

Content available at: <https://www.ipinnovative.com/open-access-journals>

The Journal of Dental Panacea

Journal homepage: <https://www.jdentalpanacea.org/>

Original Research Article

Scanning electron microscopy evaluation of smear layer generated by rotary instrumentation techniques: An in-vitro study

S K Moin Ul-Haq^{1,*}, S Anita Rao¹, T Muralidhar¹, Buggaveeti Pradeep¹¹Dept. of Conservative Dentistry & Endodontics, Mamata Dental College, Khammam, Telangana, India

ARTICLE INFO

Article history:

Received 29-06-2021

Accepted 23-01-2022

Available online 31-01-2022

Keywords:

Smear layer

Hyflex EDM

Protaper gold

VDW Mtwo scanning electron microscope

ABSTRACT

Aim: To evaluate the Smear layer generated by three rotary instrumentation techniques**Materials and Methods:** Thirty single-rooted freshly extracted teeth were selected for this study, teeth were decoronated at the level of CEJ (Cemento enamel junction) and were divided into three groups for cleaning and shaping of root canals, group I (protaper gold) group II (M two) group III (Hyflex EDM) After splitting the roots longitudinally, the Smear layer generated by each instrument for each root canal was evaluated using a scanning electron microscope and the data obtained was statistically analyzed using Kruskal Wallis and Mann-Whitney U test.**Results:** Instrumentation with Protaper gold (Group 1) showed the maximum amount of Smear layer generation followed by Hyflex EDM (Group 3) files and VDW Mtwo (Group 2) showed the least values of Smear layer generation.**Conclusion:** Within the limitations of the study, it can be concluded that Mtwo (group 2) showed better results in removing the Smear layer than Protaper gold and Hyflex EDM file systems.This is an Open Access (OA) journal, and articles are distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License](https://creativecommons.org/licenses/by-nc-sa/4.0/), which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.For reprints contact: reprint@ipinnovative.com

1. Introduction

The mechanical and biological goals of root canal treatment are the cleaning and shaping of the root canal system. It consists of eradicating residual vital and non-vital pulp tissue and reducing the number of pathogenic organisms, disorganizing the bacterial biofilm, facilitating canal disinfection through irrigation, and giving a suitable conformation for subsequent sealing.¹

The Smear layer is a surface film of 1 to 2 μm thickness that contains dentin debris, residual pulp tissue and, bacteria that remain on the dentinal walls following mechanical instrumentation of the root canal. Rotary nickel-titanium instruments (RNT) represent a comparatively new approach to rapid and simplified canal preparation with a uniform taper.²

Protaper Gold instruments have the same geometry as that of Protaper Universal (Dentsply Maillefer, Ballaigues, Switzerland) but offer increased flexibility.³ Mtwo (VDW, Munich, Germany) instruments have an S-shaped cross-sectional design with a non-cutting tip. The two cutting edges have a positive rake angle to chop dentine effectively. The pitch length in Mtwo increases from the tip to the shaft. This design is claimed to eliminate threading and binding in continuous rotation and scale back debris transportation towards the apex.⁴ Hyflex EDM, a new generation file system with continuous rotation motion, is manufactured by EDM technique (electro-discharge machining).^{5,6} Scanning electron microscopic images are visualized at higher magnification. The basic principle of working in SEM is that a beam scans the surface of the sample to supply a spread of signals and is collected by a detector. It proved to be a valuable method in the comparison of the volume of debris and Smear layer remnants on the root canal wall after

* Corresponding author.

E-mail address: moinnayin49@gmail.com (S. K. M. Ul-Haq).

preparation with different instruments.⁷

2. Aim

This study aims to evaluate the Smear layer generated by three rotary instrumentation techniques.

3. Materials and Methods

3.1. Sample selection

30 Single-rooted teeth that, were extracted due to orthodontic and periodontal reasons were collected

3.2. Inclusion criteria

Human teeth with single, straight root, single canal and, mature apical foramen that comes under Vertucci class I.

3.3. Exclusion criteria

Teeth with caries, cracks, open apices, calcified canals and, other Vertucci classes except class I.

3.4. Methodology

Preoperative radiographs of each tooth were taken and they were decoronated standardized to 15mm. A number 10-K file was inserted into all the canals until it could be seen at the apical foramen. The working length was set at 1mm below the apical foramen.

3.5. Grouping

The 30 root samples were randomly divided into 3 groups.

Group 1: Cleaning and shaping did with Protaper gold.

Group 2: Cleaning and shaping did with VDW Mtwo.

Group 3: Cleaning and shaping did with HYflex EDM.

3.6. Cleaning and shaping

Root canals were initially flooded with 5.25% sodium hypochlorite for each group and shaping was performed with each file system till full sequence for Protaper gold SX - F3. For VDW Mtwo 10 - 25. For HyFlex EDM 10/05 Glidepath File, 25/~ Hyflex OneFile. The final irrigation protocol was performed by continuous delivery of solutions for 1min each as follows, 5ml of 17% EDTA solution, 5ml of 5.25% NaOCl followed by 5ml of distilled water.

