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Research Paper

Effectiveness of Various Endodontic Irrigants on the Micro-Hardness of the Root Canal Dentin: An In Vitro Study

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ABSTRACT
The aim of this study was to determine the impact of irrigating solutions on the root canal dentin micro-hardness. The greatest reduction was induced by EDTA, followed by Chitosan nanoparticles, Sodium hypochlorite and Silver Nanoparticle
KEYWORDS: *Dentin microhardness, EDTA, Chitosan, NaOCl, Silver, Nanoparticles, Irrigants*

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I. INTRODUCTION

Root canal instrumentation comprises of the combined action of endodontic instruments and irrigating solutions which is aimed at the elimination of pre-existing organic and inorganic debris resulting from the operative procedures as well as the reduction of the microbial content and it's by products [1]. Irrigating solutions used during endodontic treatment may lead to alterations in the chemical structure which may in turn affect the mechanical properties of dentin[1].

The most commonly used endodontic irrigant is 0.5% to 6.25% sodium hypochlorite solution (NaOCl). It is an antibacterial agent capable of dissolving vital and necrotic organic tissue, as well as the organic component of the smear layer. Sodium hypochlorite fragments long peptide chains and chlorinates protein terminal groups, resulting in N-chloramines that are further broken down into other species. The degradation of the organic components by NaOCl solutions can alter adversely dentinal biomechanics by significantly decreasing its elastic modulus and flexural strength [2]

Ethylenediaminetetraacetic acid (EDTA) is often utilized in the clinic as the final irrigation solution because of its ability to react with calcium ions in dentin forming calcium chelation, thereby dissolving the inorganic tissues from smear layers [3]. However, prolonged exposure of EDTA may alter the structural characteristic of dentin resulting in compromised mechanical integrity and erosion. [3]

Chitosan which is an animal product is used for smear layer removal. Its mechanism of action is not yet clear, but it is thought that adsorption, ionic exchange and chelation property may be responsible for formation of the complex between substance and metallic ions. [7]

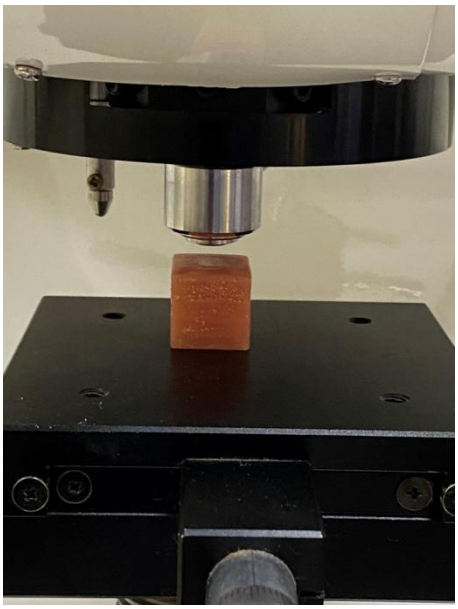
Silver nanoparticle dispersion is known to be biocompatible and non-cytotoxic. While antibacterial efficacy has been proven, there are limited studies on mechanical properties on dentin.[8]

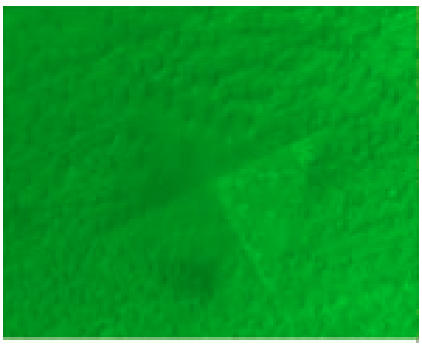
Thus the purpose of this study is to evaluate the effectiveness of endodontic irrigants on the microhardness of dentin.

II. MATERIALS AND METHODS

32 single rooted premolars were selected for the study. The selected samples were decoronated at the level of cemento-enamel junction with the help of a water cooled diamond impregnated disc.For longitudinal sectioning, grooves were created on the buccal and lingual external surface of roots without penetrating into the canals using a double faced diamond disc under water cooling, and with the help of chisel, the roots were split

into two halves. All the samples were polished with water cooled carborandum disc and finally polished with felt disc .Freshly mixed auto polymerized resin was poured in moulds of uniform diameter. The specimens were embedded on the resin with the polished surface facing outwards. After curing of resin, the moulds were removed and re-polishing of specimens were performed to remove excess material present on the tooth surface .All the samples were individually mounted on the stage of Vicker's micro-hardness tester and indentations were marked with a Vicker's diamond indenter at 200g load with dwell time of 15 s to obtain baseline data.





