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RESEARCH ARTICLE

Smear Layer Evaluation after Root Canal Instrumentation with Manual and Rotary Techniques: A Scanning Electron Microscopic Study

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Abstract

Background: The smear layer produced when root canals are instrumented is known to affect the prognosis of endodontic treatment. Clinicians are now moving towards flexible nickel titanium instruments in hand and rotary forms. It is important for them to be aware of the amount of smear layer produced by the various instrumentation systems.

Objective: To observe and compare the mean smear layer scores following instrumentation of root canals with ISO standardized stainless steel K files, ProTaper hand and rotary systems under the scanning electron microscope.(SEM)

Design: 45 single rooted human teeth with conical roots and type1 canals were divided into three groups of 15 each. The root canals in group 1 were prepared by ISO standardized stainless steel K files, group 2, by the hand ProTaper files and group 3, by the rotary ProTaper files. Irrigation was carried out using saline and 3% sodium hypochlorite. Following instrumentation, the coronal portion of the teeth was sectioned at the CEJ. The roots were then sectioned longitudinally and examined under the SEM. The SEM photographs were scored by two blinded examiners.

Statistical analysis: Consistency between the two examiners was checked using the Kappa tests.

The data was analyzed using Kruskal Wallis one way analysis of variance. The significance was set at a P value <0.01.

Results:

The difference between group 1 and group 2 was not significant. $P = 0.82$

There was significant difference between group 2 and group 3. $P<0.01$

There was significant difference between group 1 and group 3. $P<0.01$.

Conclusion: Under the conditions of the study, the group 2 showed the most smear layer, followed by the group 1. Group 3 showed the least presence of smear layer.

INTRODUCTION:

Smear layer is a deposit of organic and inorganic material which may also contain bacteria and their by-products. It is produced whenever dentine is cut using hand or rotary instruments. During the cutting process the mineralized tissues are not shredded or cleaved but shattered to create considerable quantities of debris. Much of this, made up of very small particles of mineralized collagen matrix, is spread over the surface to form the smear layer (Violich DR, Chandler NP, 2010)[22]. It was first reported by Eick et al. (1970)[7]. The smear layer in a prepared coronal cavity and in the root canal may not be directly comparable. Not only are the tools for dentine preparation different in coronal cavities, but in the root canal, the dentinal tubules show greater variation and there are likely to be more soft tissue remnants present (Violich DR and Chandler NP,2010)[1]. The first researchers to describe the smear layer in instrumented root canal surfaces were McComb & Smith (1975)[14].According to them, the smear layer in the instrumented root canals consisted not only of dentine but also the remnants of odontoblastic processes, pulp tissue and bacteria.

Root canal treatment usually involves the chemo mechanical removal of bacteria and infected dentine from within the root canal system followed by disinfection of the canal and obturation. The seal created by the obturating material with the root canal walls is a very important factor affecting the prognosis of the root canal treatment. Several workers have strived to understand the effect of the smear layer on the root canal seal (Clark-Holke Det al,2003[4]; Cobankara FK et al,2004[5]; Park DS et al, 2004[18])

The conclusions have been varied. Some authors support maintaining the smear layer. They believe that, smear layer blocks the dentinal tubules and will limit bacterial penetration by making the dentin relatively impermeable (Michelich VJ et al, 1980[16]; Pashley DH et al,1981[17];Safavi KE et al, 1990[20].)

Others believe that the smear layer should be completely removed from the root canal surface. They argue that the smear layer being a loosely adherent structure, canshelter bacteria and provide a pathway for leakage (Mader CL et al, 1984[12];Cameron JA,1987[2]; Meryon SD and Brook,1990[15])

The smear layer can also potentially limit the effective disinfection of dentinal tubules by preventing irrigants and intracanal medicaments from penetrating the dentinal tubules. A systematic review and meta-analysis by Shahravan et al. (2007)[21] set out to determine whether smear layer removal reduced leakage of root filled teeth ex vivo. They concluded that smear layer removal improved the fluid-tight seal of the root canal system.