3.7. Scanning electron microscopic evaluation

To prevent penetration of debris in the root canal during sectioning, the canal orifices were plugged with cotton pellets and cavitated. Teeth were then split for scanning electron microscopy evaluation. One half of each sectioned specimen was used for evaluation and the other half was discarded.

Specimens were air-dried and sputter-coated with a gold-palladium layer and observed under a scanning electron microscope. Images were taken at 1, 3 and, 5mm from apex at 1000x magnification.

3.8. Scoring

Scoring was done to evaluate Smear layer level and the following scoring criteria were used.

Score 1: No Smear layer covering the root canal wall.

Score 2: Small Amount of Smear layer, some dentinal tubules open.

Score 3: Homogenous Smear layer covering the basis canal wall only a couple of dentinal tubules open.

Score 4: Complete root canal wall covered by a homogenous Smear layer, no open tubules.

Score 5: Heavy, Homogenous Smear layer covering the whole root canal.

3.9. Statistical analysis

The data were evaluated using Kruskal-Wallis, Mann - Whitney U test, and Friedman's ANOVA test.

4. Results

Table 1: Comparison of 1mm, 3mm, and 5mm in group 1 (Protapergold) with Smear layer generation by Friedman's ANOVA.

Groups at	Mean	SD	SE	Mean rank
1mm	3.40	0.70	0.22	1.70
3mm	3.60	0.84	0.27	2.05
5mm	4.20	0.63	0.20	2.25
ANOVA		2.2142		
Chi Sqr.				
P-value		0.3350		

Table 2: Comparison of 1mm, 3mm, and 5mm in group 2 (VDW Mtwo) with Smear layer generation by Friedman's ANOVA.

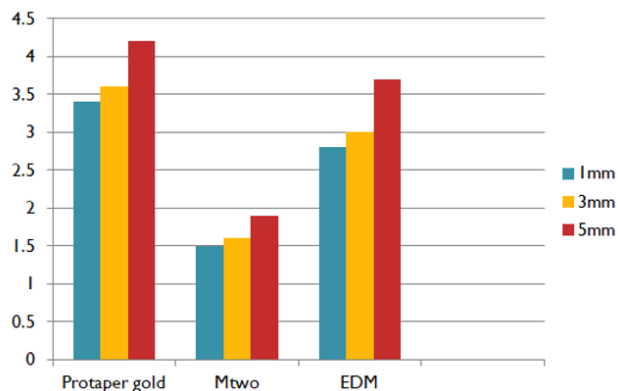
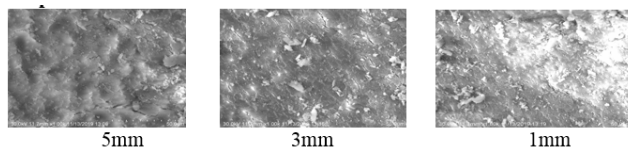
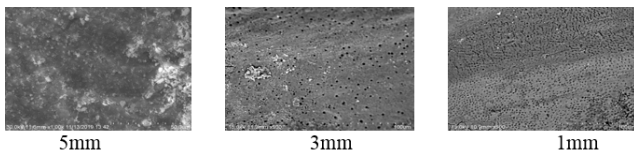
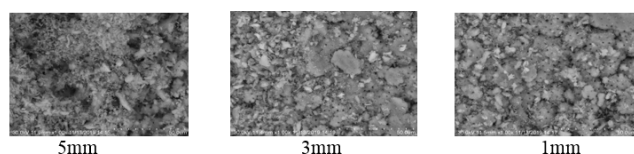
Groups at	Mean	SD	SE	Mean rank
1mm	1.50	0.53	0.17	1.75
3mm	1.60	0.52	0.16	1.90
5mm	1.90	0.32	0.10	2.35
ANOVA Chi Sqr.		4.3333		
P-value		0.1145		

5. Discussion

The Currently used methods of instrumentation, especially rotary instrumentation techniques, produce a Smear layer that covers root canal walls and thus the openings to the dentinal tubules. The Smear layer consists of an

Table 3: Comparison of 1mm, 3mm, and 5mm in group 3 (Hyflex EDM) with Smear layer generation by Friedman's ANOVA.

Groups at	Mean	SD	SE	Mean rank
1mm	2.80	0.63	0.20	1.45
3mm	3.00	0.67	0.21	1.80
5mm	3.70	0.48	0.15	2.75
ANOVA Chi Sqr.	11.3125			
P-value	0.0035			

**Fig. 1:** Shows that Group 1 (Protapergold) generated a high Smear layer compared to Group 2 Hyflex EDM that generated a moderate Smear layer and Group 3 that showed the least Smear layer values.**Fig. 2:** Group I**Fig. 3:** Group II**Fig. 4:** Group III

organic and inorganic substance that includes fragments of the odontoblastic processes, microorganisms, and necrotic material.⁸ The Smear layer interferes with the adhesion

or penetration of sealer in a root canal system and may prevent the penetration of gutta-percha. Smear layer removal increases the adhesion of sealer to dentin.⁹

