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ORIGINAL RESEARCH

A Scanning Electron Microscopic Study to evaluate the Efficacy of NaviTip FX in removing the Canal Debris during Root Canal Preparation: An *in vitro* Study

Vinay Chandra, Padma Gandi, Anil Kumar Shivanna, Siva Srinivas, S Himgiri, KG Nischith

ABSTRACT

Objective: To evaluate the efficacy of NaviTip FX in removing the canal debris during root canal preparation using scanning electron microscopic study.

Materials and methods: Thirty single rooted teeth with completely formed apices were used in this study. Standard endodontic access cavity preparations were performed. Then the teeth were randomly divided into two groups: groups 1 and 2 of 15 teeth each group. For group 1, NaviTip FX (brush covered needle) was used to irrigate the canal with 5.25% sodium hypochlorite after each instrument use. For group 2, NaviTip (brushless needle) was used for irrigation following each instrument use. ProTaper rotary files were used for the canal preparation. The teeth were then cleaned and dried before splitting them into two halves. The half with most visible part of the apex was used for scanning electron microscopic evaluation. The results were statistically analyzed using the Mann-Whitney U-test at significance level $p < 0.005$.

Results: The mean values for coronal and middle third of group 1 showed lower debris scores than group 2 and this difference was statistically significant at a p-value 0.01 and 0.05 respectively, but no significance difference between them at the apical third at a p-value of < 0.05.

Conclusion: The NaviTip FX (brush covered needle) showed effectively better canal wall debris removal than the NaviTip (brushless needle).

Keywords: Debris, NaviTip FX, Brush covered needle, Canal preparation.

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INTRODUCTION

Careful removal of vital and necrotic remnants of pulp tissues, microorganisms and microbial toxins from the root canal system is essential for endodontic success.[1] Nevertheless, chemomechanical preparation does not predictably remove pulp tissue, dentin debris and smear layer because of the complex nature of root canal anatomy.[2,3] Debris removal is mandatory; removal of the smear layer remains a controversial issue. [4,5]

Debris was defined as dentin chips and residual vital and necrotic pulp tissue loosely attached to the root canal wall that in most cases is infected. The presence of debris on prepared root canal surfaces prevents efficient removal of microorganisms, one of the major goals of thorough debridement of the root canal system.[6,7] Studies have all demonstrated that debris remain in the root canal system after instrumentation and irrigation.[8-12]

Few attempts have been described to remove root canal debris like cotton wrapped around an endodontic file or a broach[13] or the use of an endobrush.[14]

Recently, a new NaviTip FX (Ultradent, Products Inc, South Jordan, UT, United States) brush covered needle introduced for the irrigation during canal preparation. The product feature of NaviTip FX is that, it removes the canal wall debris mechanically and chemically simulataneously during irrigation. NaviTip FX scrubs the canal walls while applying irrigants for the removing the debris. The brush may aid in removing debris from the root canal because it is flexible and the bristles may extend into canal irregularities and remove trapped tissues and debris.

Hence, the purpose of this study is to evaluate the efficacy of NaviTip FX in removing the canal debris during root canal preparation using scanning electron microscope.

MATERIALS AND METHODS

Thirty single rooted teeth with completely formed apices were used in this study. Standard endodontic access cavity

preparations were performed. After access cavity preparation, No. 15 K-file (Maillefer Dentsply, Ballaigues, Switzerland) was inserted into the canal until the tip was just visible at the apical foramen. The length of the file was measured and 1 mm was subtracted from this length to establish working length. The teeth were then randomly divided into two groups: groups 1 and 2 of 15 teeth each group.

For group 1, the brush covered 30 gauge needle NaviTip FX (Ultradent, Products Inc, South Jordan, UT, United States) was used to irrigate the canal with 5.25% sodium hypochlorite (Vensons, Bengaluru, India) after each instrument use.

For group 2, NaviTip needle (Ultradent, Products Inc, South Jordan, UT, United States) that is a 30 gauge needle similar to the one used in group 1 but without the covering brush, was used for irrigation following each instrument use.

The needle was advanced into the canal until it bound to the canal walls and then was retracted by 1 mm to allow easy back flow of the irrigating solution. Preliminary coronal enlargement was achieved using Gates Glidden drills (Mani, Inc, Tochigi, Japan) size 4, 3 and 2 with a low-speed hand piece. Initial instrumentation was performed using K-files (Maillefer Dentsply, Ballaigues, Switzerland) size 15, 20 and 25 to the working length. The canals were then prepared using ProTaper nickel-titanium rotary file (Maillefer Dentsply, Ballaigues, Switzerland) using X-Smart endodontic motor (Dentsply, Switzerland).

