Biomedical & Pharmacology Journal, December 2018. Vol. **11**(4), p. 2157-2162

Effect of Final Irrigation Protocol on Dentin Microhardness

Farah Salahalden Abbas, Nadeen Jamal Abdulredah and Amer Salman Hassan

Department of Conservative Dentistry, Al MustansiriyahDental College, Baghdad, Iraq.
*Coressponding author E-mail: haneenmustafa292@ yahoo.com

http://dx.doi.org/10.13005/bpj/1596

(Received: 04 September 2018; accepted: 01 November 2018)

Endodontic therapy is essentially a debridement procedure that requires the removal of the irritants of the canal and periapical tissue if success is to be gained. The debridement may include instrumentation of the canal, placement of medicament and irrigants. Complete cleaning of the root-canal system requires the use of irrigants that dissolve organic and inorganic material. The study aimed to evaluate changes in dentin microhardness after canal irrigation with different solutions. Twenty four freshly extracted human mandibular molars (distal roots with single canals) were used. 10mm root length was taken as standard length. The roots were embedded into auto polymerizing acrylic resin using plastic molds before the canals preparation and micro hardness test. The distal roots were prepared with one shape rotary file. Before the preparation each root was irrigated with 1ml distilled water. Then the roots were divided into four groups according to the final irrigation protocol: Group A: NaOCl 2.5%, Group B: EDTA 17%, Group C: Citric Acid 40%, Group D: Distilled Water. For (Vickermicrohardness test) the same load and time 500 g test load for 20 seconds, will be conducted three times at distance 0.5mm from canal lumen ; thus there will be 9 indentations on each specimen surface. An average of the three readings for each test condition will be recorded as the VHN value of a specimen. Comparing all four groups statistically there was no significant difference among them. The mean values were found more reduced in EDTA group followed by NaOCL group, and then Control and Citric Acid groups. All the groups showed reduction in dentin microhardness. EDTA group showed the maximum reduction followed by NaOCL group, and least with Citric Acid group.

Keywords: Microhardness; irrigation; EDTA; Citric acid; Vicker test.

Endodontic therapy is essentially a debridement procedure that requires the removal of the irritants of the canal and periapical tissue if success is to be gained. The debridement may be carried out in various ways as the case demands and may include instrumentation of the canal, placement of medicament and irrigants[1]. The main goal of instrumentation is to facilitate effective irrigation, disinfection, and filling. Several studies using advanced techniques such as microcomputed tomography (CT) scanning have demonstrated that proportionally large areas of the main root-canal wall remain untouched by the instruments,1 emphasizing the importance of chemical means of cleaning and disinfecting all areas of the root canal[2].

Microhardness defined as the resistance to local deformation and it tests based on the induced permanent surface deformation that remains after removal of load. Any change in the microhardness

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of the root dentin may adversely affect sealing ability and adhesion of dental material such as resin cements and root canal sealers to dentin.

Microhardness tests are commonly used to study the physical properties of materials, and they are widely used to measure the hardness of teeth[3,4,5]. This method is easy, quick, and requires only a tiny area of specimen surface for testing. Using this technique, the specimen surfaces were impressed with a diamond indenter (a Knoop or a Vickers) at a certain load for a certain period of time. After load removal, diagonals of the indentation were measured with an optical microscope. The hardness number was defined by the ratio between the indentation load and the area of the residual impression, which depended on the indenter shape.

There is no single irrigating solution that alone sufficiently covers all of the functions required from an irrigant. Optimal irrigation is based on the combined use of 2 or several irrigating solutions. Complete cleaning of the root-canal system requires the use of irrigants that dissolve organic and inorganic material[2].

Sodium hypochlorite is the most popular irrigating solution and is commonly used in concentrations between 0.5% and 6%. It is a potentantimicrobial agent, killing most bacteria instantly on direct contact. It also effectivelydissolves pulpal remnants and collagen, the main organic components of dentin.Although hypochlorite alone does not remove thesmear layer, it affects the organic part of the smear layer, making its complete removalpossible by subsequent irrigation with EDTA or citric acid.Thepresence ofinactivating substances such as exudate from the periapical area, pulp tissue, dentincollagen, and microbial biomass counteract the effectiveness of NaOCl[6].

As hypochlorite is active only against the organic matter, other substances must be used to complete the removal of the smear layer and dentin debris. EDTA and Citric Acid effectively dissolve inorganic material, including hydroxyapatite[7,8] they have little or no effect on organic tissue and alone they do not have antibacterial activity.

