ORIGINAL RESEARCH PAPER
Volume - 12 | Issue - 06 | June - 2023 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

SILVER CITRATE: EFFECT OF A NEW CHELATING AGENT ON THE MICROHARDNESS OF ROOT DENTIN

Dentistry

Harishma S — Krishnadevaraya College of Dental Sciences and hospital, Krishnadevarayanagar, Hunasamaranhalli, Near Sir MVIT, Yelahanka, Bengaluru, Karnataka 562157.

Jayalakshmi K B — Head of the department, Professor, Krishnadevaraya College of Dental Sciences and hospital, Krishnadevarayanagar, Hunasamaranhalli, Near Sir MVIT, Yelahanka, Bengaluru, Karnataka 562157.

Sujatha I — Professor, Krishnadevaraya College of Dental Sciences and hospital, Krishnadevarayanagar, Hunasamaranhalli, Near Sir MVIT, Yelahanka, Bengaluru, Karnataka 562157.

Sowmya B — Reader, Krishnadevaraya College of Dental Sciences and hospital, Krishnadevarayanagar, Hunasamaranhalli, Near Sir MVIT, Yelahanka, Bengaluru, Karnataka 562157.

ABSTRACT

Present study was aimed to evaluate the effect of various chelating irrigants on the micro-hardness of the root canal dentin. A total of 30 extracted mandibular premolars with single canals were selected and decoronated. Samples were randomly divided into 3 groups, according to the chelating irrigants used: Group 1: EDTA 17%, Group 2: Citric Acid (CA) 10%, Group 3: Silver Citrate Solution. Then mid root portion of teeth were longitudinally sectioned into segments and then embedded in an auto-polymerizing acrylic resin. Vickers microhardness values were measured before and after treatment with 5ml of chelating agent for 1 minute. Data were analyzed using One-way ANOVA and Student paired t-tests. On comparing: Silver Citrate (group 3) showed significantly higher mean micro hardness as compared to EDTA 17% (group 1) and Citric Acid 10% (group 2) at p=0.004 & p=0.01 respectively. And on comparing micro hardness before and after treatment with chelating agents showed significantly lesser values than baseline values which was statistically significant at p<0.001. All groups showed reduction in dentin microhardness.17% EDTA and 10% Citric acid has shown maximum reduction in dentin micro hardness. And the least reduction in dentin micro hardness was seen with silver citrate solution.

KEYWORDS

Dentin, Microhardness, Silver Citrate, Chelating Agents, EDTA, Citric acid

INTRODUCTION

The goal of root canal treatment is to remove all vital, necrotic tissues, microorganisms, and microbial by-products from the root canal system which can be accomplished by chemical and mechanical cleaning.[1] Irrigation plays a central role in root canal therapy as it helps cleaning beyond what might not be achieved by mechanical instrumentation alone and aids in removal of microorganisms, tissue remnants and dentin chips from root canal through flushing mechanism.[2] For an irrigant to be effective it should exhibit a number of physicochemical properties. However no endodontic irrigant exhibits all ideal properties.[3]

Sodium hypochlorite is the most commonly used irrigant in endodontics.[1] Though it has excellent antibacterial action and capacity of dissolving organic materials it does not effectively remove the smear layer.[3] Chelators have demineralizing effect which act indistinguishably on smear layer and root dentin[3]. In 1957 Nygaard Ostby introduced chelators in endodontics.4 Their demineralizing effect aids in removal of smear layer, increases the access of the irrigants into the dentinal tubules allowing adequate disinfection. They also facilitate the action of endodontic instruments in narrow, calcified root canals but reduces dentin microhardness.[3]

Microhardness of dentin depends on the amount of calcified matrix per square millimeter.[5] Alteration in the chemical structure and Ca/P ratio is seen when irrigating solutions are used during endodontic therapy which in turn affects the mechanical properties of dentin.[6] It can also affect adhesion between the dental material and hard tissues.[6] Microhardness measurement, micro radiographic assessments, scanning electron microscopic methods, energy dispersive spectrometric analysis and surface roughness testing can be used to evaluate alteration in calcium phosphorous ratio and surface changes. Among the mechanical characterization methods microhardness measurement is a simplest non-destructive method. Vickers microhardness was adopted for this study due to its suitability and practicability.[5]

