

## Original Research

### In Vitro Action of Various Root Canal Irrigants on Microhardness and Surface Roughness of Root Canal Dentin: A Comparative Study

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#### ABSTRACT:

**Context:** To assess and compare the effect of irrigating solutions on the micro hardness and roughness of the root canal dentin of permanent teeth. **Materials and Methods:** 54 specimens were obtained by decoronating single rooted teeth at cemento enamel junction and separating each root longitudinally using a high- speed diamond disc under water cooling. A plastic ring was taken and auto- polymerizing acrylic resin was put inside the ring. The specimens were embedded in auto-polymerizing acrylic resin, leaving the polished dentin surface exposed. Specimens were divided into three groups and immersed in plastic jar containing irrigating solutions. The groups were 3% sodium hypochlorite, guava leaf extract and distilled water. Surface roughness and microhardness values were evaluated after remineralization procedure. **Result:** The comparison of mean values of surface roughness and microhardness of root canal dentin after immersion in irrigating solutions, showed an increase in surface roughness and a decrease in microhardness values. The inter group comparison of changes with respect to surface roughness showed that 3% sodium hypochlorite showed more reduction in microhardness and increase in surface roughness. **Conclusion:** In accordance to the results of the present study and support from the literature, the study concluded that guava leaf extract can be advocated as a root canal irrigant due to its harmless effect on microhardness and surface roughness of root canal dentin.

**Keywords:** Irrigating Solutions, Microhardness, Roughness. Sodium Hypochlorite

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#### INTRODUCTION

The success of any endodontic procedure depends on various factors like case selection, chemomechanical preparation with precise instrumentation application of effective irrigating solution. The objective is to obtain trinomial: cleaning, shaping and disinfection of root canal for filling of canal. Anatomical complexities like varied shapes, narrow fins, isthmus,

lateral extensions, and microbiological factors often pose serious threats to adequate root canal disinfection.<sup>1</sup> It is a prerequisite to use endodontic irrigants in addition to mechanical preparation in order to ensure the success of root canal treatment.<sup>2</sup> Irrigation is fundamental not only in mechanical shaping but also aids in removal of microorganisms, tissue fragments, dentinal debris via flushing action.

Sodium hypochlorite solution ranging from 0.5% to 5.25% has been recommended for use in endodontics. It has been used as an irrigant in endodontics for many years. Sodium hypochlorite of concentration 0.5% and greater than that will effectively remove organic component of the dentin and changes their components.<sup>1</sup> Sodium hypochlorite (NaOCl) is the gold standard in root canal irrigation. The irrigant is well known for its antibacterial property and tissue dissolving capacity.<sup>2</sup> The actions and the toxicity of NaOCl are dose-dependent.<sup>3</sup> 5.25% NaOCl has better effectiveness in dissolving organic tissue, greater antibacterial action, more alkaline pH, and shorter effectiveness time. But in contrast it is more irritating to the periapical tissues, making its use undesirable. 2.5% NaOCl is less cytotoxic, being more indicated for root canals endodontic treatment.<sup>4</sup> The natural plant products such as Neem, babool and miswak, etc have been proven to be the most effective biologically active compounds that are used in traditional practices to maintain oral hygiene. Considering the increasing resistance of many pathogens to commonly used antibiotics has led to the development of antimicrobial compounds derived from herbs. The use of the herbal plants as a traditional medicine to maintain oral health is common in developed countries. Leaves of *Psidium guajava* are used in USA as an antibiotic in the form of poultice or decoction for wounds, ulcers, and toothache.<sup>5</sup> *Psidium guajava* is a phytotherapeutic plant commonly known as Guava. It belongs to the Family Myrtaceae species. The leaves of the plant *P. guajava* are reported to possess antioxidant, hepatoprotective, anti-allergy, antimicrobial, antigenotoxic, antiplasmodial, cytotoxic, antispasmodic, cardioactive, anti-cough, antidiabetic, anti-inflammatory and antinociceptive activities. Considering the antimicrobial and antioxidant effect of Guava leaf extract, it can be used as an effective root canal irrigant.<sup>6</sup> Irrigating solutions clean the dentin surface, and may interfere with the chemical structure of dentin, changing the calcium/phosphorus (Ca/P) ratio of the surface.<sup>7</sup> These alterations can increase the surface roughness which may affect the sealing ability and adhesion of root canal sealers to dentin and alter

