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A REVIEW ON THE EFFECT OF ETIDRONATE ON ROOT CANAL DENTIN MICROHARDNESS

Dr Moksha Nayak	MDS, PhD, Principal & Professor, Department of Conservative Dentistry and Endodontics, KVG Dental College and hospital, Sullia, Dakshina Kannada, Karnataka, India.
Dr Bhavana Sreenivasan*	Post graduate student, Department of Conservative Dentistry and Endodontics, KVG Dental College and hospital, Sullia, Dakshina Kannada, Karnataka, India 574327. *Corresponding Author
Dr Aysath Aphiya A	Post graduate student, Department of Conservative Dentistry and Endodontics, KVG Dental College and hospital, Sullia, Dakshina Kannada, Karnataka, India 574327.

ABSTRACT

Objective: The present narrative review focused to investigate the effect of etidronate on the microhardness of root dentin

Search method: A comprehensive literature search was performed on PubMed, Google Scholar and Medline databases from 2010 to 2021. The main search terms used were etidronate, HEBP, microhardness, dentin microhardness and root canal dentin microhardness.

Selection criteria : Inclusion criteria was based on in vitro and comparative studies that evaluated the direct effect of etidronate as endodontic irrigant on the microhardness of root dentin. Articles in English or those having detailed summary in English, in vitro and comparative studies were included. All the case reports, abstracts, letters to editors, editorials, and in vivo studies were excluded from the present review.

Results : A total of seven studies were included in the final review. The paper evaluated the effect of HEBP on the microhardness of root dentin based on the irrigant concentration, exposure time and its effect on the location in radicular dentin. The optimal concentration to remove the smear layer and exert antibacterial activity was found to be 9-18%. The effect of the irrigating solution on the microhardness of root dentin increased with exposure time and radicular dentin microhardness value declined from superficial to deep regions.

Conclusion : Etidronate a weak chelating agent used as alternative to other chelating agents with a concentration of 9-18% for 5 minutes has optimal effects on dentin microhardness and can be used in association with NaOCl, without interfering its action.

KEYWORDS :

INTRODUCTION

The combined action of irrigation solution and chelating agents in endodontic treatment facilitate root canal instrumentation and removal of the smear layer[1]. Sodium hypochlorite (NaOCl) when used as a standalone irrigant does not remove the smear layer to the full extent[2], thus NaOCl is mixed with other chelating agents like Chitosan, maleic acid, EDTA, citric acid or MTAD for complete smear layer removal[3,4]. The sequential use of NaOCl/EDTA/NaOCl caused incomplete removal of biofilm from root canal[5]. Additionally, the risk of eroding peritubular dentine[6] and the inactivation of NaOCl, as it reacts chemically with EDTA has led to the recommendation that NaOCl and EDTA should not be used sequentially, without first emptying and drying the canal[7]. It resulted in the demineralization process causing chemical alterations in the root canal dentin structure leading to erosive changes and decrease dentine hardness[8,9].

In 2005, Zehnder et al. introduced the concept of continuous chelation to counteract the problems associated with the use of NaOCl/EDTA[10]. It involves the simultaneous use of a chelator and NaOCl in a single solution, thus simplifying the irrigation procedure[10,11]. Considerable research has focused on the use of the weak chelator etidronate at alkaline pH combined with NaOCl. Etidronic acid (also known as 1-hydroxyethylidene-1, 1-bisphosphonate or HEBP) is a biocompatible chelator systematically administered to treat osteoporosis or neoplastic diseases involving osteolytic bone destruction[12].

Sodium hypochlorite-etidronic acid combination is used as a single irrigant during and after instrumentation without short term loss of the desired properties of either compound[10,13]. It interferes minimally with the physical properties of the dentin, such as microhardness[14] and roughness[11], and it prevents the formation of the smear layer during instrumentation[15,16]. However, the chelating capacity of etidronic acid is relatively weak, and it is not known whether its use results in root canals that are as clean as counterparts irrigated with NaOCl followed by EDTA[17].

In the clinical setting, chemical adjuncts are used to enhance the root canal disinfection and condition the dentin to optimize the interactions with root fillings[18]. Despite the vast literature on the effects of root canal irrigants on the dentin characteristics, the precise effects of the irrigating agent etidronate on the dentin microhardness remain unclear. Thus the paper describes a narrative review on the effect of etidronate as an alternative to other chelating agents on the microhardness of root dentin.

REVIEW

1. Question addressed by this review

What is the effect of etidronate on the microhardness of root dentin when used as an irrigating solution in root canal treatment?

2. Literature search

A comprehensive search of the literature was undertaken from 2010 to 2021. An advanced search was carried on the PubMed, Google Scholar and Medline databases. The main search terms used were etidronate, HEBP, microhardness, dentin microhardness and root canal dentin microhardness.