Nowadays the attention of the researchers and clinicians has shifted to silver based active particles dispersed in aqueous solution [7] as they have powerful biocidal properties that could be ideal for an innovative root canal irrigant.[7]

Silver Citrate is a white substance with a very limited solubility in water and completely soluble in citric acid[4]. The pH of Silver Citrate solution is approximately 1.7.[7] Invitro studies have shown that Silver Citrate solution was able to remove smear layer and expose most of the dentinal tubules in coronal, middle and apical portion. And it has comparable antibacterial activity to 5.25% NaOCl against E.fecalis biofilm[8] which is a gold standard irrigant.

The aim of the present study was to evaluate the effect of various chelating agents on the micro-hardness of the root canal dentin.

MATERIALS & METHODOLOGY

Sample preparation and grouping:

A total of 30 human mandibular premolar teeth that were recently extracted were used in this study. Teeth were stored in saline solution at room temperature until used. The teeth samples were decoronated using a diamond disk at CEJ level. The root canal length was standardized to 15mm. All canals were instrumented with Neoendo files according to manufacturer's instruction. The Neoendo file sequence was used up to size 30 - 4%. Saline was used for irrigation. Then each sample was sectioned perpendicular to the long axis to obtain three 5mm dentin discs. The mid root portion of the root canal was selected. The mid root portion was then split in the buccolingual direction to obtain root halves. One-half from each root was embedded in an acrylic resin block. In order to obtain a smooth surface the dentine surfaces of the specimens were placed on a circular grinding machine with silicon carbide abrasive papers under constant water irrigation and polished with fine alumina suspension on a rotary felt disc. Randomly selected teeth samples were divided equally into 3 groups depending on the chelating agents used. Each group consists of 10 teeth samples.

Group 1→17% EDTA→ n=10
Group 2→10 % CITRIC ACID→n=10
Group 3→SILVER CITRATE SOLUTION (4.846% Citric acid and 0.003% silver ions)→n=10

The samples were subjected to microhardness testing before treating with chelating agents to obtain baseline values. Then samples were irrigated with 1ml of these test solutions for one minute.[7] Saline was used as a final rinse and again samples were subjected to microhardness testing.

Determination Of Microhardness

Dentin microhardness was determined in each specimen with a Vickers hardness tester. The indentations were made with a Vicker's diamond indenter using a load of 200 g and a dwell time of 15 seconds. The indentations were done at 0.5 mm away from the canal for standardization in this study. The diamond shaped indentations were carefully observed and average length of 2 diagonals was used to calculate the microhardness. The mean for each sample was calculated. (Figure 1)

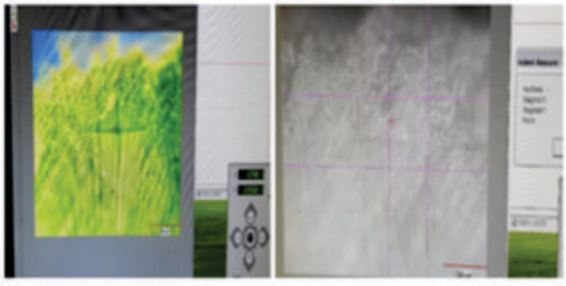

Figure 1: Determination of microhardness

Statistical Analysis:

GPower software v. 3.1.9.4 [(Franz Faul, Universität Kiel, Germany) was used to estimate the sample size. Statistical analysis of this study was performed using Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 Released 2013. Armonk, NY: IBM Corp.

One-way ANOVA test followed by Tukey's HSD Post hoc Analysis was used to compare the mean Micro Hardness between 03 groups. The level of significance [P-Value] was set at P<0.05.