After using each file, the canals were irrigated with 1 ml of 5.25% sodium hypochlorite using the needle type designated for each group. At the end of instrumentation, each canal was flushed with 1 ml of 5.25% sodium hypochlorite solution.

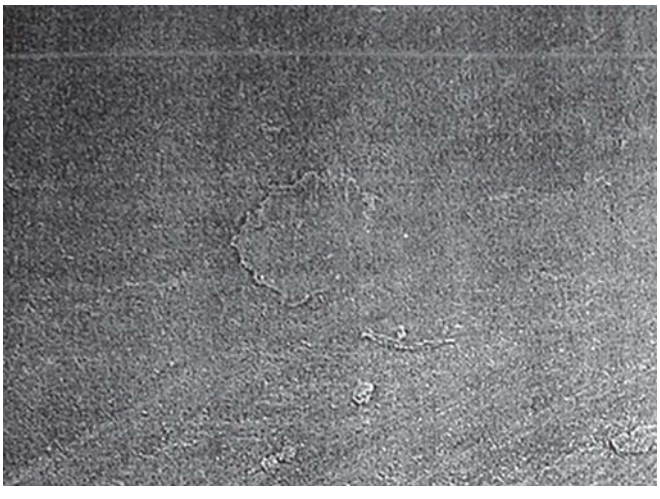


Fig. 1: SEM photograph showing clean surfaces of a canal wall irrigated using NaviTip FX (group 1)

Fig. 2: SEM photograph showing almost completely covered by debris of a canal wall irrigated using NaviTip (group 2)

The teeth were grooved vertically with a carborundam disk on the buccal and lingual surfaces. The teeth were then cleaned and dried before splitting them into two halves with a chisel and mallet. The half with most visible part of the apex was used for scanning electron microscopic evaluation. Each sample was divided into three equal parts (apical, middle and coronal) by making small grooves with a sharp knife on the side of the root.

Debris on the canal wall was evaluated using the following scoring system:[15]

- *Score 1:* Clean root canal, only few small debris particles.
- *Score 2:* Few small isles of debris covering less than 25% of the canal wall.
- *Score 3:* Many accumulations of debris covering more than 25% but less than 50% of the root canal wall.
- *Score 4:* More than 50% of the root canal wall covered by debris.

The results were statistically analyzed using the Mann-Whitney U-test at significance level $p < 0.005$.

RESULTS

The mean values for coronal and middle third of group 1 showed lower debris scores than group 2 and this difference was statistically significant at a p-value 0.01 and 0.05 respectively, as shown in Table 1.

A comparison of groups 1 and 2 for canal wall debris removal, revealed no significance difference between them at the apical third at a p-value of <0.05.

The mean rank for coronal and middle third of groups 1 and 2 showed statistically significant at p-value 0.01 and 0.05 respectively, as shown in Table 2. Mean rank of groups 1 and 2 revealed no significance difference between them at the apical third at a p-value of <0.05.

Comparison of mean scores for canal wall debris in apical, middle and coronal third is shown in Graph 1.

Table 1: Mean scores for canal wall debris using each needle type

	NaviTip FX (mean ± SEM)	*NaviTip (mean ± SEM)*
Apical	2.47 ± 0.133	2.8 ± 0.107
Middle	1.73 ± 0.182	2.33 ± 0.126
Coronal	1.47 ± 0.133	2.13 ± 0.133

Table 2: Mean rank scores of debris for NaviTip FX and NaviTip

	NaviTip FX	*NaviTip*	*U**	*p-value*
Apical	13	18	75	>0.05 NS
Middle	12	19	60	<0.05 S
Coronal	11.3	19.7	49.5	<0.01 S

*Man-Whitney test; NS: Not significant; S: Significant

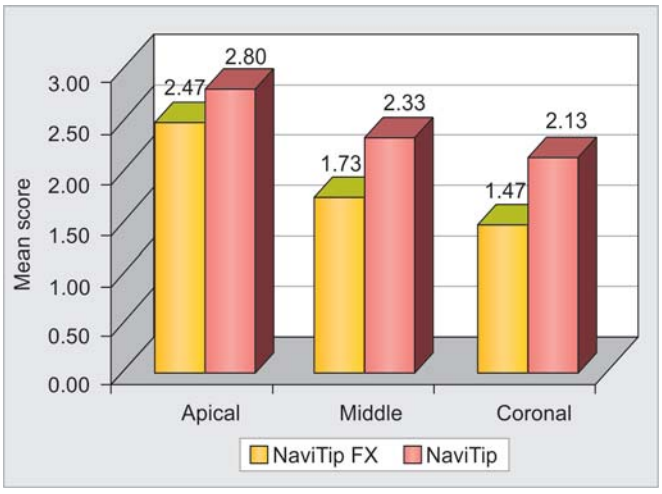
SEM photograph of group 1 showed almost clean surfaces of root canal wall (Fig. 1) compared to the group 2 where debris covered almost completely the root canal wall (Fig. 2) in all the three thirds of the root canal wall respectively.

