

# Effect of Different Herbal Irrigants on the Surface Topography of One Curve Rotary NITI Files: A Scanning Electron Microscopic Analysis

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## Abstract:

**Background:** Nickel-titanium (Ni-Ti) rotary files are important instruments used in Endodontics during root canal preparation. The wear and surface topography of NiTi instruments may be affected by the irrigating solutions used during root canal treatment. In view of less literature on the efficacy of various extracts on surface topography, the current study was undertaken.

**Objective:** The aim of the study was to evaluate the effect of sodium hypochlorite, aloe vera extract, neem leaf extract and tea tree oil extract on the surface topography of one curve rotary files with a scanning electron microscope (SEM).

**Materials and Methods:** A total of 24 human upper incisors were used for the study, done at KIMS, Amalapuram. All the teeth were decoronated at the level of Cemento-enamel Junction (CEJ) and the working length was standardized to a length of 18mm. All the teeth were randomly divided into five groups according to the irrigants used. GROUP I- 25% NaOCl is used, GROUP II- 90% Aloe vera extract is used, GROUP III- 1:10(w/v) Neem leaf extract, GROUP IV- 2% Tea tree oil extract were used as irrigants for 5min. Group V is control group. After root canal instrumentation with 25.6% one curve rotary files they were kept in the distilled water and were cleaned. Randomly selected half the number of samples from each group were evaluated using SEM.

**Results:** There is no visible defect in 90% aloe vera group and control group followed by 1: 10 (w/v) Neem leaf extract group, 5.25% sodium hypochlorite group and the highest number of defects found in 2% tea tree oil extract group as per examiner 1 and 2 respectively. A kappa value of 0.72 was observed between the two examiners indicating good agreement between them and this agreement is found to be statistically significant.

**Conclusion:** Among the irrigants tested, least surface defects were shown by the aloe vera group. Hence, this can be used as an excellent alternative to chemical irrigants which shows various deteriorating effects.

**Key Words:** Aloe Vera, Herbal irrigants, Neem leaf extract, Root canal treatment, Surface topography.

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## I. Introduction

Chemo-mechanical root canal preparation aims to eliminate microbes from the root canal system, and uses both mechanical instrumentation and antibacterial irrigation.<sup>1</sup> In 1988, the manual nickel-titanium (NiTi) instrument was introduced. Later, Walia introduced rotary NiTi files to the field of endodontics in consideration of its greater elasticity and resistance to torsional fracture.<sup>2</sup> Two separate mechanisms - torsional fatigue and cyclic fatigue cause the clinical fracture of NiTi files.<sup>3,4</sup>

CM NiTi files are manufactured using a special method that manages the material's memory, making the instrument highly flexible and resistant to cycle fatigue.<sup>5</sup> Manufactured from these heat-treated Nickel-Titanium alloy, One Curve (OC) is a single-use, rotary file that enables shaping of the full length of the canal with a single instrument, directly to the apex.<sup>6</sup>

However, Mechanical friction or chemical stimulation of the rotary files during endodontic instrumentation may result in surface wear and the development of surface flaws such as scratches and microcracks.<sup>7</sup> A lot of research has been done recently in endodontics on the effectiveness, safety, and accessibility of using herbal medicines as root canal disinfectants.<sup>8</sup> Numerous studies have demonstrated that herbal products have significant antibacterial action.<sup>9</sup> Very little literature is available that evaluated the efficacy of herbal irrigants on the surface characteristics of NiTi rotary files. Hence the current study was undertaken.

**Objective:** To evaluate the effect of sodium hypochlorite, aloe vera extract, neem leaf extract and tea tree oil extract on the surface characteristics of one-curve rotary files using a scanning electron microscope (SEM).

## II. Material And Methods

**Study site:** KIMS, Amalapuram, Andhra Pradesh, India

**Study duration:** Three months October 2022 to December 2022

### Subjects & selection method:

GROUP I- 5.25% NaOCl is used

GROUP II- 90% Aloe Vera Extract is used

GROUP III- 1:10(w/v) Neem leaf extract is used

GROUP IV- 2% Tea tree oil extract was used as an irrigant for 5min.