The stainless steel K- files are traditionally the most extensively used instruments in root canal preparation. In the recent past, newer designs made from Nickel Titanium tapers in excess of 2% have become popular. Flexible Nickel Titanium (NiTi) instruments for use in hand and in rotary forms, have enabled the clinician to deliver predictable canal shapes with enhanced speed and increased efficiency.

The type and sharpness of the cutting instruments determines the thickness of the smear layer (Barnes IE, 1974[1]; Gilboe DB et al, 1980[9]; Cameron JA,1988[3]).

According to Jodaikin & Austin(1981)[10], centrifugal forces generated by the movement and proximity of the root canal instrument to the dentinal wall resulted in a thicker smear layer. Motorized instruments like gates glidden drills have also been reported to produce greater volumes of smear layer than that produced by hand filing (Czonstkowsky M, et al,1990[6]).So, considering the fact that different instruments generate different amounts of smear layer, there is a need to be aware of the amount of smear layer generated by the various systems.

There are many studies in literature which have evaluated the cleaning efficacy of various NiTi systems through their smear layer scores(Yang G et al, 2008[23];Manjunatha et al,2013[13]). But, comparison of hand and the rotary variants of the ProTaper system for the amount of smear layer produced have not been well documented in literature. This is an important area of research as more clinicians are aspiring to move form ISO standardized instruments towards the NiTi systems. The ProTaper system is a popular NiTi system. It has hand and rotary variants possessing the same designs and hence offers an opportunity to compare the smear layer generation between the two variants.

The objective of this study was to observe and compare the mean smear layer scores following instrumentation of root canals with ISO standardized stainless steel K files,ProTaper hand and rotary systems under

the scanning electron microscope. The null hypothesis of the study was that there would be no significant difference in the smear layer scores between the three systems.

METHODOLOGY:

Study design type:
This was an in-vitro randomized control trial.
Sample size calculation:

Assuming standard deviation of ±0.5 and minimum expected difference of 0.74 with significance criterion of 0.05 and statistical power of 90%, this study comparing the mean smear layer scores will have a sample size of 15 /group.

Study design:

45 single rooted human teeth with conical roots and type1 canals were selected immediately following extraction and stored in0.5% chlorhexidine solution (M Ahlquist et al,2001[11]).

The roots were inspected for defects and fractures before being used for the study. The ones with defects were discarded. Only roots with mature apices were used for the study. Mesiodistal and Bucco-lingual radiographs of each root were made to confirm canal configuration. Teeth with curvature more than 25 degrees from the axial plane were excluded from the study.

Just prior to the root canal preparation, access opening was done using a high speed handpiece and water spray on each tooth and a barbed broach was used to extirpate the pulp.

A no. 8 K-file was introduced until it could be just seen at the apical foramen. The working length was determined by subtracting 1mm from the actual root canal length.
The teeth were randomly divided into 3 groups of 15 teeth each.

In Group 1, the root canals were prepared by ISO standardized stainless steel K files. (MANI, JAPAN)
In Group 2, the root canals were prepared by the hand ProTaper files. (DENTSPLY)
In Group 3, the root canals were prepared by the rotary ProTaper files. (DENTSPLY)

In group 1, Gates Glidden drills were used to enlarge the orifice and shape the coronal third. Following this the stainless steel K-files were used in crown down sequence to an apical preparation from 15to 35no's.

In group 2 and group 3, ProTaper hand and rotary files from SX toF3 were used for the canal preparation as prescribed by the manufacturer.

The files were used in a brushing motion against the outer wall of the canal.

Copious irrigation was carried out using saline and 3% sodium hypochlorite.

Once the root canal preparations were completed the coronal part of the teeth were sectioned off at the CEJ.

The roots of the teeth were then sectioned longitudinally using a diamond point. Two cuts were placed on the mesial and distal surface with the diamond point coming close to the canal walls. To prevent contamination of the canals by the separation process, a sharp chisel was used to split the tooth during the last part of the separation (M Ahlquist et al, 2001[11]).

The buccal half was retained for examination while the lingual half was discarded.

The samples were wrapped in absorbent paper during transportation to the SEM laboratory.

