

# Comparative Evaluation of Action of RISA and Sodium Hypochlorite on the Surface Roughness of Heat Treated Single Files, Hyflex EDM and One Curve- An Atomic Force Microscopic Study

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## Abstract:-

### ➤ Aim:

The aim of the study is to evaluate the action of RISA and Sodium hypochlorite on the surface roughness of heat treated single files, Hyflex EDM and One Curve using an Atomic Force Microscope.

### ➤ Materials and Methods:

A total of ten new files from each brand (Hyflex EDM and One Curve) were taken. Before immersion, all the files were observed under Atomic Force Microscope to determine the surface roughness. Five files from Hyflex EDM were immersed in 5.25% sodium hypochlorite and five files were immersed in RISA solution. Five files from One Curve were immersed in 5.25% sodium hypochlorite and the other five files were immersed in RISA solution. The dynamic immersion of the files were done by attaching it to an endomotor at constant speed [300 rpm] and torque [2.5 N Cm] into plastic tubes. After immersion, all the files were kept on the staging platform of AFM and 3mm section of the tip was examined for surface roughness.

### ➤ Results:

Within the limitations of this study, Hyflex EDM files immersed in sodium hypochlorite showed highest increase in surface roughness. Among the irrigant solutions used, increase in surface roughness was more for files immersed in Sodium hypochlorite as compared to files immersed in RISA solution.

**Keywords:-** RISA, Sodium Hypochlorite, Hyflex EDM, One Curve, Atomic Force Microscopy, Surface Roughness.

## I. INTRODUCTION

Successful endodontic therapy requires adequate cleaning and shaping which includes proper disinfection of the root canal. Irrigation is the most efficient method for the removal of tissue remnants and dentin debris during instrumentation. Irrigation flushes away loose, necrotic, contaminated materials before they are inadvertently pushed deeper into the canal and periapical tissues.<sup>1</sup>

Nickel titanium rotary instruments have been used in endodontics since 1988. NiTi rotary instruments have undergone revolutionary changes in terms of its design, cross section and kinematics. Heat treatment of nickel titanium rotary files increased the flexibility and enhanced the cyclic fatigue resistance of rotary files. The new single-file technique has been recently introduced to simplify instrumentation protocols, to decrease stresses and to avoid the risk of cross-contamination. However, root canal shaping with only one file submits the instruments to a great degree of torsional and flexural stresses. The files are not used for further canals and do not require thermal sterilization in autoclave, so it will be not exposed to other stresses.<sup>2,3</sup>

During irrigation, when an irrigant comes in contact with the rotary file, it can lead to corrosion, surface roughness and deformation of the rotary file leading to its failure.<sup>5,6</sup> Currently, the most commonly used irrigant is sodium hypochlorite. Continuous irrigation can lead to decrease in cutting efficiency and increase in surface roughness of these files.<sup>7,8</sup>

The HyFlex EDM (HEDM; Coltene/Whaledent, Altstätten, Switzerland) rotary file system is a new-generation single-file system, that works in continuous rotation motion. HEDM (25/.08) files are fabricated using electric discharge machining treatment. This electric discharge machining treatment has significantly improved the mechanical properties of the files.<sup>9</sup>

One Curve files by Micro Mega is produced from heat treated NiTi, manufactured using C wire technology, a shape memory alloy that allows pre bending. The One Curve system exhibits better canal centering ability and improved cutting efficiency accounted due to its variable cross section.<sup>10</sup>

RISA has been developed to improve the disinfection efficacy and biocompatibility and has been previously referred to as Modified Salt Solution (MSS) by van der Waal et al. in 2012<sup>11</sup>. It is a hypertonic solution of sodium chloride with added potassium sorbate in water with a pH of 6.8. It is based on a Multiple hurdle strategy mode of action, relied on hyperosmotic stress, weak acid stress and antimicrobial action of sorbic acid.

Atomic force microscopy is used to assess the surface topography accurately. This technique allows topographic mapping of the surface using non destructive probes. Hence, the aim of this study was to evaluate the surface roughness of heat treated single files following exposure to two different irrigants , sodium hypochlorite and RISA.

**II. MATERIALS AND METHODS**

Ten new files from each brand were taken. Before immersion , all the files were observed under AFM to determine the surface roughness. Five files from Hyflex EDM were immersed in 5.25% sodium hypochlorite and five files were immersed in RISA solution. Five files from One Curve were immersed in 5.25 % sodium hypochlorite and the other five files were immersed in RISA solution. The dynamic immersion of the files were done by attaching it to an endomotor at constant speed [300 rpm] and torque [2.5 N Cm] into plastic tubes. After immersion , all the files were kept on the staging platform of AFM and 3mm section of the tip was examined for surface roughness.