the nature of adhesion. Studies on modes of action and efficiency of various chemical irrigating solutions have shown their direct effect on both organic and inorganic components of root canal dentin. In turn, the mechanical, chemical, and physical properties of dentin structure changes. It has been noted that microhardness and roughness are sensitive to composition and surface changes of tooth structures.<sup>7</sup> Hence, this study was designed to evaluate the effect of widely used irrigating solutions on micro hardness and surface roughness of root canal dentin.

## MATERIALS AND METHODS

### Sample Selection

Fifty-four non carious, non hypoplastic extracted human intact permanent single rooted teeth were selected and stored at 37°C in buffered saline.

### Specimen Preparation

The crowns of the teeth were decoronated at cemento enamel junction (CEJ) using a high-speed diamond point under water-cooling. Then, each root was separated longitudinally using a diamond disc under water-cooling. Thus, specimens were obtained. These specimens were then examined to eliminate the teeth with cracks and other specimens were added to compensate for them. The specimens were then ground- polished with water cooled carborundum disc. Final polishing was carried out in felt cloth and buff by using 0.05 µm size aluminium oxide powder mixed with distilled water. A plastic ring was taken and auto-polymerizing acrylic resin was put inside the ring. The specimens were embedded in auto-polymerizing acrylic resin, leaving the polished dentin surface exposed. After curing of the resin, the ring was removed and re-polishing of specimens was done. A total of 54 specimens were then divided into three groups with 18 specimens in each group according to the irrigating solutions used. Exposed dentin surfaces were immersed in plastic jar containing irrigating solutions. (Fig 1)

Group 1: 5 ml, 3% NaOCl for 15 min.

Group 2: 5 ml, Guava leaf extract for 15 min.

Group 3: 5 ml, Distilled water for 15 min (control).



**Figure 1: Specimens immersed in solutions**

At the end of active treatment period (15 min), the samples were rinsed with distilled water and dried. Every group was then divided into two subgroups. Subgroups 1a, 2a, 3a were used to determine the

micro hardness of root dentin using Vickers hardness tester. And subgroups 1b, 2b, 3b were used to determine the surface roughness of root dentin using the surface profilometer.



**Figure 2: Microhardness testing**



**Figure 3: Surface roughness testing**

### **Microhardness Testing**

The specimens were mounted on stage of Vickers microhardness tester. The mid- root portion was halfway from the outer surfaces was focused for testing. Indentations were made with Vickers diamond indenter using 100 gm load with a dwell time of 10 seconds. These indentations were measured and converted into Vickers hardness number (VHN) values by the monitor. (Fig 2)

### **Surface Roughness Testing**

The specimens were placed on the flat table surface profilometer. The machine was then made to record the surface roughness values of root dentin. (Fig 3)

### **Statistical Analysis**

Data was analysed using IBM, SPSS (Statistical Package for Social Sciences, IBM Co., Armonk, NY, USA) version 26 statistical software. Descriptive statistics was used to summarize the data. Normality of data was checked using Shapiro wilk test. For comparison of materials based on micro hardness

and surface roughness, One way Analysis of variance (ANOVA) test was applied with appropriate post hoc tests. Statistical significance was inferred at  $p \leq 0.05$ .

### **RESULTS**

Table 1 and graph 1 show the mean average values of microhardness of each group after treatment with the irrigating solutions. Group 1 (3% sodium hypochlorite) showed the least mean value of microhardness (46.5). The mean value of microhardness for guava leaf extract (group 2) was 53.92 and for distilled water (group 3) was 58.5. The values showed that there was decrease in microhardness after treatment with both 3% sodium hypochlorite and guava leaf extract compared to the control group. Table 2 and graph 2 show the mean average values of surface roughness of each group after treatment with the irrigating solutions. The mean value of surface roughness for group 1 was 0.76. Group 2 (guava leaf extract) showed a mean value of 0.53 for surface roughness compared to the control group (distilled water) with a mean

value of 0.43. These values indicate that there is an increase in surface roughness of root canal dentin when treated with the irrigating solutions used in this study. When group 1 and group 2 were compared,

