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A Comparative Evaluation of the Effect of Different Irrigating Solutions on the bases of Micro-hardness and Roughness of Root Canal Dentin - An *In-Vitro* Study

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Abstract

Aims:

To compare and assess the effect of irrigating solutions on the microhardness and roughness of root canal dentin in deciduous teeth.

Background and Objectives:

The success of any endodontic procedure depends on various factors like case selection, combination of proper instrumentation, irrigation, filling of the canal. Endodontic treatment is successfully accomplished by considering Chemo-mechanical preparation as one of the important factors [1].

Chemo-mechanical debridement of root canal system is achieved by use of instruments and effective irrigating solution. The objective is to obtain trinomial: cleaning, shaping and disinfection of root canal for filling of canal. During each instrumentation procedure the canals are washed and irrigated with a solution capable of disinfecting and removing the smear layer. Micro hardness defined as the resistance to local deformation and it tests based on the induced permanent surface deformation that remains after removal of load. Any changes in the micro hardness of the root dentin may adversely affect sealing ability [2].

Various irrigating solutions have been used in deciduous teeth such as 0.5% NaOCl, 2% NaOCl, H_2O_2, normal saline, chlorhexidine solution, Ozonated water. The irrigation solutions might influence the physicochemical properties of human root canal dentin including

micro-hardness, permeability, solubility, wettability and roughness. Hence this study was designed to evaluate the effect of widely used irrigating solutions on micro hardness and roughness of root canal dentin. Ozone has a very good antimicrobial efficiency. A study have concluded that Ozonated water had almost the equal antimicrobial effectiveness as 2.5% NaOCl for endodontic irrigation. They also showed low grade of toxicity against bacterial cells [3].

Methodology:

Sixty, non-carious extracted human primary incisor teeth were selected. The crowns of the teeth were sectioned and the roots were separated longitudinally to get one twenty specimens. These specimens were then divided into four groups according to the irrigating solutions used. The solutions used were 0. 5% and 2.5% NaOCl solutions, 3% H_2O_2 and Ozonated water. Every group was then divided into two subgroups of 15 each. Group 1a, 2a, 3a and 4a were used to determine the micro-hardness of root dentin. And Group 1b, 2b, 3b and 4b were used to determine the surface roughness of root dentin. The data were analyzed using ANOVA and Tukey's multiple comparison tests.

Results:

Group 1a showed changes in the micro-hardness and surface roughness with values of 42VHN followed by 2a with 46VHN, Group 3a with 45VHN and maximum changes observed in Group 4a with value of 41.5VHN. Similarly, with surface roughness of root dentin samples when treated with irrigating solutions Group 4b control group showed 0.97 Ra. Surface roughness changes was seen with Group 1b with 0.96 Ra, followed by 1.22 Ra with group 2b and changes in roughness with group 3b with 0.88 Ra.

Keywords: Irrigating Solution, Ozonated Water, Micro-Hardness, Surface Roughness, SURFCOM 130A.

Introduction

Considering the rapid progress of caries in teeth and consequently the pulp damage, the endodontic treatment is very important. This therapy promotes the removal of necrotic pulpal tissues remnants, disinfection of the root canals and dentin tubules. In this context, the cleansers become very significant to the success of the endodontic treatment [4]. Ideal Requirements of Root Canal Irrigants expected is antimicrobial property, dissolves tissue debries, aids in debridement of root canal, non-toxic to periapical tissue. In addition, the cleansers would act in the dentin of the teeth in a different mode in relation to the dentin permeability, bactericidal action and irritating potential during the endodontic instrumentation [5].

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 endodontic for many years [6]. Sodium Hypochlorite concentration 0.5%and greater than that will effectively remove organic component of the dentin and changes their component. Therefore, the micro-hardness of the root canal dentin will be changed [7].

H_2O_2 is a widely used irrigating solution for disinfection and sterilization. It is a clear, colourless liquid that is used in a variety of concentrations in dentistry, ranging from 1% to 30%. H202 acts as an oxidizing agent. H_2O_2 is active against viruses, bacteria, yeasts, and even bacterial spores [8].

Ozone has a very good antimicrobial efficiency. A study have concluded that Ozonated water had almost the equal antimicrobial effectiveness as 2.5% NaOCl for endodontic irrigation. They also showed low grade of toxicity against bacterial cells.

Ozonated water is known as a strong antimicrobial agent towards bacteria, fungi, viruses and protozoa [9]. With an antimicrobial action, use of ozone is confirmed as a new alternative of irrigating agent with antimicrobial action [10]. Ozone in the aqueous phase has advantages that are its potency, lack of mutagenicity, rapid micro-bicidal effects, ease of handling and suitability for use as a soaking solution for dental and medical devices [11]. Aqueous ozone presents no cytotoxicity and is highly biocompatible compared with other antiseptics [12]. In addition, sodium hypochlorite is not as biocompatible as ozone in the aqueous phase for human oral epithelial cells, periodontal cells and gingival fibroblast cells [13].