Aim of the study

The study aimed to evaluate changes in dentin microhardness after canal irrigation with different solutions.

MATERIAL AND METHODS

Sample selection

Twenty four freshly extracted human mandibular molars (distal roots with single canals) were used.

Selection criteria

1. Straight roots with single canals.
2. Free from caries and cracks.
3. Centered apical foramen.
4. Roots without resorption.
5. Roots length 11mm.

Sample preparation

The teeth were cleaned of all debris and stored in distilled water till the time of preparation. Teeth were sectioned transversely at cemento-enamel junction using diamond disc operated by low speed hand piece under continuous water coolant. Remnant of pulp tissue were removed by barbed broaches, thenthe patency of the canals were determined with S.S. k-file size 10,15 until it was visible at apical foramen and the working length were established 10mm.The roots were embedded intoauto polymerizing acrylic resin using plastic molds before the canals preparation and micro hardness test.

Root canal preparation

The distal roots were prepared with one shape rotary file operated by x-smart micro motor at speed 350-450 r.p.m., torque 1.5 N/cm, gear ratio 16:1. Before the preparation each root was irrigated with 1ml distilled water and one shape rotary file was operated in the canal not more than 1 minute, then the specimens were irrigated with 5 ml of each test solution to receive the final irrigation according to the sample grouping.

Sample grouping

The roots were divided into four groups according to the final irrigation protocol:

1. Group A: 6 roots were irrigated with 5ml NaOCl 2.5%.
2. Group B: 6 roots were irrigated with 5ml EDTA 17%.
3. Group C: 6 roots were irrigated with 5ml Citric Acid 40%.
4. Group D: 6 roots were irrigated with 5ml Distilled Water.

MicrohardnessTest

For microhardness test the specimens were ground flat on a circular grinding machine

with ascending grades of SiC abrasive papers (400 and 1000 grit) under constant water irrigation on rotary felt disk.Then each test condition with the same load and time will be conducted three times at distance 0.5mm from canal lumen as shown in figure (1) using Vicker Micro hardness Machine as shown in figure (2); thus there will be 9 indentations on each specimen surface obtained from 500 g test load for 20 seconds. An average of the three readings for each test condition will be recorded as the VHN value of a specimen.

RESULTS

The results of Descriptive Statistics which include mean, standard deviation, standard of error, minimum and maximum for all groups are shown in Table (1).

It has shown that EDTA group has lowest mean values of dentin microhardness after final irrigation protocol. And Citric Acid group has the highest mean values of dentin microhardness.

Analysis of variance ANOVA test was performed to identify the presence of any statistically significant difference among the means of microhardness reduction for all groups Table (2).

ANOVA test revealed that there was no statistically significant difference (P Ã 0.05) among the groups.

The Least signifigant different test (LSD) was performed for multiple comparisons between groups Table (3).

The results of (LSD) test showed that there was a significant difference between NaOCL and EDTA groups and there was a significant difference between NaOCL andand control groups.

DISCUSSION

Irrigation is presently the best method for the removal of tissue remnants and dentin debris during instrumentation. Numerous solutions

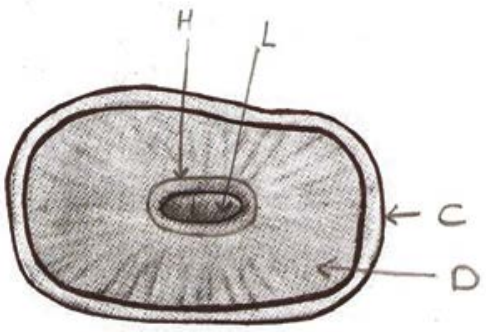

Fig. 1. Cross section of the root show the area at which the microhardness of root canal dentin measured., L: Lumen of the root can , D: Dentin, H: area which the hardness measured(0.5mm from the lumen) , C: cementum

Fig. 2. Vickers Micro hardness Machine

Table 1. Descriptive statistics

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
NaOCL	6	48.3	2.3281	0.9504	45.857	50.743	45.9	52.1
EDTA	6	43	3.2533	1.3282	39.586	46.414	40	47.3
Citric Acid	6	58.133	3.9343	1.6062	54.005	62.262	54.3	62.5
CONTROL	6	54.567	3.1379	1.2811	51.274	57.86	50.4	59.3
Total	24	51	6.6464	1.3567	48.193	53.807	40	62.5