They were examined using a scanning electron microscope at 1000x magnification for the amount of smear layer covering the canal walls following the instrumentation.(Figures 1-3)

Blinding:

The SEMphotographs were coded to avoid the identification of the preparation technique used. Further, the photographs were evaluated by two examiners to avoid bias of the result.

Consistency between the two examiners was checked using the Kappa tests. This was calculated for the three groups individually.

The kappa results were

For group I, Kappa = 1

For group II, Kappa could not be calculated to the linearity in the scoring. But the correlation was deemed satisfactory.

For group III, Kappa = .69

The scoring was done as follows (M Ahlquist et al,2001[11]).

Score1: No smear layer, open dentinal tubuli
Score 2: Slight smear layer, most dentinal tubuli were open
Score 3: Homogeneous smear layer covering the major part of the surface, a few dentinal tubuli open
Score 4: Homogeneous smear layer covering the surface, no dentinal tubuli open (Fig. 4)
Score 5: thick non-homogeneous smear layer covering the surface.

STATISTICAL ANALYSIS:

The data were analyzed using Kruskal Wallis one way analysis of variance to analyze and establish whether there was a significant difference among the groups. The significance was set at a P value <0.01.

RESULTS:

The values of the scoring by the two examiners in each group are shown in Table 1.

The average values of the sum of scoring by the two examiners were used to calculate the mean and standard deviation for each experimental group. (Table 2)

The difference between group 1 and group 2 was not significant. P = 0.82

There was significant difference between group 2 and group 3. P<0.01

There was significant difference between group 1 and group 3. P<0.01.

The inference of the above results is that the group instrumented with ProTaper hand files showed the most smear layer, followed by the group in which the stainless steel hand files were used. The group instrumented with ProTaper rotary files showed the least presence of smear layer

Table 1: The values of scoring by the two examiners

Group 1		Group 2		Group 3	
Examiner 1	Examiner 2	Examiner 1	Examiner 2	Examiner 1	Examiner 2
3	3	3	3	2	2
3	3	3	3	2	2
3	3	2	2	2	2
3	3	5	5	2	2
2	3	3	3	3	2
3	3	3	3	2	2
3	3	3	3	2	2
3	3	3	3	2	2
3	3	3	3	3	3
3	3	2	2	2	2
3	3	3	3	2	2
3	3	3	3	2	2
3	3	5	5	3	3
4	3	3	3	4	3

4	3	3	3	2	2

Table 2: Mean, standard deviations and standard error of mean in the 3 groups

	Group1	Group2	Group3
Mean	3.07	3.13	2.33
SD	(0.46)	(0.84)	(0.62)
SEM	(0.12)	(0.22)	(0.16)

Group 1 Stainless steel hand K-files
Group 2Protaper Nickel Titanium hand files
Group 3 Protaper Nickel Titanium rotary files