Group V is the control group.

### Ethical considerations:

Institutional ethical committee approval was obtained before conducting the study.

### Methodology:

After taking appropriate clearance from the institutional ethical review board, twenty-four freshly extracted Human maxillary incisors with mature apices and a 0°–10° curvature were selected. The teeth were decoronated to create root segments that were 18 mm long using diamond disk and randomly distributed into 4 experimental groups based on the irrigants used. Group-I were those samples in which 5.25% NaOCl was used as an irrigant; Group-II were those samples in which 90% Aloe Vera extract was used as irrigant; Group-III were those samples in which (1:10 w/v) Neem Leaf extract was used as irrigant, Group-IV were those samples in which 2% Tea Tree Oil extract was used as irrigant. Group V (Control group) were the samples taken directly from the sterile packets. Before being included into the study, the teeth were cleared of debris and soft tissue remnants and kept in physiological saline. The working length was set to be 1 mm less than the Radiographic length of the teeth. To create an appropriate seal, teeth were kept inside a glass tube filled with self-curing acrylic resin. Irrigation was done according to the allotted irrigants with respect to each group for 5 minutes and were initially instrumented using K files till 20# followed by new one curve NiTi file of size 25# 6%, one in each tooth. After the root canal instrumentation was completed, the files were cleaned in an ultrasonic bath for 400 seconds in 96% pure alcohol, dried on a cotton pellet at room temperature, and then stored in sterile bottles. Randomly, 3 samples from each group were selected which was evaluated using SEM JEOL- JCM 6000+ under the magnification of 500x. To reduce the bias the surface characteristics was evaluated by two blindfolded examiners using the Eggert's scoring system.<sup>10</sup>

<i>Score</i>	<i>Criteria</i>
1	No visible defect
2	Pitting
3	Fretting
4	Micro fractures
5	Complete fracture
6	Metal flash
7	Metal strips
8	Blunt cutting edges
9	Disruption of cutting edge
10	Corrosion
11	Debris

### Statistical analysis

Data were analyzed using SPSS 23.3 software. Tukey Post hoc test was used to analyze the data. Chi square test was used to compare categorical parameters between all groups and in between the examiners. P value below 0.05 is considered significant.

### III. Results

#### Defects as per examiner 1:

Table 1 shows defects observed by examiner 1. In the sodium hypochlorite group, all three samples were observed with pitting, microfracture and corrosion.

In the aloe vera group and control group, all three samples were free of visible defects.

In the Neem leaf extract group, all the samples were observed with corrosion and debris; in tea tree oil group, all samples had pitting, corrosion and debris.

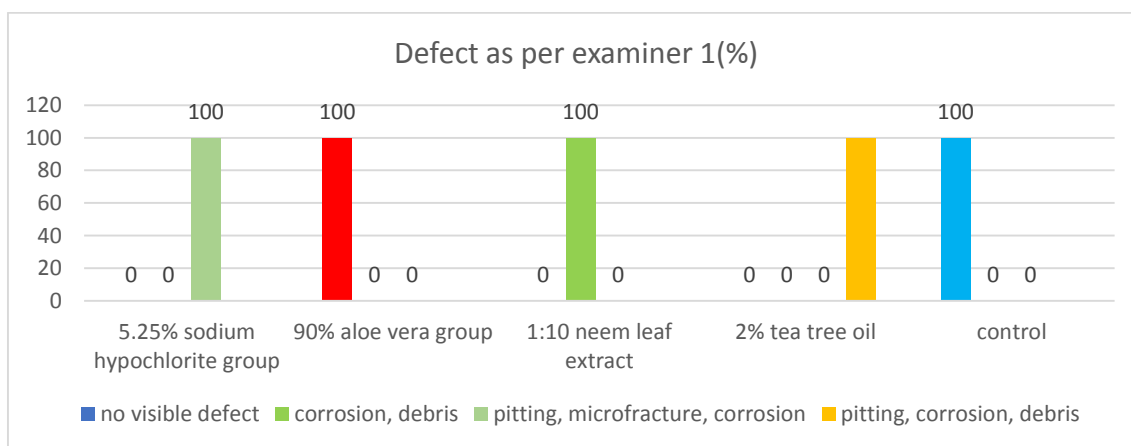
A highly significant difference (p=0.000) was observed within the groups in the distribution of defects in the samples.