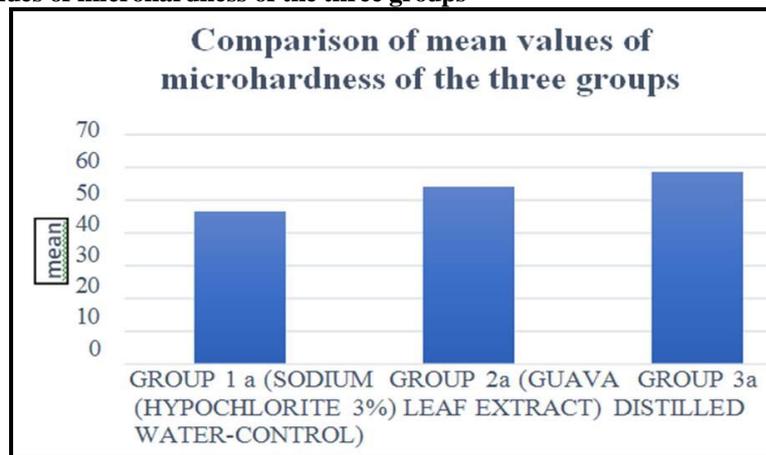
sodium hypochlorite showed superior increase in surface roughness. The difference was statistically significant.

**Table 1: Comparison of mean values of microhardness of the three groups**

	Mean	Std. Deviation	95% Confidence Interval for Mean		P value
			Lower Bound	Upper Bound	
Group 1	46.50	2.22	44.79	48.21	0.001*
Group 2	53.92	1.28	53.00	54.98	
Group 3	58.50	1.20	57.58	59.43	

One way ANOVA: p< 0.05 statistically significant

**Graph 1: Mean values of microhardness of the three groups**

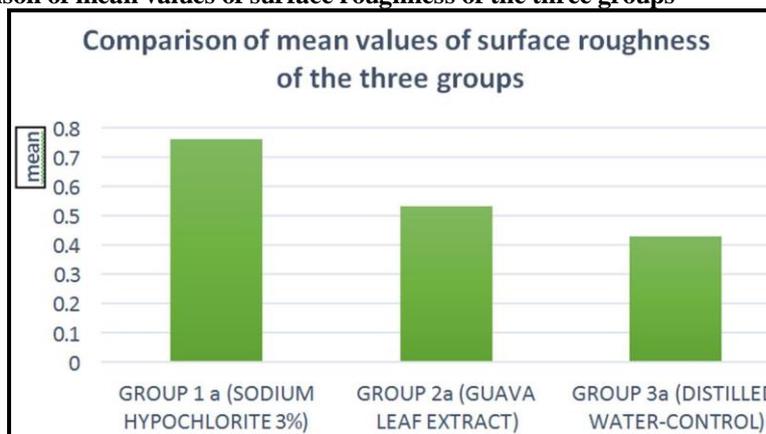


**Table 2: Comparison of mean values of surface roughness of the three groups**

	Mean	Std. Deviation	95% Confidence Interval for Mean		P value
			Lower Bound	Upper Bound	
Group 1	0.76	0.101	0.68	0.84	0.001*
Group 2	0.53	0.031	0.51	0.56	
Group 3	0.43	0.024	0.41	0.45	

One way ANOVA: p< 0.05 statistically significant

**Graph 2: Comparison of mean values of surface roughness of the three groups**



**DISCUSSION**

Preventing or curing infection in the root canal is the aim of endodontic therapy. Every root canal system has areas that require careful chemomechanical debridement of pulpal tissue, dentin debris, and pathogenic microbes because they cannot be cleaned

mechanically.<sup>8</sup> The path to success for the clinician is a well-maintained root canal system combined with a three-dimensional seal.<sup>9</sup> It is a difficult task to remove bacteria from diseased root canals. If infection is successfully eliminated prior to the root canal obturation, there is a far greater likelihood of a