Micro-hardness is defined as the resistance to local deformation and it tests based on the induced permanent surface

deformation that remains after removal of load. A strong relationship exists between micro-hardness of dentine and restorative bond strength.

Therefore, the present study was undertaken to investigate to what extent the dentin of the root canal is affected by the use of various irrigating solutions.

Materials and Methods

A total of 120 specimens are then divided into four groups with 30 specimens in each group according to the irrigating solutions used. Exposed dentin surfaces are immersed in plastic jar containing irrigating solutions. Group 1: 5 ml, 0.5% N_aOCl for 15 min. Group 2: 5 ml, 2.5% N_aOCl for 15 min., Group 3: 5 ml, 3% Hydrogen peroxide for 15 min., Group 4: 5 ml, Ozonated water for 15 min.

At the end of active treatment period (15 min), the samples are rinsed with distilled water and dried. Every group is then divided into two subgroups of 15 each.

The specimens given above in group (b) are subjected to surface roughness and will be monitored through the surface roughness tester.

Determination of Micro-hardness:

The specimens were mounted on stage of Vickers micro-hardness tester (Matsuzawa – MMT 5421X, Japan). The mid-root portion is 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.

Determination of Surface Roughness:

The specimens were placed on the flat table surface of roughness tester (SURFCOM 130A) and the needle of the tester was on the mid root region of the tooth surface. The machine was then made to record the surface roughness values of root dentin by travelling on the Surface along the length. The values were displayed digitally on the screen of the roughness tester. These values were expressed as Ra (μm). The Ra parameter describes the overall roughness of the surface and is defined as the arithmetical average value of all absolute distances of the roughness profile from the centre line within the measuring length.

Results

Sixty extracted human primary anterior teeth with four different irrigating solutions were tested on root dentin samples. The solutions used were 0.5% and 2.5% NaOCl solutions, 3% H_2O_2 and Ozonated water. Then, the specimens were subjected to micro-hardness and roughness testing [14].

The Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance [15].

Table - 1: Micro-Hardness values of 15 samples treated by 0.5% NaOCl (1a)

Specimens in 0.5% NaOCl	Hardness Values (VHN)
1	42
2	41
3	42
4	42
5	43
6	41
7	43
8	42
9	41
10	41
11	42
12	41
13	42
14	43
15	42
Average	**42**

Table-1: Shows the values of the Micro-hardness for 15 samples treated with 0.5% NaOCl solution. The average value calculated is 46.27.

Table-2: Micro-Hardness values of 15 samples treated by 2.5% NaOCl (2a)

Specimens in 2.5% NaOCl	Hardness Values (VHN)
1	45
2	45
3	46
4	46
5	46
6	45
7	47
8	47
9	45
10	46
11	46
12	45
13	46
14	46
15	47
Average	**46**

Table-2: Shows the values of the Micro-hardness for 15 samples treated with 2.5% NaOCl solution. The average value calculated is 41.2.

Table-3: Micro-Hardness values of 15 samples treated by 3% H_2O_2 (3a)

Specimens in 2.5% NaOCl	Hardness Values (VHN)
1	45
2	45
3	45
4	46
5	47
6	45
7	45
8	45
9	45
10	46
11	45
12	45
13	46
14	45
15	45
Average	**45**

Table-3: shows the values of the Micro-hardness for 15 samples treated with 3% H_2O_2 solution. The average value calculated is 46.2.

Table-4: Micro-Hardness values of 15 samples treated by 3% H_2O_2 (3a)

Specimens in 2.5% NaOCl	Hardness Values (VHN)
1	42
2	43
3	42
4	42
5	41
6	42
7	41
8	42
9	42
10	41
11	42
12	41
13	42
14	41
15	42

Average	41.5

Table-4: shows the values of the Micro-hardness for 15 samples treated with Distilled water. The average value calculated is 53.

Table-5: Mean of micro-hardness values in VHN of all groups by ANOVA test.

	0.5% NaOCl 1a	2.5% NaOCl 2a	3% H_2O_2 3a	Ozonated water 4a	P Value
Micro hardness	42	46	45	41.5	0.001

Surface Roughness Tables

Table-6: Surface roughness values of 15 samples treated by 0.5% NaOCl (1b)

Specimens in 0.5% NaOCl	Surface roughness Values
1	0.97
2	0.98
3	0.96
4	0.98
5	0.97
6	0.97
7	0.96
8	0.96
9	0.94
10	0.97
11	0.97
12	0.98
13	0.97
14	0.97
15	0.96
Average	**0.96**

Table-6: Show the values of the surface roughness for 15 samples treated with 0.5% NaOCl solution. The average value calculated is 0.970.