3. Inclusion and exclusion criteria

Inclusion criteria was based on in vitro and comparative studies that evaluated the direct effect of etidronate as endodontic irrigant on the microhardness of root dentin. Articles in English or those having detailed summary in English were selected. Review, case reports, abstracts, letters to editors, editorials, and in vivo studies related to the literature were excluded.

RESULTS

Preliminary screening consisted of a total of 155 articles that were identified through the database searching. After a thorough screening of 155 articles, 123 articles were excluded. Further, these records were assessed for any duplicates and 14 articles were removed. Further, 17 articles were screened for abstracts. Ten articles were then excluded after reviewing of abstracts. Based on the inclusion and exclusion criteria, finally seven papers were included in this narrative review (Table 1).

Author/year	Description of study	Irrigation protocol / Methods of assessment	Results
Dineshkumar MK et al.	Effect of EDTA, MTAD™, and HEBP as a the	Forty single rooted premolar	The highest microhardness was observed in HEBP-treated root dentin

JCD (2012)[19]	microhardness of root dentin.final rinse on	Group 1 – distilled water Group 2 -1.3% NaOCl for 20 min+17% EDTA for 1 min Group 3 -1.3% NaOCl 20 min +MTAD for 5 min Group 4 -1.3% NaOCl 20 min +18% HEBP for 5 min Vickers microhardness test.	(53.74 ± 1.18) followed by EDTA(51.63 ± 0.860 and MTAD (42.85 ± 0.99). HEBP had a lesser impact on the mineral content of root dentin.
Tartari T et al., International Journal of Dentistry (2013)[14]	A new weak chelator in endodontics: effects of different irrigation regimens with etidronate on root dentin microhardness.	Seventy two single rooted extracted teeth Group 1 (= 9): saline solution for 30min Group 2 (= 9): 5% NaOCl + 18% HEBP for 30min, Group 3 (= 27): 2.5% NaOCl for 30min After the microhardness measurements, the Group 3 samples were divided to Group 4(= 9): 17% EDTA for 3min Group 5(= 9): 10% Citric Acid for 3 min Group 6(= 9): 9% HEBP for 5 min These groups received a final flush with 2.5% NaOCl for 3min, producing G7, G8, and G9 Knoop indenter of the microhardness tester FM-700 ultrasonic tub was used	All tested irrigation regimens significantly decreased the microhardness. Maximum reduction in microhardness was seen in group 7 (0.06) followed by group 4 (0.08) and least reduction was seen in saline group (0.68) 18%HEBP and 9% HEBP resulted in significant decrease in hardness with values 0.16 and 0.59 respectively than Citric Acid (0.86) or EDTA (0.08)
Jain et al, International Journal of Oral Health and Medical Research (2016)[20]	Comparative Evaluation of Calcium Ion Loss and Microhardness using Different Irrigants - An In Vitro Study	Twenty single rooted premolars Group 1: 5.25% (NaOCl) + distilled water for 5 min Group 2: 5.25% NaOCl + 18% HEBP for 5 min Group 3: 5.25% NaOCl + 15% Citric acid for 5 min . The calcium loss - Atomic Absorption Spectrophotometer Microhardness -Vickers Hardness Tester.	The use of 5.25% NaOCL, 18 % HEBP or 15% Citric acid results in calcium loss which alter the microhardness of root dentin as 77.29 VHN , 69.053 VHN and 66.804 VHN respectively during the first 5 min of action.5.25% sodium hypochlorite solution was capable of extracting small amounts of calcium from root dentin as compared to HEBP, and maximum loss occured with Citric acid.
Bhagwat et al, Journal of Dental Research and Review (2016)[21]	Comparison of the effect of ethylenediamine tetra-acetic acid, chlorhexidine, etidronic acid and propolis as an irrigant on the microhardness of root dentin: An *in vitro* study	Hundred single rooted teeth Group I : distilled water for 20min Group II : 1.3% NaOCl for 20min + 17% EDTA for 1 min Group III: 1.3% NaOCl for 20min + 2% CHX digluconate for 5 min Group IV: 1.3% NaOCl for 20min +18% HEBP for 5 min Group V: 1.3% NaOCl for 20min +4% propolis for 5min Vickers microhardness test	18 %HEBP had the least effect on the root dentin microhardness (55.6 VHN) , followed by 4% propolis(49.7 VHN) and 2% CHX (42.8 VHN). 17% EDTA showed maximum effect on the microhardness of the dentin (41.4 VHN).
Ragevendra et al, Saudi Journal of Oral and Dental Research (SJODR) (2018)[22]	Effect of Etidronic Acid, Chitosan and EDTA on Microhardness of Root Canal Dentin	Forty seven single rooted teeth Group I- 20 % HEBP for 5 min Group II- 17% EDTA for 5 min Group III – 0.2% chitosan solution for 5 min Vickers hardness test	EDTA had better reduction of dentin microhardness (61.6VHN,60.5 VHN,59.5 VHN when compared with 0.2% Chitosan (62.03VHN,60.2 VHN,59.57VHN) and Etidronic acid (60.5VHN,58.8 VHN,57.5 VHN) at 1000μ, 1200μ and 1400μ from orifice.
Paulina et al, International Journal of Applied Science and Technology (2019)[23]	Effects of Irrigation Solutions on Root Canal Dentin	Forty one single rooted teeth Samples decoronated and longitudinally sectioned to obtain 56 dentin specimens C group (n=14) : saline for 1min E group (n=14) : 17 % EDTA for 1min ES group (n=14) : 17% EDTA + 2.5% NaOCl for 1min H group (n=14) : Dual Rinse HEDP for 3 min Vickers hardness test	All irrigation solutions significantly decreased root canal dentin micro-hardness compared to saline.The greatest reduction was induced by Dual Rinse HEDP(49.74 VHN) while 17% EDTA (51.55 VHN)and 17% EDTA + 2.5% NaOCl (51.42VHN)
Elika et al, Journal of Clinical and Translational Research (2021)[24]	Comparative evaluation of Chloroquick with Triphala, sodium hypochlorite, and ethylenediaminetetraacetic acid on the microhardness of root canal dentin: An in vitro study	Forty single rooted extracted teeth Group 1 – Saline Group 2 – 5% NaOCl +17% EDTA; Group 3 – Triphala; Group 4 – Chloroquick (18% etidronic acid+ 5% NaOCl) All the samples were immersed in the irrigating solutions with a mean time of 15 min. Vickers microhardness	Except saline all the tested specimens showed a decrease in the microhardness values Triphala (43.60±5.95 VHN) and Chloroquick(38.80±4.90VHN) has minimal effect on the microhardness of root canal dentin post-treatment when compared with 5% NaOCl and 17% EDTA (48.00±5.32 VHN).

