

ISSN: 0976-3031

*International Journal of Recent Scientific
Research*

Impact factor: 5.114

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FILE SYSTEMS-SCANNING ELECTRON MICROSCOPE
STUDY**



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Volume: 6

Issue: 9

**THE PUBLICATION OF
INTERNATIONAL JOURNAL OF RECENT SCIENTIFIC RESEARCH**

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ISSN: 0976-3031

Available Online at <http://www.recentscientific.com>

International Journal of Recent Scientific Research
Vol. 6, Issue, 9, pp.6320-6324, September, 2015

*International Journal
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RESEARCH ARTICLE

AN INVITRO-COMPARATIVE EVALUATION OF CLEANING EFFICACY OF HYFLEX AND HERO SHAPER ROTARY NITI FILE SYSTEMS-SCANNING ELECTRON MICROSCOPE STUDY

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ARTICLE INFO

Article History:

Received 06th June, 2015
Received in revised form 14th July, 2015
Accepted 23rd August, 2015
Published online 28st September, 2015

Key words:

Hyflex CM, Hero shaper, Cleaning efficacy, Smear layer

ABSTRACT

Background: The main objective of the biomechanical instrumentation is to completely eliminate the infected pulp tissue from the root canals. In addition to the pulpal remnants, debris and smear layer produced as a result of instrumentation must be totally removed. The efficiency of cleaning and preparation of the canals depends on several factors like design of the file, sequence of file usage, rotational speed, and surface conditioning of the instruments.

Aim: The aim of this study is a comparative evaluation of cleaning efficacy of Hyflex [coltinewaldent] rotary files, Hero shaper [Micro-Mega, Besançon, France] Rotary files, using a Scanning Electron Microscope.

Material and method: A total of 50 extracted maxillary permanent central incisors were taken, divided into two equal groups. Of these two groups, one group is instrumented with Hyflex [coltinewaldent] rotary files and another group is instrumented with Hero shaper [Micro- Mega, Besançon, France] files. After the completion of preparation, the crown portion was removed and roots were split into two halves longitudinally and prepared for scanning electron microscope study. Both of the groups were divided into three areas namely coronal, middle and apical third and are examined under Scanning Electron Microscope.

Results: The results of the study illustrates completely clean root canal walls were not observed in either of the instrumentation group. However the group instrumented with Hyflex files has less scores of debris and smear layer in coronal and middle third of root canals when compared to the ones that are instrumented with Hero shaper files. On the other hand, the group of extracted teeth instrumented with Hero shaper files has less debris and smear layer scores in the apical third of canals than the Hyflex files.

Conclusion: Under the circumstances of this study, both Hyflex and Hero shaper files can be recommended for clinical practice. Both the Hyflex and Hero shaper files showed clear or less debris and smear layer in the coronal and middle third but unable to produce the much clear surface in apical third.

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INTRODUCTION

With the advancement of the technical standards in dentistry, it has been proved that extraction is not the solution for carious and toothache problems. The last several years have witnessed a gradual return to the practice of root canal therapy by the clinicians. Root canal preparation includes shaping and cleaning, shaping facilitates cleaning by removing the restrictive dentin which provides space for root canal allowing extra volume of irrigants to flow in the canal. These irrigants serve to eliminate pulpal tissue, bacteria and

endotoxins. Cleaning and shaping is one of the essential steps in root canal treatment procedures for removing debris and microorganisms that are responsible for endodontic pathosis.^[1,2] Debris is defined as dentin chips or residual vital or necrotic pulp tissue attached to the root canal wall.³ This debris may be compacted along the surface of root canal walls and prevents the efficient removal of microorganisms from the canal system increasing the risk for bacterial contamination, one of the basic purposes of files thorough debridement of the root canal system.⁴ Furthermore, debris may occupy part of

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the root canal space, preventing complete obturation of the root canal. Therefore the debris should be totally removed.⁵