RESULTS:

Before treating with chelating agents (Table 1)

Mean micro hardness value before using the chelating agents were as follows:

EDTA 17% group 1→ 57.70 ± 12.91
Citric Acid 10% group 2→57.60 ± 12.02
Silver Citrate group 3→59.30 ± 7.90.

The difference in the mean micro hardness between 3 groups was not statistically significant [p=0.93]. **(Table: 1)**

- Before treating with chelating agents (Table 1)

Comparison of mean Micro Hardness b/w 3 groups before treating with chelating agents using One-way ANOVA Test						
Groups	N	Mean	SD	Min	Max	p-value
EDTA 17%	10	57.70	12.91	42.0	81.0	0.93
Citric Acid 10%	10	57.60	12.02	44.0	78.0	
Silver Citrate	10	59.30	7.90	49.0	75.0	

After treating with chelating agents (Table 2)

Multiple comparison of mean difference between groups revealed that:Silver Citrate (group 3) showed significantly higher mean micro hardness as compared to EDTA 17% (group 1) and Citric Acid 10% (group 2) at p=0.004 & p=0.01 respectively. However, no significant difference in the mean micro hardness was demonstrated between EDTA 17% & Citric Acid 10% groups [0.94]. **(Table 2)**

After treating with chelating agents (Table 2)

Comparison of mean Micro Hardness b/w 3 groups after treating with chelating agents using One-way ANOVA Test						
Groups	N	Mean	SD	Min	Max	P-Value
EDTA 17%	10	42.10	8.80	30.0	58.0	0.003*
Citric Acid 10%	10	43.50	9.80	32.0	64.0	
Silver Citrate	10	56.10	8.12	45.0	72.0	

* - Statistically Significant

Comparing before & after treatment with chelating agents (Figure: 2)

Test results showed that the mean micro hardness after treatment with chelating agents in all the 3 study groups showed significantly lesser values than baseline values

EDTA 17% group→42.10 ± 8.80
Citric Acid 10% group→43.50 ± 9.80
Silver Citrate group = 56.10 ± 8.12

The mean difference in the micro hardness between before and after treatment with chelating agents in each study group was statistically significant at p<0.001 **(Figure:2)**

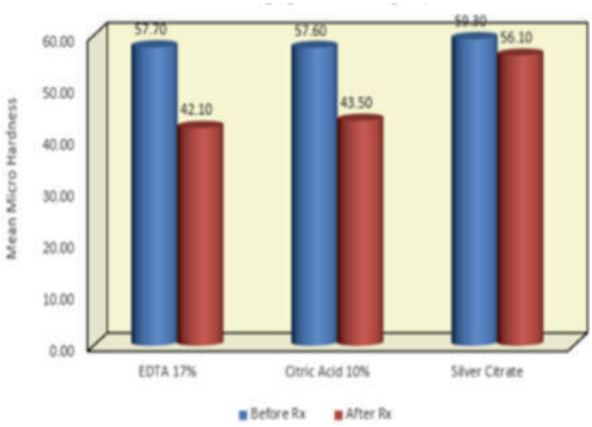

Figure 2: Comparing before and after treating with chelating agents

DISCUSSION

Endodontic irrigants are capable of modifying the chemo mechanical properties of dentin by removing the calcium ions present in the hydroxyapatite crystals. This in turn can adversely affect the adhesion of root canal obturating material.[7]

According to Pashley, dentin microhardness depends on the amount of calcified matrix per square millimeter. So net mineral loss or gain in the dental hard tissues can be indirectly measured using microhardness test.[8]Studies have reported decline in microhardness of dentin when tested from superficial to deep regions. This can be attributed to the fact that a greater number of widely opened dentinal tubules are found near the pulp, which offer least resistance to the microhardness testing indenter.[9] Pashley et al, proposed an inverse correlation between dentin microhardness and tubular density. [10]Therefore in this study, mid-root dentin region was used for testing to minimize the effect of the structural variations of different teeth and provide a reasonable baseline for evaluation.[11]

Demineralization capacity of chelating agents depends on contact time, pH, concentration and amount of available solution. There is no clear data on optimum contact time that an irrigant solution must be kept in root canals to remove the smear layer. However, a study by Yamada et al suggested a duration of 1 minute with EDTA[12] was sufficient. Hence in this study all the chelating agents were applied for one minute.