The null hypothesis was that there was no difference in the mean surface roughness of the files after immersion in the irrigants.

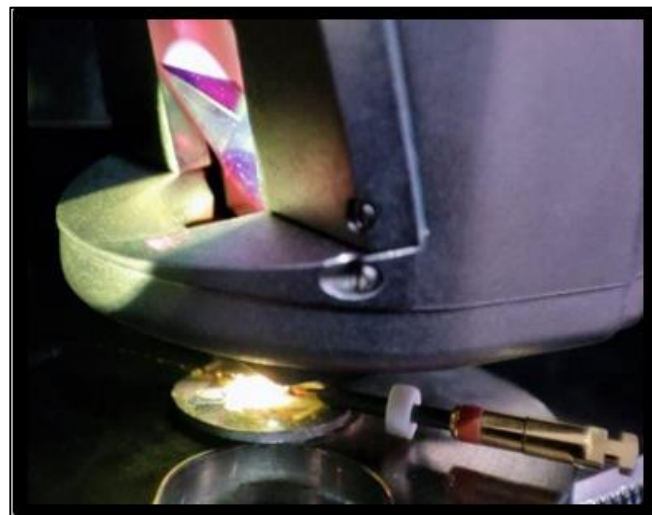


Fig 1: a) Atomic Force Microscope  
b) Specimen on Staging Platform

➤ *Statistical Analysis*

Statistical analysis, including statistical tests, normality checks, and data visualization, is carried out with SPSS version 22 and Microsoft Excel .One Way ANOVA and Bonferroni Pairwise comparison were used to compare the surface roughness of different files.

**III. RESULTS**

➤ *The Mean and Standard Deviation of the Surface Roughness Values are Displayed in Table 1.*

Table 1: Table of Anova presenting the Data Profile

Groups	Mean ± SD		Sum of Squares	df	Mean Square	F	Sig.
Group 1	0.15367 ± 0.004	Between Groups	0.431	3	0.144	1653.107	< 0.001
Group 2	0.35600 ± 0.010	Within Groups	0.001	8	0.000		
Group 3	0.46900 ± 0.010	Total	0.432	11			
Group 4	0.67767 ± 0.105						

An ANOVA analysis indicated a statistically significant variation in the average Surface roughness in four groups (F (3, 11) = 1653, P < 0.001). There were significant

differences between each four group, according to the pairwise comparison Bonferroni test.

Table 2: Bonferroni Pairwise Comparison Test

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-.202333	0.007612	< 0.001	-0.22881	-0.17585
	3	-.31533	0.007612	< 0.001	-0.34181	-0.28885
	4	-.524000	0.007612	< 0.001	-0.55048	-0.49752
2	3	-.113000	0.007612	< 0.001	-0.13948	-0.08652
	4	-.321667	0.007612	< 0.001	-0.34815	-0.29519
3	4	-.208667	0.007612	< 0.001	-0.23515	-0.18219