DISCUSSION

One of the most important objectives during root canal instrumentation is the removal of pulp tissue and elimination of microorganisms and their toxins from the root canal system.[1]

Studies showed that the some canal walls are either untouched or lightly planed by instruments, there by leaving debris. Debris and pulp tissue also are trapped or packed into *cul de sac*, isthmuses and canal irregularities and cannot be removed by instrumentation and irrigation.[9-11,16]

Previous study demonstrated that prolongations, irregularities and extensions of the main root canals are consistently not instrumented[17] and standard instrumentation methods are consistently inadequately and often leave areas that are untouched by files after completion of preparation.[18]



Graph 1: Comparison of mean scores for canal wall debris in apical, middle and coronal thirds of root canal

The results of this study showed improved cleanliness of coronal and middle thirds of instrumented root canal walls irrigated with the NaviTip FX (brush covered needle) compared to the canal walls instrumented using the same technique and irrigated with the NaviTip (brushless needle).

In this study, the canals were prepared using hand K-files up to 25 size initially and then used the ProTaper rotary files (Maillefer Dentsply, Ballaigues, Switzerland), so that the apical enlargement is equivalent to 30 size master apical file. The size of the NaviTip FX needle equivalent to the apical enlargement which was done by ProTaper F3 finishing file, so that the irrigation needle, i.e. NaviTip FX would reach the apical most part of the canal to clean the canal debris.

A study showed that an apical instrumentation to a size 30 file with 0.06 taper is effective for penetration of irrigants to the apical third.[19]

This study showed, by using NaviTip FX would produce cleaner coronal and middle third of instrumented root canal walls of single rooted teeth.

However, the debris removal from the root canal depends on the size of the apical enlargement where larger apical preparations result in better canal debridement.[20-22]

Many techniques were used to remove the canal wall debris like cotton wrapped around an endodontic file or broach, in this technique the cotton is adjusted to the width of the canal so that light pressure is applied to the canal walls. The cotton provides a mechanical cleaning but it lacks flexibility and ability to expand, it may not be able to clean irregularities.[13]

In other technique, Endobrush (C&S, Microinstruments Limited, Markham, Ontario, Canada) was used to remove the canal debris. Endobrush is an endodontically sized spiral brush that consists of nylon bristles set in twisted wires with an attached handle and is designed to remove debris from the root canal. This study showed significantly better in debris removal from the root canal.[14]

In another study, the Quantec-E irrigation pump, this can be attached to an endodontic hand piece to allow continuous irrigation during rotary instrumentation. The result of this study showed cleaner canal walls, less debris within the coronal one-third but no difference was observed in the middle and apical one-third of the root canal.[12]

CONCLUSION

Within the limitations of this study, the following conclusions can be drawn:

1. The NaviTip FX (brush covered needle) showed effectively better canal wall debris removal than the NaviTip (brushless needle).

2. The NaviTip FX (brush covered needle) showed better debris removal in coronal and middle third of the root canal walls compared to NaviTip (brushless needle).

However, further studies are required to demonstrate the efficacy of NaviTip FX in removing the canal wall debris in apical third before it can be recommended for routine endodontic therapy.

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ABOUT THE AUTHORS

Vinay Chandra

Reader, Department of Conservative Dentistry and Endodontics, Raja Rajeshwari Dental College and Hospital, Kumbalgodu, Bengaluru Karnataka, India

Padma Gandi

Professor and Head, Department of Conservative Dentistry and Endodontics, SVS Institute of Dental Sciences, Mahabubnagar, Andhra Pradesh, India

Anil Kumar Shivanna

Reader, Department of Conservative Dentistry and Endodontics, Sri Siddhartha Dental College, Agalakote, Tumkur, Karnataka, India

Correspondence Address: # 73, 1st Cross, Leelavathi Extension Maddur-571428, Karnataka, India, Phone: + 91-98454 86882, e-mail: anilendo@yahoomail.com

Siva Srinivas

Reader, Department of Conservative Dentistry and Endodontics VYWS Dental College and Hospital, Amaravathi, Maharashtra, India

S Himgiri

Professor, Department of Conservative Dentistry and Endodontics Triveni Institute of Dental Sciences and Research Centre, Bilaspur Chhattisgarh, India

KG Nischith

Professor and Head, Department of Conservative Dentistry and Endodontics, Malabar Dental College, Manoor, Mallapuram, Kerala India