17% EDTA irrigation induced more reduction in dentin microhardness. The chelating action of EDTA solution induces an adverse softening potential on the calcified components of dentin, and subsequently a reduction in the microhardness was expected.[13] Though as chelator, EDTA has been popular among clinicians, its drawback lies with its insubstantial antimicrobial efficacy[14]

10% Citric acid is a weak organic acid. The chelating action of citric acid solution has a demineralizing effect on the calcified dentin components, and as a result of this calcium is lost.[13] Due to its low pH, 10% Citric acid causes more dentine erosion than other chelators and leaves precipitated crystals on the root canal wall that might interfere with the root canal filling.[15] According to Soram Oh et al 17% EDTA induced more calcium dissolution than 10% CA[16]. However, no significant difference in the mean micro hardness was demonstrated between Group 1 (EDTA 17%) and Group 2 (Citric Acid 10%) in this study.

Aqueous Silver Citrate solution provides a stabilized form of silver

ions in an organic acid (Citric acid). [17]The bioavailability of the ions allows the silver citrate complex to be rapidly efficacious against a broad spectrum of bacteria,[18] fungi and viruses.[19] Silver Citrate targets these structural proteins and dismantles their structure, leading to the disruption of the organism's membrane and subsequent lysis of the microbial cells.[17]

In this study samples treated with Silver Citrate shows higher microhardness values compared to group 2 (10% citric acid) which may be due to lower concentration of Citric acid.

In a study conducted by Hassan et al. nano silver intracanal medicament showed a gradual increase of microhardness with time[20]. However, the increase in dentine microhardness found in the samples treated with silver nanoparticles could be attributed to the deposition of silver nanoparticles on the dentine surface and inside the dentinal tubule[21].Hence in the current study silver ions present in Silver Citrate solution might have attributed for better dentin microhardness values compared to 10 % Citric acid and 17% EDTA groups

An irrigant with the ability to remove the smear layer without causing much erosion of the radicular dentin and also eradicate microbial biofilms would be considered close to ideal. Thus, one can say Silver Citrate is a "GLIMMER OF HOPE" IN ENDODONTICS.

CONCLUSION

Within the limitations of this study, it can be concluded that all irrigants used in this study showed reduction in dentin microhardness.17% EDTA and 10% Citric acid has shown maximum reduction in dentin micro hardness. And the least reduction in dentin micro hardness was seen with Silver citrate solution

REFERENCES:

