9</sup>.

Regarding the smear layer formation, the results of this study showed a significant difference between the both systems used ( $P > 0.05$ ). Race had the lower scores in all thirds than neolix rotary file system. Race Pair wise comparison showed a significant difference between Apical third the highest mean and both (Middle and Coronal thirds ( $P < 0.05$ ). This may be attributed to the limited efficiency of all instruments tested in cleaning the apical part of the root canal<sup>10</sup> and limited irrigant delivery to the apical part of the root canal.

Neolix rotary file system showed to have the highest smear layer formation value ( $4.40 \pm 0.96$ ) at the apical third followed by (Middle ( $3.20 \pm 0.42$ ) and the coronal third ( $2.30 \pm 0.48$ ) had the lowest (mean $\pm$ SD) value. For NEOLIX pair wise comparison showed a significant difference between (Apical) and (Coronal) sections ( $P < 0.05$ ).

Generally Race file system had better results in smear layer formation than neolix file system this may be attributed to the manufacturer's design showing triangular cross section with alternating cutting edges of the race files but non homogenous rectangular cross section with rough surface of neolix files.

Regarding debris removal, there was no significant difference between both main groups

( $P > 0.05$ ). NEOLIX had a higher scores than Race file system in both coronal and apical thirds with ( $3 \pm 0.81$ ) and ( $4.400.5 \pm$ ) respectively. Neolix file had a lower score than Race file system regarding the middle third of mean value ( $2.40 \pm 0.51$ ).

Both Race and Neolix file systems almost had similar scores for debris removal due to root canal preparation with slightly better action for race files on debris removal at the coronal section, this may be due to the presence of wider furrows, active cutting blades of race files that facilitates the movement of debris in coronal direction<sup>11</sup> FlexMaster and ProFile rotary instruments on smear layer formation by scanning electron microscopy. Eighty-four caries-free freshly extracted human single-rooted teeth were selected and divided into three groups, each containing 28 teeth. The teeth were instrumented with rotary instruments sequentially: Group A: ProFile Rotary Instruments; Group B: FlexMaster Rotary Instruments; and Group C: RaCe Rotary Instruments. Instrumentation was performed by the crown-down method and according to the manufacturer's instructions. The specimens were then examined with SEM according to Hülsmann's classification. One-way ANOVA and a post hoc Tukey test were used for statistical analysis. The results showed that there were no statistically significant differences among the three groups in the coronal third ( $P = 0.39$ ).

Race rotary file system was better than the Neolix file system and this could be due to the multiple or larger number of files used for canal cleanliness as this will allow better delivery of the irrigant especially to the apical one third<sup>10</sup> facilitating the cleaning ability of the file system.

In this study superior cleanliness including both debris removal and smear layer formation occurred at the coronal parts of the root canal after chemo mechanical preparation is confirmed by previous study<sup>12</sup>, some studies found increasing amount of debris and smear layer towards apical region after preparation with race files system<sup>13</sup>.

## Conclusion

Multiple file system (Race) showed less smear layer formation than did the single file system (Neolix) during chemo-mechanical preparation.

Multiple file system (Race) showed more debris removal than did the single file system (Neolix) during chemo-mechanical preparation.

Multiple file system (Race) showed better cleaning ability than did the single file system (Neolix) after chemo-mechanical preparation.

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