Table-7: Surface roughness values of 15 samples treated by 2.5% NaOCl (2b)

Specimens in 0.5% NaOCl	Surface roughness Values
1	1.09
2	1.23
3	1.02
4	1.23
5	0.98
6	1.24
7	1.24
8	1.24
9	1.23
10	1.23
11	1.24
12	1.22
13	1.24
14	1.23
15	1.24
Average	**1.22**

Table-7: Show the values of the surface roughness for 15 samples treated with 2.5% NaOCl solution. The average value calculated is 1.281.

Table-8: Surface roughness values of 15 samples treated by 3% H_2O_2 (3b)

Specimens in 3% H_2O_2 (3b)	Surface roughness Values
1	0.89
2	0.91
3	0.88
4	0.87

5	0.87
6	0.89
7	0.87
8	0.89
9	0.88
10	0.89
11	0.87
12	0.88
13	0.89
14	0.88
15	0.87
Average	**0.88**

Table-8: Show the values of the surface roughness for 15 samples treated with 3% H_2O_2 solution. The average value calculated is 1.030.

Table-9: Surface roughness values of 15 samples treated by Ozonated water (4b)

Specimens in Ozonated Water	Surface roughness Values
1	0.98
2	0.97
3	0.97
4	0.89
5	0.97
6	0.97
7	0.96
8	0.98
9	0.98
10	0.97
11	0.98
12	0.97
13	0.97
14	0.97
15	0.98
Average	**0.974**

Table-9: Show the values of the surface roughness for 15 samples treated with Ozonated water. The average value calculated is 0.738.

Table-10: Mean of Surface Roughness values in Ra of all groups by ANOVA test.

	0.5% NaOCl 1a	2.5% NaOCl 2a	3% H_2O_2 3a	Ozonated water 4a	P Value
Surface Roughness	0.96	1.22	0.88	0.974	0.001

Discussion

A clean root canal system along with a three-dimensional seal is the clinician's path to success. The main goal in root canal treatment is to eliminate infection and substrate from the root canal system and to prevent its recurrence16. Pulp therapy has been suggested since 1932 as a method for maintaining primary teeth, which would otherwise lead to removal of tooth.

Sodium hypochlorite (NaOCl) is the most frequently recommended and a commonly used endodontic irrigant. Its advantages are two-fold; pulpal dissolution and antimicrobial effect. It is available in different concentration ranging from 0.5% to 5.25% [17].

Hydrogen peroxide (H_2O_2) is a colourless liquid and has been used in dentistry in concentrations varying from 1% to 30%. H_2O_2 degrades to form water and oxygen. It is active against viruses, bacteria, bacterial spores and yeasts via the production of hydroxyl free radicals which attack proteins and DNA.

Ozone works best when there is less organic debris remaining. Therefore, the recommendation is to use either Ozonated water or ozone gas at the end of the cleaning and shaping process. It is advised to use any conventional Irrigants during the earlier phase and finally irrigate with Ozonated water using ultrasonic and also Ozonated oil as a medicament.

Oliveira et al. stated that the use of 1% NaOCl for 15 min

was sufficient to reduce dentin micro-hardness in permanent root dentin [18].

Studies showed that NaOCl reduced modulus of elasticity and flexural strength of dentin. NaOCl with PH of 7.4−11.5 a weak alkaline caused 70% protein description from the hydroxyapatite surfaces [19].

Chang found VHN of the dentine at the CEJ to be approximately 58, [20]. found the VHN to vary between 37.72 and 51.64 [21] found the VHN value for root dentine to be 50 at 500um and 55 at 1 mm distance from the root canal lumen.

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 [16].

Conclusion

Within the limits of the present in vitro study we conclude the following:

1. Ozonated water showed the maximum reduction in micro-hardness when compared 2.5% NaOCl, 3%H_2O_2 and 0.5% NaOCl.
2. There was a significant difference seen in the surface roughness in root dentin specimens following different irrigating solutions, maximum changes were observed in surface roughness by 2.5% NaOCl whereas minimal changes were seen from Ozonated water ,0.5% NaOCl and 3% H_2O_2.

References

1. Chetan R Patil, Veerendra Uppin, “Effect of endodontic irrigating solutions on the microhardness and roughness of root canal dentin:An in vitro study”, *Indian Journal of Dental Research*, 22 (1), (2011).

2. Wiaam MO AL-Ashou, “The Effects of Two Root Canal Irrigants and Different Instruments on Dentin Microhardness”, Al – Rafidain *Dent J* Vol. 11, No.1, (2011).