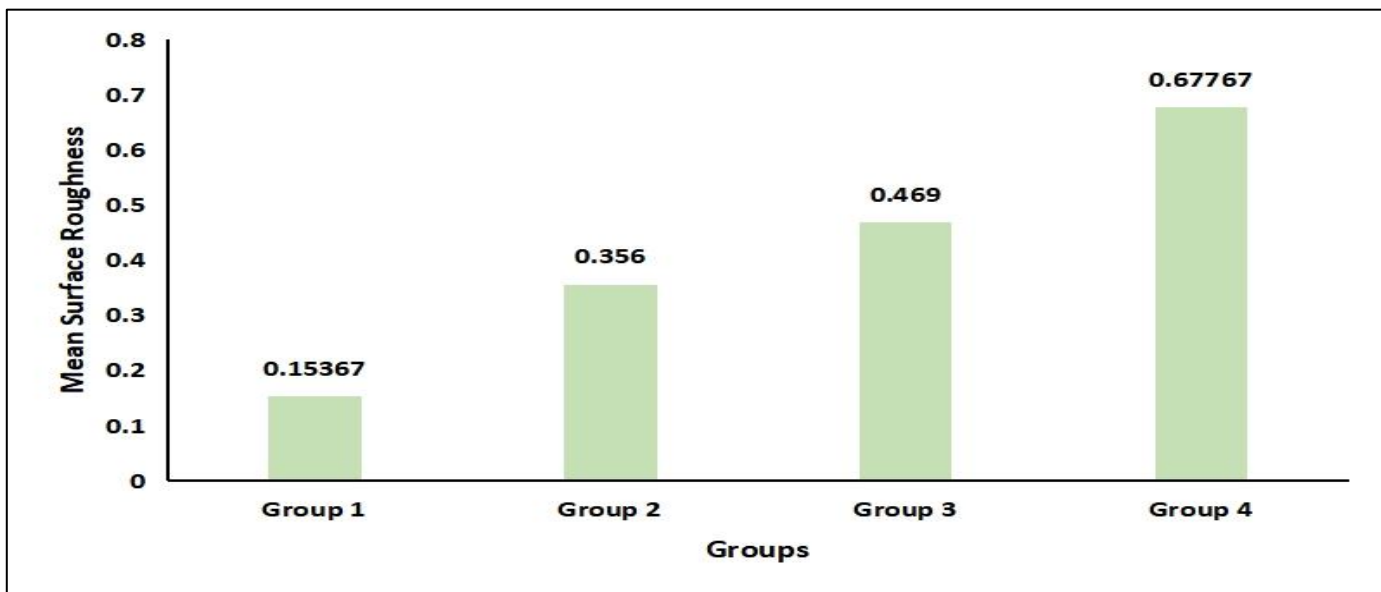


Fig 2: Bar Chart Representing the Average Surface Roughness of the Four Groups

Among the irrigant solutions, files immersed in sodium hypochlorite showed highest increase in surface roughness compared to files immersed in RISA solution. Among the files used, Hyflex EDM files showed more increased surface roughness after immersion when compared to One Curve files. Comparing the surface roughness, the highest values were obtained following the immersion of Hyflex EDM files in sodium hypochlorite.