Table 1 shows defects as per examiner 1

		Examiner_1				Chi square	P value
		no visible defect	corrosion, debris	pitting, microfracture, corrosion	pitting, corrosion, debris		
Examiner 1	5.25% sodium hypochlorite group	0 (0.0%)	0(0.0%)	3 (100%)	0 (0.0%)	45.00	0.000 HS
	90% aloe vera group	3 (100%)	0 (0%)	0 (0%)	0 (0%)		
	1:10 neem leaf extract	0 (0.0%)	3 (100%)	0 (0.0%)	0 (0.0%)		
	2% tea tree oil	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (100%)		
	control	3 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		

Statistical test applied: Chi square test; HS – Highly significant at p<0.01

Graph 1 shows defects as per examiner 1



#### Defects as per examiner 2:

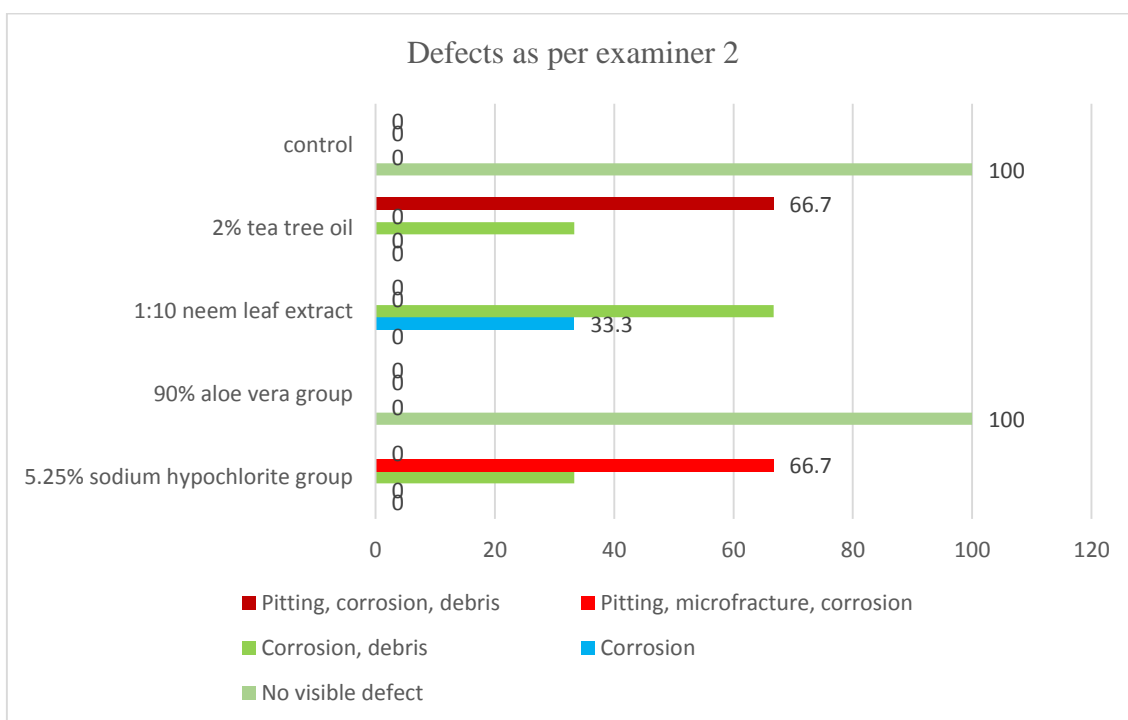
Table 2 shows defects observed by examiner 2. In sodium hypochlorite group, 33.3% of samples had corrosion and debris and 66.7% of samples had pitting, microfracture and corrosion. In aloe vera group and control group, all three samples were free of visible defects. In Neem leaf extract group, one (33.3%) sample had corrosion while 2 (66.7%) samples were observed with corrosion and debris; In tea tree oil group, one sample had corrosion and debris while 2 samples had pitting, corrosion and debris. A highly significant difference(p=0.009) was observed within the groups in the distribution of defects in the samples.