In 2003, the American Association of Endodontists defined smear layer as a surface film of debris retained on dentin or other surface after instrumentation with either rotary instruments or endodontic files; it consists of dentin particles, remnants of vital or necrotic pulp tissue, bacterial components, and retained irrigants. There is still a controversy about the influence of smear layer on the outcome of endodontic treatment.⁶ After the introduction of nickel-titanium (NiTi) rotary instruments for the first time in 1990s, new rotary files and NiTi systems have been introduced to the dental market with increasing frequency. The modulus of elasticity for Nickel Titanium (NiTi) alloy is comparatively lower than stainless steel.⁷ This property allows NiTi files to be placed in curved root canals with less lateral force being exerted against the root canal walls.⁸ Besides this, NiTi also has a straightening tendency, especially in instruments with greater taper and tip. The most important factors for efficient instrumentation includes file designs, rotational speed, different sequences of instrumentation and surface conditioning of the instruments.⁹ NiTi file systems can maintain original canal shape, reduce procedural errors and prepare the canal faster.¹⁰ Hyflex files [coltinevaldent] are characterized by controlled memory NiTi files with positive rake angle. In contrast Hero shaper instrument (Micro- Mega, Besançon, France) have constant taper and positive rake angle. Many investigations have paid close attention to the shaping ability of these two systems in simulated or extracted tooth canals.^{11,12,13,14} There is still a lack of scientific data regarding the debris and smear layer remaining on canal walls after preparation with these two instrument systems in canals. Numerous studies report on the relative effectiveness of different instrumentation techniques based on a variety of ways to evaluate canal debridement outcomes of instrumentation differ according to method of canal preparation and evaluation; each method has its own advantages and disadvantages.¹⁵ Introduction of Scanning Electron Microscope has proved to be a valuable method for assessment of the ability of the endodontic procedures to remove debris from root canals thus enabling comparison of instruments and techniques. The purpose of this study is to compare the efficacy to remove smear layer and debris on canal walls following the preparation of canals with Hyflex [coltinevaldent] rotary files, Hero shaper [Micro-Mega, Besançon, France] Rotary files, using a scanning electron microscope in two separate individual groups.

MATERIAL AND METHODS

A total of 50 extracted maxillary permanent central incisors were collected. The teeth were rinsed in tap water to remove blood stains and tissue debris as well as disinfected in sodium hypochlorite 5.25% for thirty minutes and stored in normal saline until use. Access opening was done using endo access bur and working length determination is done by placing 10-size Kfile at the apical foramen. The working length was taken 1mm short from this point. The teeth were divided into two equal groups namely Hyflex and Hero shaper. GROUP A: In the Hyflex group of extracted teeth, Hyflex instruments were

used in a crown down manner according to the working sequence proposed by the manufacturer; the files are used in the following manner #30.06, #25.06, #20.06, #20.04 to full working length. The canals are later irrigated with 2.5% NaOCl and 17% EDTA in each instrument change. The files were used with reduction contra angle hand piece at torque 16:1 and 300 rpm constant speed.

Groupb: In the Hero shaper group of extracted teeth, the shaping was accomplished by using the protocol described by manufacturer. In crown down technique, the files are used in the following manner #30.06, #25.06, #20.06, #20.04 to the full working length. The canals are irrigated with 2.5% NaOCl and 17% EDTA in each instrument change. The files were used with reduction contra angle hand piece at torque 16:1 and 300 rpm constant speed.

During the canal preparation the irrigation regimen and amount of irrigation used in both the groups was standardized. 4ml of NaOCl, 2ml of EDTA was used for each canal. No.25 gauge needle syringe was used to deliver the irrigant with the needle loosely fitting into the canal. After the completion of preparation, all the root canals were cleaned with 3% Sodium Hypochlorite solution and dried with absorbent paper points. Crown portion was removed with a wheel diamond disc and the roots were split longitudinally into two halves, preparing for scanning electron microscopic study. Each of the samples in Group A and Group B were divided into three areas from the coronal, middle, and the apical portion and are examined under a scanning microscope at 1000X magnification for the evaluation of debris and smear layer. The scoring was given separately for debris and smear layer for both groups.

The scoring system used was proposed by [Hulsmann et al.](#)¹⁶ and criteria for the scoring is as follows:

For Debris

(Dentin chips, pulp remnants, and particles loosely attached to the canal wall)

Score 1: Clean canal wall, only very little debris particles.

Score 2: Few conglomerations of debris present

Score 3: conglomerations < 50% of the canal wall covered

Score 4 : > 50% of the canal wall covered with debris.

Score 5: Complete or nearly complete covering of the canal wall by debris

For Smear Layer

Score 1: No smear layer, orifice of dentinal tubuli patent.

Score 2: Small amounts of smear layer some dentinal tubuli patent open.

Score 3: Homogenous smear layer along almost the entire canal wall, only very few dentinal tubuli open.