successful outcome with root canal therapy. However, the presence of microorganisms during of obturation or after it may lead to failure of treatment.<sup>1</sup> For easy removal of bacteria and pulp tissue, irrigation acts as an excellent adjuvant. This study was conducted to evaluate and compare the effect of 3% NaOCl and guava leaf extract on surface roughness and microhardness of root canal dentin. Distilled water was used as a control. In the present study single rooted teeth were selected. Selecting single rooted teeth helped in easy separation to get longitudinal sections with exposed root dentin surfaces.<sup>7</sup> The longitudinal sections of teeth were embedded in acrylic resin to have a proper base and support for testing which ensured a reproducible and unbiased experimental design resembling clinical situation more accurately. The sections were cut under water-cooling to prevent desiccation of teeth while sectioning. The sections were ground polished to have even and polished surfaces for microhardness and roughness testing.<sup>7</sup> In this study, the endodontic irrigating solutions were used on root canal dentin surface for 15 min, to obtain optimum results.<sup>10</sup> Pashley et al (2001) reported that the microhardness of dentin declined when tested from superficial to deep regions. The increased number of widely opened dentin tubules free of peritubular dentin near the pulp offered little resistance to the microhardness testing indenter. He also found that in the midroot region dentin surface of root was uniform and it could minimize the effect of the structural variations of different teeth and establish a reasonable baseline for evaluation. So, in this study midroot region was used for testing, approximately halfway between the central lumen and root cementum.<sup>11</sup> According to Pashley et al (2001), dentin microhardness depends on the amount of calcified matrix per mm<sup>2</sup>. Determination of microhardness provides indirect evidence of mineral loss or gain in the dental hard tissues. The microhardness measurement was one of the simplest non-destructive mechanical characterization methods. Previous investigations have shown the suitability and practicality of Vickers (VHN) microhardness test for evaluating surface changes of dental hard tissues treated with chemical agents.<sup>11</sup> It is also less susceptible to surface conditions and provides more accurate measurements.<sup>2</sup> Distilled water was the most commonly used irrigating solution before 1940, as it was chemically inactive, readily available, and inexpensive. It also provided a lubricating effect during instrumentation and removed the debris.<sup>12</sup> It was used as control because it does not interfere with dentin microhardness and surface.<sup>13</sup> The disadvantage of distilled water is that it lacks antibacterial properties and does not significantly reduce the bacterial load.<sup>12</sup> Sodium hypochlorite (NaOCl) has a long history of usage in dentistry and medicine and is still widely used today. NaOCl is an effective organic solvent that degrades dentin by dissolving collagen through the disintegration of carbon-atom bonds and

disrupting the main structure of the proteic acid. The loss of collagen fibrils from the dentin surface by NaOCl may be the reason of the decrease in binding strength observed between adhesive systems and dentin walls, and prevention of the development of a stable hybrid layer.<sup>14</sup> The use of herbal plant extracts for the eradication of microbes has been the topic of interest due to the drawbacks of chemical irrigants and due to their therapeutic properties and biocompatibility. Biswas et al (2013) concluded from their study that the flavonoids such as mosin glycosides, quercetin, and quercetin glycosides may have contributed to antibacterial action of guava leaf extracts.<sup>5</sup> The results of the present study indicated that both 3% sodium hypochlorite and guava leaf extract decreased microhardness of root canal dentin significantly when compared with control group (P<0.05). In this study both the microhardness and surface roughness mean changes were statistically significant. Among the irrigating solutions, mean value for surface roughness was highest for sodium hypochlorite (3%) while for microhardness the value was higher for guava leaf extract. A deficiency of the study is the absence of baseline values in the experimental methods. Instead, a negative control group was utilized where all specimens were immersed in distilled water. In vitro studies give immediate result and are relatively cheap, simple to procure and efficient. The in vitro experimental design and simulated time of exposure are the limitations of this study. This study showed the possibility to make use of large amount of the irrigating solutions in close contact with flat dentin surface. In clinical situations this may not be the case as root canal system has complex morphology. Hence, more questions require to be answered as to the extent to which these chemical alterations may affect the adhesion of sealers to the treated surfaces. Therefore, the effect of various concentrations and application time on dentin microhardness and roughness can be further evaluated.

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