Table 2 shows defects as per examiner 2

		Examiner_2					Chi square	P value
		no visible defect	Corrosion	corrosion, debris	pitting, microfracture, corrosion	pitting, corrosion, debris		
Examiner 2	5.25% sodium hypochlorite group	0 (0.0%)	0 (0.0%)	1 (33.3%)	2 (66.7%)	0 (0.0%)	32.5	0.009 HS
	90% aloe vera group	3 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
	1:10 neem leaf extract	0 (0.0%)	1 (33.3%)	2 (66.7%)	0 (0.0%)	0 (0.0%)		
	2% tea tree oil	0 (0.0%)	0 (0.0%)	1 (33.3%)	0 (0.0%)	2 (66.7%)		
	control	3 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		

Statistical test applied: Chi square test; HS – Highly significant at p<0.01

Graph 2 shows defects as per examiner 2:



**Kappa value between examiners:**

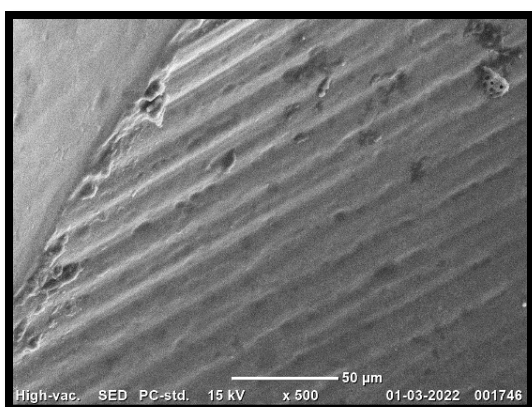
Table 3 shows interrater agreement between examiners 1 and 2 for the observation of samples defects across 5 groups. A kappa value of 0.72 was observed between the two examiners indicating good agreement between them and this agreement is found to be statistically highly significant (0.000)

Table 3: Agreement between examiner 1 and 2.

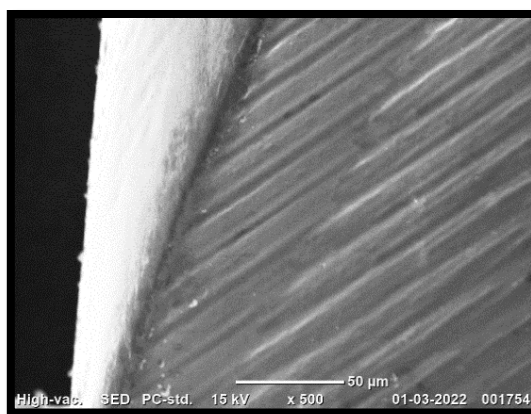
Cohen's Kappa value	P value
0.727	0.000 HS

The statistical test applied: Kappa statistics; HS – Highly significant at p<0.01  
 Interpretation: 0.72 means- good agreement