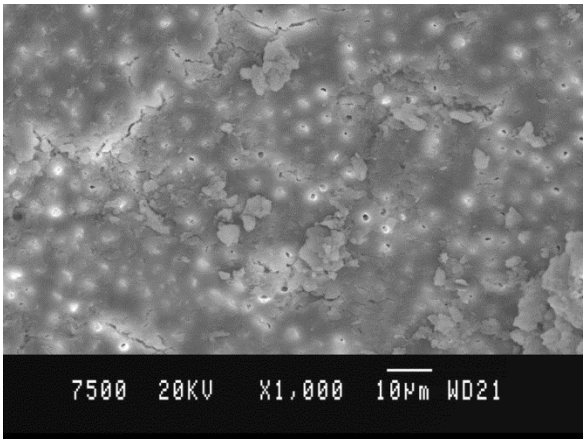

Figure 1-SEM photograph of GROUP 1

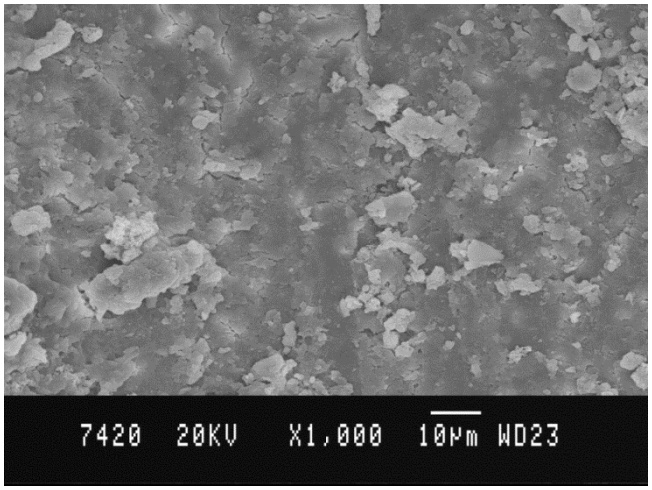

Figure 2-SEM photograph of GROUP 2

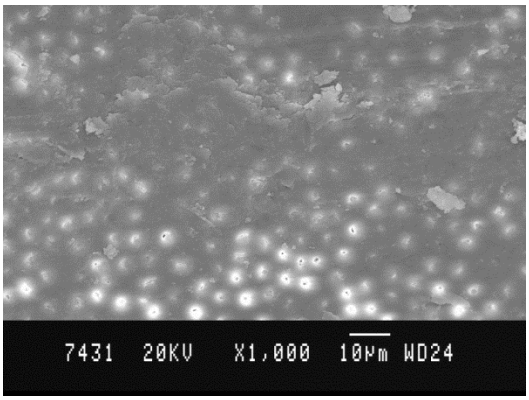

Figure 3-SEM photograph of GROUP 3

DISCUSSION:

The objective of this study was to observe and compare the mean smear layer scores following instrumentation of the root canals with ISO standardized Stainless Steel K files, ProTaper hand and rotary files under the scanning electron microscope. The results suggest that the ProTaper rotary files produced significantly less smear layer compared to theProTaper and stainless steel K hand files.

Contrary to previous studies where automated rotary instrumentation showed higher reading of smear layer (Gambarini G,1999[8] ; Ruddle and Clifford J,2002[19]), in this study the group where rotary ProTaper was used, showed the least presence of smear layer, post instrumentation. A SEM evaluation of debris and smear layer remaining following use of rotary ProTaper and hero shaper instruments by Yang G and workers(2008)[23] showed that canal walls prepared with ProTaper showed lower mean smear layer scores compared with those prepared with hero shaper.

Increased smear layer signifies better contact of the instrumentation system with the canal walls. This would enable enhanced cleaning efficiency by ensuring removal of the root canal contents and the inner layer of the radicular dentin. The benefit of hand filing over rotary in root canal instrumentation has been commented on in earlier reports. This can been attributed to the better control, adaptation and reciprocating filing motion that takes place in the hand techniques (Ruddle and Clifford J, 2002[19]).Hence the increased presence of the smear layer in groups 1and 2 in this study can be accredited to these factors and the absence of a smear layer removing irrigant which could have influenced the results.

Several factors may cause the depth of smear layer to vary. Dry or wet cutting of the dentin, the size and shape of the cavity or root canal, the type of instrument used, and the amount and chemical makeup of the irrigating solution (Violich DR and Chandler NP,2010[1]). During endodontic instrumentation, EDTA products are used as detergents to deal with the smear layer. In this study, a simple irrigation technique with saline and sodium hypochlorite was used to avoid any associations of different irrigation solutions, since the major objective of the present investigation was to observe and compare the amounts of smear layer produced.

CONCLUSION:

Under the conditions of the study,

- There was no significant difference in the mean smear layer scores following root canal instrumentation with ProTaper hand or ISO stainless steel K files under the SEM.
- The mean smear layer score was significantly less in the root canals instrumented with ProTaper rotary files compared to the ISO standardized stainless steel K files.
- The mean smear layer score was significantly less in the root canals instrumented with ProTaper rotary files compared to the ProTaper hand files.

In summary, ProTaper rotary files showed the least amount of smear layer following root canal instrumentation compared to ProTaper hand or ISO stainless steel K files under the SEM.