Preoperative radiographs were taken to detect calcified or large canals and were discarded from the study. Working lengths were established at -1 mm from the foramen in all samples to standardize. The new Hyflex EDM Files, which is also a successor of Hyflex CM nickel-titanium files have completely new properties and fewer files due to their innovative manufacturing process using electric discharge machining. As a result of the EDM process, the file is extremely flexible and with variable cross-section design (Quadratic at the tip, trapezoidal in middle and triangular cross-section at top) contributes to high breakage resistance and also controls the memory of the material.¹⁰

In this study Protaper gold (Group I), showed the highest amount of Smear layer. Protaper gold has a modified triangular cross-section presenting no active cutting edge with a neutral rake angle. A positive rake angle permits the instrument to cut more aggressively whereas a negative or a neutral rake angle will just grind the root canal wall and instruments with fixed taper alone dentin chips to accumulate in the coronal part of the file and have a screw-in effect. The greater taper of 0.09 is the reason for increased Smear layer formation.¹¹

The use of Mtwo files showed significantly less Smear layer formation in all three canal areas compared to HyFlex EDM and ProTaper instruments. This difference in cleanliness between the rotary nickel-titanium files could be attributed to their cross-sectional design. Mtwo files are characterized by a positive rake angle with two sharp cutting edges and have a smaller cross-sectional area which increases its flexibility and a greater chip space allowing increased debris clearance. Also, increasing helical pitch from tip to shaft reduces the transportation and the accumulation of debris towards the apex.²

6. Conclusion

Within the limitations of this study, it can be concluded that VDW Mtwo (Group 2) showed better results compared to Protaper gold and Hyflex EDM file systems which showed high levels of Smear layer.

7. Conflict of Interest

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

8. Source of Funding

None

References

1. Feghali M, Jabbour E, Koyess E, Sabbagh J. Scanning electron microscopy evaluation of debris and Smear layer generated by two instruments used in reciprocating motion WaveOne Gold and Reciproc Blue. *Aust Endod J*. 2019;45(3):388–93.
2. Sharma G, Kakkar P. A Comparative SEM Investigation of Smear layer Remaining on Dentinal Walls by Three Rotary NiTi Files with Different Cross-Sectional Designs in Moderately Curved Canals. *J Clin Diagn Res*. 2015;9(3):ZC43–7.
3. Arslam H, Yildiz ED, Gunduz HA, Sumbullu M, Bayrakdar IS, Karatas E, et al. Comparative study of ProTaper gold, reciproc, and ProTaper universal for root canal preparation severely curved root canals. *J Conserve Dent*. 2017;20(4):222–4.
4. Krishna V, Sujatha I, Jayalakshmi KB, Nadig PL, Chandra SMS, Mayur GN, et al. Comparison of the cleaning effectiveness of Mtwo & protaper next rotary systems in permanent molar root canals: An in vitro study. *Int J App Dent Sci*. 2016;2(2):19–23.
5. Gundogar M, Özyürek T. Cyclic Fatigue Resistance of OneShape, HyFlex EDM, WaveOne Gold, and Reciproc Blue Nickel-titanium Instruments. *J Endod*. 2017;43(7):1192–6. doi:10.1016/j.joen.2017.03.009.
6. Sanjib, Kumar Pradhan SL, Satchidananda P, Sinha. Comparative evaluation of dentinal crack formation after root canal preparation using ProTaper Next, OneShape, and Hyflex EDM. *J Conserv Dent*. 2018;21(2):153–6.
7. Ranganath G. Comparative evaluation of canal cleaning ability of various rotary endodontic files in apical third: A scanning electron microscopic study. *Dent Res J*. 2016;13(6):508–14.
8. Toraniejad M. A new solution for the removal of the Smear layer. *J Endod*. 2003;29(3):170–5.
9. Jahromi M, Fathi MH, Zamiran S. Experimental Study of Smear layer and Debris Remaining Following the Use of Four Root Canal Preparation Systems Using Scanning Electron Microscopy. *J Islam Dent Assoc Iran*. 2013;25(4):235–41.
10. Premalata DT. Comparative evaluation of cleaning efficacy of the root canal by k-file and protaper next, hyflex EDM rotary system an in vitro study. *J Evolution Med Dent Sci*. 2015;5(10):7365–9.
11. Ali M. Comparative Evaluation of Smear layer Formation of WaveOne Gold, Protaper Gold, and Manual files: an In vitro SEM Study. *Current sci int*. 2020;9(2):381–6.

Author biography

S K Moin Ul-Haq, Student

S Anita Rao, Professor and HOD

T Muralidhar, Professor

Buggaveeti Pradeep, Reader

Cite this article: Ul-Haq SKM, Rao SA, Muralidhar T, Pradeep B. Scanning electron microscopy evaluation of smear layer generated by rotary instrumentation techniques: An in-vitro study. *J Dent Panacea* 2021;3(4):169-172.