After obtaining the baseline Vicker's Hardness Number (VHN) results of all the eighty specimens, were divided into groups of 8 samples each. The specimens in these groups were immersed in the respective irrigating solutions for 5 minutes. At the end of the active treatment period of 5 minutes, the samples were rinsed with distilled water and dried. The samples were again mounted on the stage of Vicker's micro hardness tester and for each sample indentations were marked at three different locations with a Vicker's diamond indenter. All the indentations were marked in the middle region of the roots. These indentations were measured and converted into VHN values.

STATISTICAL ANALYSIS

The microhardness is summarised using mean and standard deviation

One way ANOVA is used to compare the mean microhardness in 4 groups. Tukey test is used for comparison.

III. RESULTS

Paired t test

Group		Mean(standard deviation)	Test statistic	p value	95% confidence interval	
					Lower	Upper
NaOCI	Before	47.62(5.54)	3.468	0.01	2.525	13.349
	After	39.68(4.45)				
EDTA	Before	41.62(7.90)	4.412	0.003	5.185	17.164
	After	30.45(5.09)				
AgNp	Before	46.7(4.19)	2.11	0.073	-0.581	10.206

	After	41.88(7.09)				
CNP	Before	43.4(9.06)	3.592	0.009	2.199	10.675
	After	36.96(6.48)				

There is a significant difference between before NaOCI and after NaOCI.
There is a significant difference between before EDTA and after EDTA.
There is a significant difference between before CNP and after CNP.

Kruskal-wallis test

Groups(After)	Median	IQR	Mean rank	Kruskal value	p value
NaOCI	43.6	12.18	15.56	0.934	0.817
EDTA	45.2	8.82	14.44		
AgNp	45.4	8.65	18.56		
CNP	44.1	13.1	17.44		

There is no significant difference between the groups.

IV. DISCUSSION

The long-term prognosis of endodontic treatment depends on the quality of the instrumentation, disinfection and obturation of the root canal system. During irrigation, both coronal and root dentin are affected by irrigation solutions, what may have an impact on the physical and chemical properties including the dentin microstructure. Ideal irrigation solution should remove both the organic and inorganic parts in all thirds of the canal without damaging the dentine [9]. In this study, root canal dentin was not pretreated with instruments and NaOCl trying to avoid decrease in micro-hardness or causing the erosion because the purpose of research was to evaluate the effect on dentin of final irrigation solutions

Widely used Vickers hardness test was chosen in this study because of its ability to assess the changes in human hard tissue due to chemical exposure [10,11]. This test could be used with all materials and test specimens as the procedure covers the entire hardness range and ensures indentation very clear and easy measure

Micro-hardness of the dentin differs depending on the tooth area and number of tubules [12]. In order to obtain the most accurate results, in previous studies, dentin micro-hardness was measured before and after the use of irrigation solutions [13].

When using EDTA, the recommended time for removing the smear layer is 1 min [14]. In this study, the dentin surface had been irrigated by 17% EDTA for 5 min what significantly reduced the dentin micro-hardness. This result is in agreement with other studies by Baldasso et al. 2017, Patil et al. 2011, Dineshkumar et al. 2012. Calt et al. 2002 concluded, that EDTA solution should be applied for a maximum of 1 min. to avoid dentin erosion and found out that EDTA produces erosive effect in both peritubular and intertubular dentine, if exposition time is longer than 10 min. However, in most of the previous studies, EDTA was used longer than one minute, usually 3-5 min. or even 15 min., making the changes of dentin hardness more obvious . Saha et al. (2017) used EDTA 17% for 15 min., resulting in very significant micro-hardness change ranging from 56.88 ± 1.48 VHN to 43.12 ± 2.51 VHN.

Sodium hypochlorite is associated with a significant decrease in micro-hardness in in vitro studies). In other study was found that EDTA significantly reduced dentin micro-hardness and caused erosion when the final irrigation with 2.5% NaOCl was performed

The chitosan chelating effect to root canal dentin may be described in three phases: adsorption mechanism, ion exchange, and chelation.28 Hydrophilic characteristics of chitosan cause this solution to be absorbed rapidly to the root surface wall; hence, ionic contact between calcium in dentin and chelating agent may occur.29 The 0.5% chitosan nanoparticles with a contact time of 1 minute and 3 minutes produce the same effect on the microhardness and surface roughness. This probably indicates that chitosan is a weak chelating agent, consequently affecting a smaller amount of the root canal dentin surface compared to EDTA.

AgNP solution has obvious impact on physiochemical properties of dentin by decreasing its surface wettability. However, it may not bring better penetration inside dentinal tubules due to its higher surface tension.

V. CONCLUSION

Within the limitations of the current study it can be concluded that using endodontic irrigants significantly reduced the rootdentine's micro-hardness

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