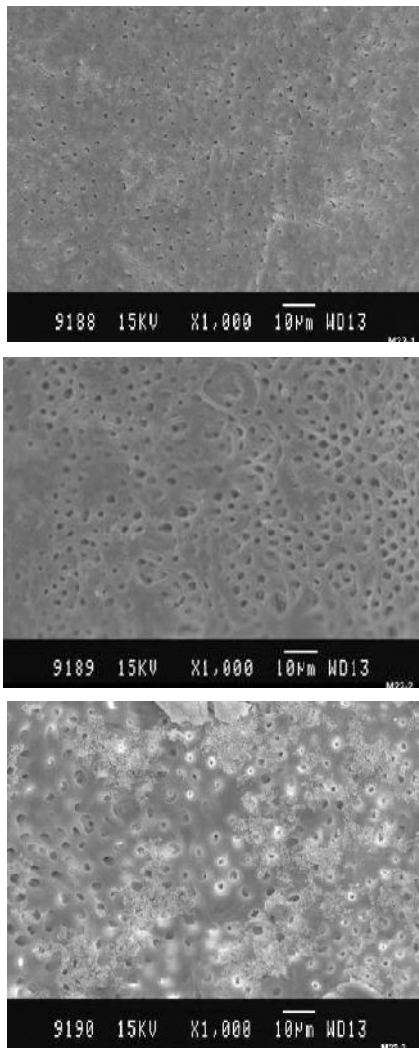
Score 4: The entire root canal wall is covered with homogenous smear layer, no open dentinal tubuli.

Score 5: A thick homogenous smear layer covering the entire root canal wall.

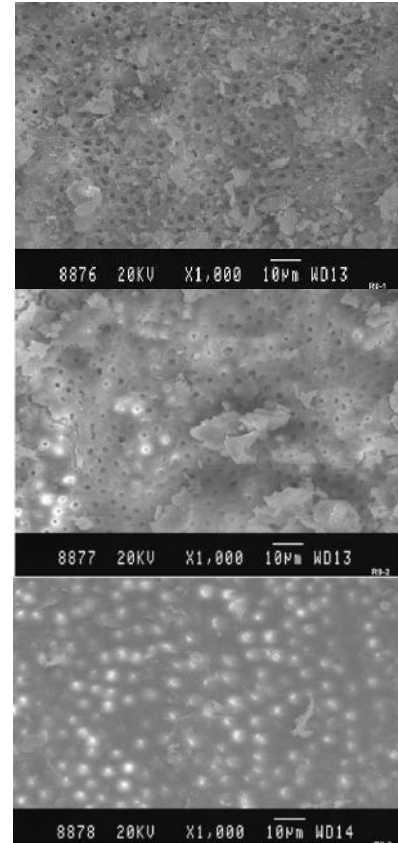
RESULTS

Completely clean root canal walls were not observed in either of the instrumentation groups. Scores of smear layer and debris of the two instrumentation groups in coronal, middle, and apical third are listed in table 1 and 2. Both Hyflex and Hero shaper files clear the debris and smear layer or leave few debris and smear layer on the surface walls of coronal and middle third of root canal. The orifices of dentinal tubules are also visible clear and open. But both the files were unable to clear the debris and smear layer in the apical thirds as they cleared in coronal and middle thirds. In comparison of both the files Hyflex files were scores less in debris and smear layer in coronal and middle third of root canal surface than Hero shaper files. Hero shaper file cleared debris and smear layer more efficiently in the apical third of root canal surface than the Hyflex files. Representative photomicrographs of the presence of debris and smear layer in coronal, middle and apical third of canals prepared with both instruments are shown in the figures below. Canals prepared with the Hyflex files presented only small conglomerations in the coronal and middle third than Hero shaper files. In the apical third Hero shaper file showed lower scores than Hyflex files.

Smear layer and debris on canal walls coronal, middle, apical prepared by group A [Hyflex files] instrumentation:



Smear layer and debris on canal walls coronal, middle, apical prepared by Group B [Heroshaper] instrumentation:



DISCUSSION

The main objective of the biomechanical instrumentation is to totally eliminate the infected pulp tissue from the root canal. In addition to the pulpal remnants, debris and a smear layer produced by instrumentation of the root canal walls must be totally removed.¹⁷ The aim of the present study is to compare the root canal debridement capability of two different NiTi rotary files namely Hyflex files and Hero shaper files. The results indicate none of the file system could remove the contrast medium completely. This finding is similar to the previous studies with another NiTi rotary file systems.¹⁸⁻²⁰ Nickel Titanium files have recently been introduced into the field of Endodontic Instruments. The alloys exhibit superelasticity, a term used to describe the property of certain alloys to return to their original shape upon unloading from substantial deformation. The low modulus of elasticity of Nickel Titanium instruments permits maintenance of the original canal shape and minimizes iatrogenic errors such as ledging, zipping and canal transportation. Additionally when compared with stainless steel instruments NiTi Instruments demonstrate a superior resistance to fracture.²¹ In this study results showed both Hyflex and Hero shaper files show clear or less debris and smear layer in coronal and middle third but unable to produce the much clear surface in apical third of canal surface. Instruments with positive cutting angles cut more efficiently and may have a superior cleaning ability compared with those with neutral or negative cutting angles.^{22, 23} In this study variation of cleaning efficacy of both files in apical third might be due to the differences in surface conditioning and the design of the files.