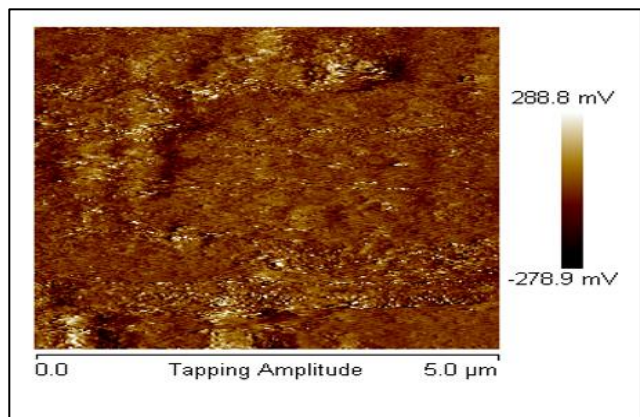


Fig 3: One Curve after Immersion in RISA

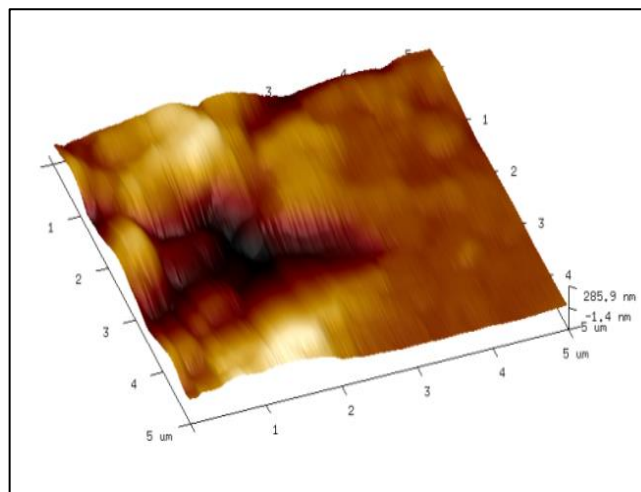


Fig 5: Hyflex EDM after Immersion in RISA

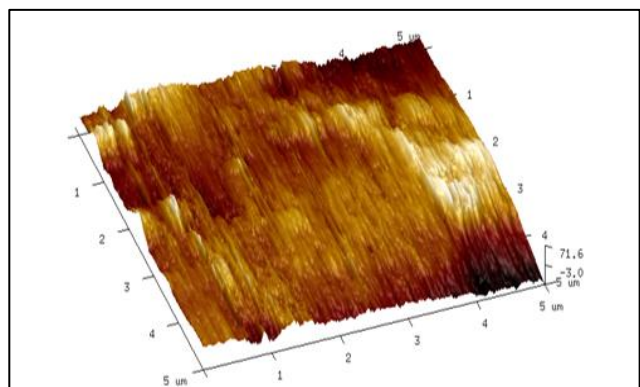


Fig 4: One Curve after Immersion in Sodium Hypochlorite

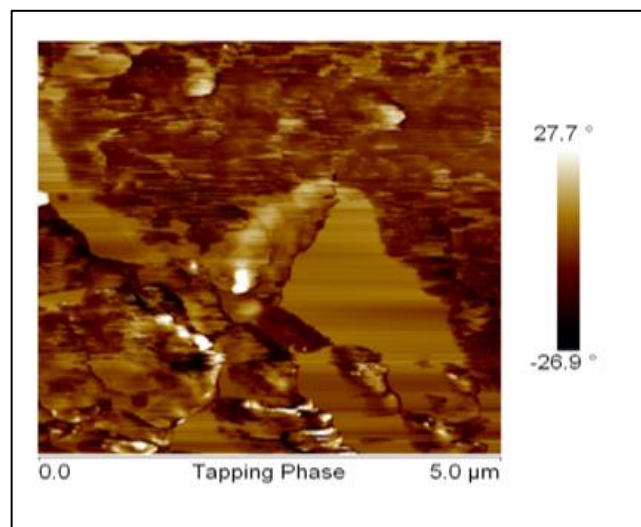


Fig 6: Hyflex EDM after Immersion in Sodium Hypochlorite

#### IV. DISCUSSION

The Surface roughness in the study was obtained using Atomic force microscopy as it creates three dimensional topographical images compared to Scanning Electron Microscopy, which gives two dimensional images of the surface. Atomic Force Microscopy is the technique for imaging three dimensional surfaces and it analyse the surface both qualitatively and quantitatively. It is efficient in scanning conducting and insulating surfaces and works under ambient conditions in air, liquid, and in vacuum. In the Scanning Electron microscope, fragile samples are damaged by sputtering, dehydration, and exposure to vacuum, while such artifacts are reduced in Atomic ForceMicroscopy.<sup>13</sup>

Among the files used ,those files which were immersed in 5% sodium hypochlorite showed higher increase in surface roughness compared to those immersed in RISA, as sodium hypochlorite resulting in selectively removing of nickel ions from the surface of NiTi instruments causing micro pitting and thereby reducing the fracture resistance of files.<sup>14</sup>

RISA is the recently introduced irrigant solution which showed penetration into areas beyond the main root canal and was able to eliminate the *E.Feacalis*. It has a highly concentrated formula , which is targeted to diffuse into areas beyond the main root canal space.<sup>12</sup> There occurs migration of molecules from an area of high concentration to an area of a lower concentration and this diffusion causes hyperosmotic stress in micro-organisms and is one of the important hurdles of the multiple-hurdle strategy . Other mode of actions are weak-acid stress and the inhibition of growth of the microbes by sorbic acid.<sup>11</sup>

Electric Discharge Machining is the unique process of manufacturing of files by generating a potential difference between the workpiece and the tool. The electric spark produced during this process cause melting and evaporation of the surface of files rendering the Hyflex EDM files more strength and resistance to fracture.<sup>13,16</sup> This results in increased flexibility and fracture resistance and thereby reduce the number of files needed for cleaning and shaping of the canal, without compromising root canal anatomy.

Comparing the surface roughness, both Hyflex EDM and One Curve showed increase in surface roughness after immersion in irrigants. The Hyflex EDM files when immersed in sodium hypochlorite have the highest increase in surface roughness. The electrical spark produced during the fabrication process of the Hyflex EDM files accounts for the improved cutting efficiency of files but also produced micropores leading to corrosion pits, which are associated with crack initiation and propagation of corrosion by the action of sodium hypochlorite.<sup>14,15,17</sup>

Among all the groups, Hyflex EDM files immersed in sodium hypochlorite showed the highest increase in surface roughness.

#### V. CONCLUSION

Among the files tested, the Hyflex EDM files immersed in sodium hypochlorite have the highest increase in surface roughness. Irrigation with RISA and sodium hypochlorite both affected the surface roughness but sodium hypochlorite irrigant increased the surface roughness significantly when compared to RISA.

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