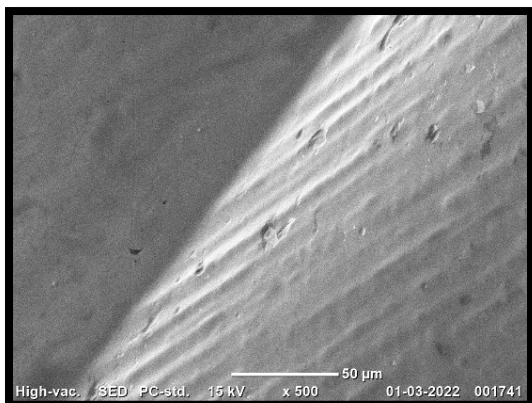
**SEM images**



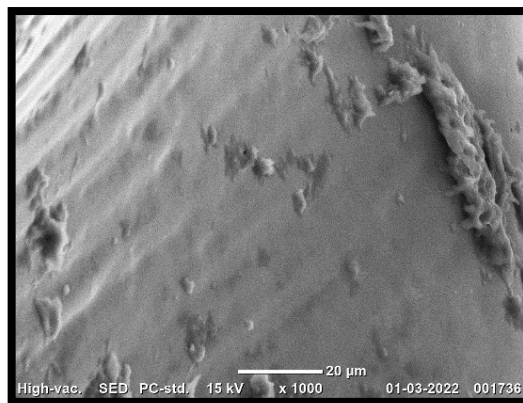
**5.25% NaOCl Group**



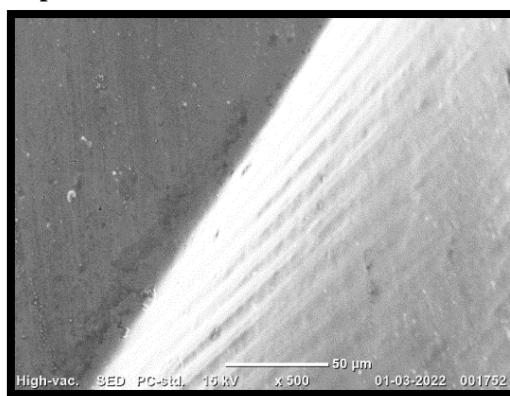
**90% Aloe vera Extract Group**



10% Neem leaf Extract Group



2% Tea tree oil Extract Group



Control Group

#### IV. Discussion

In our study, teeth were decoronated using diamond disk at 18mm length. To standardize all sample lengths 18mm is considered.

Patil P et al did a study in which, the teeth were decoronated obtaining a root segment of 15 mm.<sup>11</sup>

In the study of Madhu K, roots were decoronated using a diamond disc operated at low-speed and standardized at 16mm length.<sup>12</sup>

In our study, we used .25% NaOCl, 90% aloe vera extract, 1:10(w/v) neem leaf extract and 2% tea tree oil extracts as herbal irrigants.

Prasad PS et al used 5% sodium hypochlorite, 17% EDTA and triphala on different rotary Ni-Ti instruments in their study previously.<sup>13</sup>

Riaz Ahmed et al. used previously used 17% EDTA and *Sapindus mukorossi* on gold rotary endodontic instruments.<sup>14</sup>

Jerry Jose et al did a study on qualitative assessment of surface topographic changes of XP-endo Shaper after exposure to NaOCl and EDTA.<sup>15</sup>

Mahali RR et al used did a study to evaluate and compare tensile strength values and effect of taper on the tensile strength of Gutta-percha cones after disinfection with NaOCl and Aloe vera gel (AV).<sup>16</sup>

In our study, we used NiTi file of size 25# 6%, one in each tooth.

Rapisarda *et al*<sup>17</sup>. in his study, published in 2001 used ProFile instruments (#25 taper) where the surface was treated using a distinct method than cathodic arc evaporation method. So, we used NiTi file of size 25# 6%, one in each tooth in our study.

During the treatment of root canal, NiTi instruments may get fractured due to maximum number of usages suggested by the manufacturer, which it may jeopardize clinical outcomes of the root canal treatment. The fracture of NiTi rotary instruments occurs due torsional fracture and flexural fatigue and hence some authors recommend considering the file as a disposable instrument.<sup>18-19</sup> But, due to high cost of rotary instruments, NiTi files are commonly reused after sterilization to reduce the cost and risk of cross-infection during endodontic treatment.