Table 2. Analysis of variancetest (ANOVA)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	809.373	3	269.791	26.111	0
Within Groups	206.647	20	10.332		
Total	1016.02	23			

Table 3. Leastsignifigant different test (LSD)

(I) Irrigation Solution	(J) Irrigation Solution	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
NaOCL	EDTA	5.3000*	1.8558	0.01	1.429	9.171 -5.962
	Citric Acid	-9.8333*	1.8558	0	-13.705	-2.395
	CONTROL	-6.2667*	1.8558	0.003	-10.138	
EDTA	NaOCL	-5.3000*	1.8558	0.01	-9.171	-1.429
	Citric Acid	-15.1333*	1.8558	0	-19.005	-11.262
	CONTROL	-11.5667*	1.8558	0	-15.438	-7.695
Citric Acid	NaOCL EDTA	9.8333*	1.8558	0	5.962	13.705
	CONTROL	15.1333*	1.8558	0	11.262	19.005
		3.5667	1.8558	0.069	-0.305	7.438
CONTROL	NaOCL	6.2667*	1.8558	0.003	2.395	10.138
	EDTA	11.5667*	1.8558	0	7.695	15.438
	Citric Acid	-3.5667	1.8558	0.069	-7.438	0.305

have been recommended for use as root canal irrigants(1). The effect of mechanical washing, reduction of friction, and control of temperature are all important underlying reasons for irrigation; however, the most important tasks are dissolution of organic and inorganic tissue, and killing of the microbes.

The study aimed to evaluate changes in dentin microhardness after canal irrigation with different solutions; and in this study we use three of commercially available irrigating solutions. Research and clinical experiences have shown that NaOCl has several properties that contribute to effective chemomechanical debridement of a root canal system. The use of chelating agents (EDTA and Citric Acid) for final irrigation removes the smear layer and reduces dentin microhardness, which increases the access of the irrigant to dentinal tubules, allowing for proper disinfection[9].

In the present study EDTA promoted the largest reduction in dentin microhardness at 0.5 mm from canal lumen. These results are in agreement with those of several previous studies[9,10,11,12,13] in which this solution also reduced microhardness. This effect is desirable in the layer next to the canal lumen and it has been associated with increasing calcium loss, resulting in dentin demineralization and softening.

The use of 2.5% Sodium Hypochlorite as a root canal irrigation significantly reduce the microhardness of root dentin this due to organic dissolving properties of Sodium Hypochlorite on collagen component of dentin[14]. In addition to that Sodium Hypochlorite extract the Calcium ion from the dentin and decrease the calcium/ phosphorus ratio[15, 16,17]. The current study agree with the study by Slutzky-Goldberg *et al*[18], Ari *et al*[19] and Oliveira *et al*[20] who conclude that Sodium Hypochlorite significantly reduces the microhardness of root canal dentin.

In the present study Citric Acid group did not significantly change microhardness at 0.5 mm from canal lumen. The results of control group and citric acid group showed that there was no statistically significant difference between them, and these results may be related to that the teeth

have different initial physical characteristics[10,21,22] and the initial microhardness of root dentin in this study not evaluated.

The primary factors that govern the action of an irrigant are the contact time and the concentration; and in the present study we used the root canal irritant for 5 minutes in our microhardness test and this is in agreement with studies Ulusoy & Görgül[23] and Sayin*et al*[16] who use the root canal irrigants in their microhardness tests for 5 minutes, stating that this duration is more realistic in terms of clinical practice. The solutions were taken to the canal with the help of a syringe coupled to the irrigation needle, thus simulating clinical practice.

Calt&Surper[24], their study suggested that one minute application of 17% EDTA was effective to remove the smear layer. But previous studies evaluated the effect of root canal irrigants on the microhardness of the root canal dentin for five minutes[23,25]. Likewise, in the present study we use test solutions for 5 minutes.

Another determinant that has a profound effect on the post-treatment microhardness values of dentin is the concentration of the irrigating solution[25]. As the concentration of NaOCl increases, its bactericidal and smear layer removal efficacy also increases[26, 27]. Most studies showed that 17% EDTA was effective to remove the smear layer but a few reports have indicated that solutions with lower concentrations (eg, 10%, 5%, and even 1%) remove the smear layer equally well after NaOCl irrigation. Citric Acid is also marketed and used in various concentrations, ranging from 1% to 50%, with a 10% solution being the most common.

CONCLUSIONS

All the groups showed reduction in dentin microhardness. EDTA group showed the maximum reduction followed by NaOCL group, and least with Citric Acid group.

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