3. Hgin Akeay, Needet Erdilek, Bilge Hakan Sen. “Efficacy of an experimental single solution versus alternate use of multiple irrigants on root dentin micro hardness”. *J Clin Exp J Clin Exp Dent*. (2013); 5 (2): e83 – e88.

4. Saleh AA, Ettman WM. “Effect of endodontic irrigation solutions on micro hardness of root canal dentin”. *J Dent* (1999); 27: 43-46.

5. Barbosa SV, Safavi KE, Spanberg SW. “Influence of sodium hypo chloride on the permeability and the structure of cervical human dentin”. *International Endodontic Journal* (1994); 27: 309-312.

6. Fabiano Riberio Cirano, Giuseppe Alexandre Ramito, Jose Hildebrando Tadescan. “Determination of root dentin and cementum micro-hardness”. Brazilian Journal of Oral Science, vol.3, NO.8, Jan/Mar. (2004), pp 420-424.

7. Pashley D, Okabe A, Parham P. “The relation between dentin micro hardness and tubule density”. Endo Dent Traumatol (1985); 1: 176-179.

8. Arturo J.A. Garcia, Milton C. Kuga, Regina G. Palma-Dibb, Marcus V.R. S, Mariza A. Matsumoto3, Gisele Faria and K_atia C. Keine. “Effect of sodium hypochlorite under several formulations on root canal dentin micro-hardness”. *Journal of Investigative and Clinical Dentistry* (2013), 4, 1-4.

9. Hu X, Ling J, Gao Y. “Effects of irrigation solutions on dentin wettability and roughness”. *J Endod*. (2010) Jun; 36 (6): 1064-1067.

10. Pascon, Fernanda Miori; Kantovitz, Kamila Rosamilia; Borges, Ana FláviaSanches; Puppin- Rontani, Regina Maria “Effect of Cleansers and Irrigation Methods on Primary Root Dentin Permeability”. *Journal of Dentistry for Children*, Volume 74, Number 1, January-April (2007), pp. 30-35 (6).

11. American Academy of Pediatric Dentistry. Reference Manual (2002-2003). Guidelines for pulp therapy for primary and young permanent teeth. *Pediatr Dent* (2002); 24: 86-90.

12. Willians CECS, Reid JS, Sharkey SW, Saunders WP. “In vitro measurement of apical extruded irrigant in primary molars”. *Int EndodJ*. (1995); 28: 221-225.

13. Juliana Santos Oliveira, Walter Raucci Neto, Natalia Spadine de Faria, Fernanda Silva Fernandes, Carlos Eduardo Saraiva Miranda, Fuad Jacob Abi Rached-Junior. “Quantitative Assessment of Root Canal Roughness with Calcium-Based Hypochlorite Irrigants by 3D CLSM”. *Brazilian Dental Journal* (2014) 25 (5): 409-415.

14. Zhang K, Tay FR, Kim YK, Mitchell JK, Kim JR, Carrilho M, *et al.* “The effect of initial irrigation with two different sodium hypochlorite concentrations on the erosion of

instrumented radicular dentin". *Dent Mater* (2010); 26: 514-523.

15. Ferraz, Nayara Kelly Lyrio1; Nogueira, Lilian Capanema1; Pinheiro, Marcos Luciano "Clinical Consequences of Untreated Dental Caries and Toothache in Preschool Children" *Pediatric Dentistry*, Volume 36, Number 5, September/October (2014), pp. 389-392.

16. Cruz-Filho AM, Paula EA, Sousa-Neto "Effect of different EGTA concentrations on dentine micro-hardness". *Brazilian Dental Journal* (2002); 13: 188-190.

17. Slutzky-Goldberg I. Liberman R, Heling I. "The effect of instrumentation with two different file types, each with 2.5% NaOCI irrigation on the micro-hardness of root dentine". *Journal of Endodontics* (2002); 28: 311-312.

18. Haikel Y, Gorce F, Allemann C, Voegel JC. "*In-vitro* efficiency of endodontic irrigation solutions on protein desorption". *Int Endod J* (1994); 27: 16-20.

19. Chng HK, Palamara JE, Messer HH. "Effect of hydrogen peroxide and sodium perborate on biomechanical property of human dentin". *J Endo* (2002); 28: 62-67.

20. Pécora JD, Cruzfilho AM, Sousaneto,Silva RG. "*In-vitro* action of various bleaching agents on micro-hardnesss of dentin". *Braz Dent J* (1994); 5: 129-334.

21. Fuentes F, Toleno M, Osorio R and Carvalho R. "Micro-hardness of Deep and Superficial Sound Human Dentin". *J Bio-med Mater Res*. (2003); 66A: 850-853.