References:

1. Barnes IE.The production of inlay cavity bevels.Br Dent J.(1974);137:379-90.
2. Cameron JA. The synergistic relationship between ultrasound and sodium hypochlorite: a scanning electron microscope evaluation. J Endod. (1987); 13: 541–5.
3. Cameron JA. The use of ultrasound for the removal of the smear layer. The effect of sodium hypochlorite concentration;SEM study. Aust Dent J (1988); 33:193–200.
4. Clark-Holke D, Drake D, Walton R, Rivera E, Guthmiller JM. Bacterial penetration through canals of endodontically treated teeth in the presence or absence of the smear layer.J Dent. (2003); 31: 275–81.
5. Cobankara FK, Adanir N, Belli S .Evaluation of the influence of smear layer on the apical and coronal sealing ability of two sealers. J Endod. (2004); 30: 406–9.
6. Czonstkowsky M, Wilson EG, Holstein FA. The smear layer in endodontics. Dent Clin North Am. (1990); 34: 13–25.
7. Eick JD, Wilko RA, Anderson CH, Sorensen SE. Scanning electron microscopy of cut tooth surfaces and identification of debris by use of the electron microprobe.J Dent Res. (1970); 49(Suppl): 1359–68.
8. Gambarini G. Shaping and cleaning the root canal system: a scanning electron microscopic evaluation of a new instrumentation and irrigation technique. J Endod. (1999); 25: 800–03.
9. Gilboe DB, Svare CW, Thayer KE, Drennon DG Dentinal smearing: an investigation of the phenomenon. J Prosthet Dent. (1980); 44: 310–6.
10. Jodaikin A, Austin JC .Smear layer removal with chelating agents after cavity preparation. J Prosthet Dent. (1981); 46:171–4.
11. M Ahlquist, OHenningsson,K. Hultenby & J. Ohlin .The effectiveness of manual and rotary techniques in the cleaning of root canals: a scanning electron microscopy study. Int Endod J. (2001); 34:533 – 37.
12. Mader CL, Baumgartner JC, Peters DD. Scanning electron microscopic investigation of the smeared layer on root canal walls. J Endod. (1984); 10: 477–83.
13. Manjunatha M, Annapurna K, Sudhakar V, Sunil Kumar V, Hiremath VK, Shah A. Smear Layer Evaluation on Root Canal Preparation with Manual and Rotary Techniques using EDTA as an Irrigant: A Scanning Electron Microscopy Study. (2013); Feb 5(1):66-78. J Int Oral Health.
14. McComb D, Smith DC .A preliminary Scanning electron microscopic study of root canals after endodontic procedures.J Endod. (1975); 1: 238–42.
15. Meryon SD, Brook AM Penetration of dentine by three oral bacteria in vitro and their associated cytotoxicity.Int Endod J. (1990); 23: 196–202.
16. Michelich VJ, Schuster GS, Pashley DH Bacterial penetration of human dentin in vitro. J Dent Res (1980); 59: 1398–403.
17. Pashley DH, Michelich V, Kehl T .Dentin permeability:effects of smear layer removal.J Prosthet Dent. (1981); 46: 531–7.
18. Park DS, Torabinejad M, Shabahang S. The effect of MTAD on the coronal leakage of obturated root canals. J Endod. (2004); 30: 890–2.
19. Ruddle, Clifford J. Finishing the apical one third: endodontic considerations. Dentistry today (2002); 21(5): 66-73.
20. Safavi KE, Spangberg LSW, Langeland K. Root canal dentinal tubule disinfection. J Endod. (1990); 16: 207–10.
21. Shahravan A, Haghdoost AA, Adl A, Rahimi H, Shadifar F Effect of smear layer on sealing ability of canal obturation: a systematic review and meta-analysis. J Endod. (2007); 33: 96–105.
22. Violich DR, Chandler NP.The smear layer in endodontics - A review. International Endodontic Journal. (2010); 43(1):2-15.
23. Yang G, Wu H, Zheng Y, Zhang H, Li H, Zhou H. Scanning electron microscopic evaluation of debris and smear layer remaining following use of protaper and hero shaper instruments in combination with NaOCl and EDTA irrigation. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. (2008) Oct; 106(4):63-71.