All files were qualitatively evaluated for various surface changes at tip, shaft and the edges using SEM two examiners to reduce bias and improve accuracy. This method was done previous in the study of Qaed Na et al.<sup>20</sup>

Newly introduced to the market in recent years, the One Curve (OC; Micro Mega) is a single-file system that reduces the root canal instrumentation time, while preserving the original root canal form. The OC system is made of C-wire heat-treated NiTi material with the property of controlled memory (CM); as such, the shape of the file can be flexibly modified before entering the canal to ensure easy access to the root canal. The manufacturer states that the instrument was developed to respond to the need for efficient shaping while respecting the initial root canal anatomy. Therefore, the instrument has a blade structure with a variable cross-section, ensuring the effective removal of debris up to the medium and coronal parts of the root canal. Furthermore, the non-existent ovalization of this instrument secures the apical zone.<sup>21</sup>

In the present study, files with an apical diameter of #25 were used in order to standardize the instrumentation characteristics of files. The scoring criteria used in our study to evaluate the surface defects was given by **Eggert et al.**<sup>22</sup> SEM was chosen in this study to evaluate the surface defects accurately. At higher magnification for surface defects, geometry of the cutting edges, and radial land of the instruments.<sup>23</sup>

In our study, human upper incisors were used. GROUP I- 5.25% NaOCl is used, GROUP II- 90% Aloe vera extract is used, GROUP III- 1:10(w/v) Neem leaf extract, GROUP IV- 2% Tea tree oil extract were used as irrigants for 5min. Group V is control group. After root canal instrumentation the files were kept in distilled water and were cleaned. All the samples to be tested are dried and mounted on the aluminum studs in the vacuum chamber for evaluation under SEM. Results showed that there is no visible defect of samples in 90% aloe vera group and control group as per examiner 1 and 2. There is a significant difference in the distribution of defects in the samples among the groups as per examiner 1 and 2. In. In Neem leaf extract group, 100% of samples and 66.7% samples had corrosion and debris as per examiner 1 and 2 respectively. A kappa value of 0.72 was observed between the two examiners indicating good agreement between them and this agreement is found to be statistically highly significant.

NaOCL is an agent with a wide spectrum of antimicrobial action and tissue dissolution capacity, which is also used as a presoaking solution in cleaning procedures of endodontic instruments after clinical use. Our results are in accordance with the study of **Fayyad et al.**<sup>24</sup> who evaluated the alterations on the surface of NiTi files by using atomic force microscope (AFM) and reported that NaOCl caused deteriorations. NaOCl is corrosive to metals involving the selective removal of nickel from the surface creating micro pitting. Microstructural defects can lead to areas of stress concentration and crack formation, weakening the structure of the instrument.

Tea tree extract, containing antioxidant constituents  $\alpha$ -terpineol, terpinen-4-ol, and  $\alpha$ -terpinene, has a wide range of applications in the cosmetic, food, and pharmaceutical industries. It was selected in our study due to its availability, economical price, and good antioxidant properties.<sup>25</sup>

Tea tree oil extract exhibited destructive surface characteristics on the one-curve rotary files which accounts for the highest number of defects. Literature suggested that the *Neem (Azadirachta indica)* leaf extract has a significant antimicrobial effect against *E. faecalis* derived from infected root canal samples. The extract was found to be efficacious compared with 2% sodium hypochlorite.<sup>26</sup>

**Vinothkumar et al**<sup>27</sup> et al found that neem was highly efficient to 5.25% NaOCl in decreasing microbes like *Enterococcus faecalis* and *Candida albicans* within the root canals compared to other extracts.

Limitations of our study:

1. The study was done invitro.
2. Different conditions effect during cleaning and shaping during the procedure on the patient.

## V. Conclusion

Within, the limitations of the study, V group with One curve NiTi files exhibited least surface alterations. Hence, AV can be used as safe and alternative to the routinely used chemical irrigants during RCT.

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