Table 1 Smear layer scoring

S. NO	Smear layer scoring	Coronal Third		Middle Third		Apical Third	
		Group A (n=25)	Group B (n=25)	Group A (n=25)	Group B (n=25)	Group A (n=25)	Group B (n=25)
1.	No smear layer and dentinal tubuli open	17 (68.0)	15 (60.0)	17 (68.0)	16 (64.0)	13 (52.0)	17 (68.0)
2.	Small amount of smear layer and some dentinal tubuli open	5 (20.0)	5 (20.0)	7 (28.0)	8 (32.0)	7 (28.0)	5 (20.0)
3.	Homogeneous smear layer covering the canal surface and few dentinal tubuli open	3 (12.0)	1 (4.0)	1 (4.0)	1 (4.0)	4 (12.0)	3 (12.0)
4.	Complete root wall covered by homogeneous smear layer, no dentinal tubuli open	-	1 (4.0)	-	-	1 (4.0)	-
5.	Heavy non homogeneous smear layer covering the root canal surface	-	-	-	-	-	-
Significance		P<0.001		P=0.005		P=0.0013	

Table 2 Debris scoring

S.NO.	Debris scoring	Coronal Third		Middle Third		Apical Third	
		Group A (n=25)	Group B (n=25)	Group A (n=25)	Group B (n=25)	Group A (n=25)	Group B (n=25)
1.	Clear root canals only few debris particles on surface of root canal	16 (64.0)	15 (60.0)	17 (68.0)	17 (68.0)	15 (60.0)	17 (68.0)
2.	Few small agglomerations of debris present on walls of canal	7 (28.0)	8 (32.0)	6 (24.0)	6 (24.0)	5 (20.0)	6 (24.0)
3.	Many agglomerations of debris covering less than 50% of the root canal wall	2 (8.0)	2 (8.0)	1 (4.0)	2 (8.0)	2 (8.0)	2 (8.0)
4.	More than 50% of the root canal wall covered with debris	-	-	-	-	1 (4.0)	-
5.	Complete or nearly complete root canal wall covered with debris	-	-	-	-	-	-
Significance		P<0.001		P=0.003		P=0.0024	

File designs, rotational speed, different sequences of instrumentation, and surface conditioning of the instruments are important factors for efficient instrumentation in root canals.⁹ The usage of a larger final file would be more liable to remove a greater portion of debris from apical thirds with the removal of dentin.²⁴ A similar study conducted by [Guobin Yang et al](#) concluded the canals prepared with ProTaper instruments showed smaller amounts of debris and smear layer remaining in the apical region than Hero shaper files. [Ismail DavutCapar et al](#) stated that the ProTaper Next and Twisted File Adaptive instrumentation systems were associated with less debris extrusion compared with the ProTaper Universal and Hyflex systems.²⁵ FigenKaptan concluded the Hero shaper and RaCe instruments removed almost the same. However, Hero Shaper removed more material from the middle and coronal aspects of the canal and the differences were statistically significant and Hero Shaper instruments showed better centering ability and fewer aberrations.²⁶ A study about Hyflex files by S.E.D.M. saber²⁷, He concluded that significantly Hyflex files shows less strengthening the root canals than the pro-taper next files however Hyflex files are respected to original canal curvature and were safe to use. In this study results showed that canals prepared with the Hyflex files shows lower scores of smear layer and debris in coronal and middle third of canal surfaces than Hero shaper files. In this study results showed that hero shaper files were more effective in apical one third as compared to hyflex files which were cleaning effectively in coronal and middle one thirds.

CONCLUSION

In sum, it can be stated that both the Hyflex and Hero shaper files can be recommended for clinical practice.

Both the files Hyflex and Hero shaper files showed clear or less debris and smear layer in coronal and middle third but unable to produce the much clear surface in apical third. However in comparison, Hyflex files produced clear debris free surfaces in coronal third and middle third than Hero shaper files. And Hero shaper files scores high in coronal third and middle third less in apical third than Hyflex files.

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How to cite this article:

Arun Kumar S., Rama Brahmam Lanke & Tejadeepthi C. (2015). An In vitro-Comparative Evaluation of Cleaning Efficacy of Hyflex And Hero Shaper Rotary Niti File Systems-Scanning Electron Microscope Study. *Int J Recent Sci Res*, 6(9), 6320-6324.

*International Journal of Recent Scientific
Research*

ISSN 0976-3031



9 770576 303009