1) Topbas C, Adiguzel O. Endodontic Irrigation Solutions: A Review: Endodontic Irrigation Solutions. International Dental Research. 2017 Dec 31;7(3):54-61.
2) Kaur, P., 2020. Role of Irrigants in Endodontics. *Journal of Dental Problems and Solutions*, *7*(2), pp.100-104.
3) Cruz-Filho AM, Sousa-Neto MD, Savioli RN, Silva RG, Vansan LP, Pécora JD. Effect of chelating solutions on the microhardness of root canal lumen dentin. Journal of endodontics. 2011 Mar 1;37(3):358-62.
4) Hülsmann M, Heckendorff M, Lennon A. Chelating agents in root canal treatment: mode of action and indications for their use. International endodontic journal. 2003 Dec;36(12):810-30.
5) Unnikrishnan M, Mathai V, Sadasiva K, Santakumari RS, Girish S, Shailajakumari AK. The evaluation of dentin microhardness after use of 17% EDTA, 17% EGTA, 10% citric acid, MTAD used as chelating agents combined with 2.5% sodium hypochlorite after rotary instrumentation: An in vitro SEM study. Journal of Pharmacy & Bioallied Sciences. 2019 May;11(Suppl 2):S156.
6) Doğan H, Çalt S. Effects of chelating agents and sodium hypochlorite on mineral content of root dentin. Journal of endodontics. 2001 Sep 1;27(9):578-80.
7) Tonini R, Giovarruscio M, Gorni F, Ionescu A, Brambilla E, Mikhailovna IM, Luzi A, Maciel Pires P, Sauro S. In vitro evaluation of antibacterial properties and smear layer removal/sealer penetration of a novel silver-citrate root canal irrigant. Materials. 2020 Jan 2;13(1):194.
8) Slutzky-Goldberg I, Maree M, Liberman R, Heling I. Effect of sodium hypochlorite on dentin microhardness. Journal of endodontics. 2004 Dec 1;30(12):880-2.
9) Saleh AA, Ettman WM. Effect of endodontic irrigation solutions on microhardness of root canal dentine. Journal of dentistry. 1999 Jan 1;27(1):43-6.
10) Pashley D, Okabe A, Parham P. The relationship between dentin microhardness and tubule density. Dental Traumatology. 1985 Oct;1(5):176-9.
11) Saha SG, Sharma V, Bharadwaj A, Shrivastava P, Saha MK, Dubey S, Kala S, Gupta S. Effectiveness of various endodontic irrigants on the micro-hardness of the root canal dentin: An in vitro study. Journal of clinical and diagnostic research: JCDR. 2017 Apr;11(4):ZC01.
12) Kandil HE, Labib AH, Alhadainy HA. Effect of different irrigant solutions on microhardness and smear layer removal of root canal dentin. Tanta Dental Journal. 2014 Apr 1;11(1):1-1.
13) Eldeniz AU, Erdemir A, Belli S. Effect of EDTA and citric acid solutions on the microhardness and the roughness of human root canal dentin. Journal of endodontics. 2005 Feb 1;31(2):107-10.
14) Matos FD, Khoury RD, Carvalho CA, Martinho FC, Bresciani E, Valera MC. Effect of EDTA and QMIX ultrasonic activation on the reduction of microorganisms and endotoxins in ex vivo human root canals. Brazilian dental journal. 2019 Jun 3;30:220-6.
15) Arias-Moliz MT, Ruiz-Linares M, Ferrer-Luque CM. Irrigating solutions in root canal treatment. Endod. Pract. Today. 2019 Jun 1;13:131-46.
16) Oh S, Perinpanayagam H, Lee Y, Kum JW, Yoo YJ, Lim SM, Chang SW, Shon WJ, Lee W, Baek SH, Kum KY. Effect of acidic solutions on the microhardness of dentin and set OrthoMTA and their cytotoxicity on murine macrophage. Restorative Dentistry & Endodontics. 2016 Feb 1;41(1):12-21.
17) Generali L, Bertoldi C, Bidossi A, Cassinelli C, Morra M, Del Fabbro M, Savadori P, Ballal NV, Giardino L. Evaluation of cytotoxicity and antibacterial activity of a new class of silver citrate-based compounds as endodontic irrigants. Materials. 2020 Nov 6;13(21):5019.
18) Palza H. Antimicrobial polymers with metal nanoparticles. International journal of molecular sciences. 2015 Jan 19;16(1):2099-116.
19) Manuel CS, Moore MD, Jaykus LA. Efficacy of a disinfectant containing silver dihydrogen citrate against GI. 6 and GII. 4 human norovirus. Journal of applied microbiology. 2017 Jan;122(1):78-86.
20) Hassan R, Khallaf M. Effect of a silver nanoparticle intracanal-based medicament on the microhardness of human radicular dentine. Endod Pract Today. 2018 Jun 1;12:125-7.
21) Hiraishi N, Yiu CK, King NM, Tagami J, Tay FR. Antimicrobial efficacy of 3.8% silver diamine fluoride and its effect on root dentin. Journal of endodontics. 2010 Jun 1;36(6):1026-9.