DISCUSSION

Irrigating solutions used in endodontic treatment cause changes in the physical and chemical properties including the dentin microstructure[21,23]. During biomechanical preparation, NaOCl irrigation when used alone acts only on the organic component which alters its physical and mechanical properties[20] . Lottani et al found that NaOCl when used consequently with chelating agents was capable of dissolving organic remnants and predentin or even demineralizing the inorganic calcified portion of the root canal wall[25].Several studies compared the effects of NaOCl and EDTA on the microhardness of root canal dentin, showing both solutions reduced microhardness, with EDTA irrigation causing the greatest reduction [26-28]. Cruz-Filho et al showed that EDTA and citric acid had the greatest effect on dentin micro-hardness[29].

Consequently, a moderate decalcifying effect might represent a good choice in case the prevention of dentin. According to Lottani et al. 2009, etidronic acid/sodium hypochlorite mixture could be administered as the sole irrigant[25]. A combination of HEBP and NaOCl employed as an irrigant during and later after the biomechanical preparation ,does not lead to short term loss of the desired properties[30].

The optimal concentrations HEBP to remove the smear layer and exert antibacterial activity were reported to 9-18%, respectively[31]. Dineshkumar et al[19], Jain et al[20], Bhagwat et al[21] and Elika et al[24] used 18% HEBP and Tartari et al[14] used both 9% and 18% HEBP whereas Ragevendra et al used 20% HEBP along with sodium hypochlorite as the irrigation regime. The demineralization kinetics promoted by both 9% HEBP and 18% HEBP were significantly slower than those of 17% EDTA[12] as solutions require 300 seconds to completely remove the smear layer[17]. The combined use of 5% NaOCl and 18% HEBP promoted the direct action on collagen fibers, resulting in greater tubular opening and led to a more superficial action of NaOCl on the organic portion of the dentin, as EDTA has a greater action on inorganic components[32]. The amount of calcium ion complexes removed from the root canals was found to be similar with 17% EDTA or 10% citric acid when 20% HEBP solution was used[10]. The results showed that the effect of HEBP depends on its concentration in solution. Greater the concentration greater will be its effect on the root dentin microhardness.

Increased exposure time also increases the effect of irrigating solution on microhardness of root dentin. All the researchers limited the contact time to 5 min[8] as its combination with NaOCl takes 300 seconds to completely remove the smear layer without interfering with its antimicrobial or dissolution activity[17,30,33-35]. In contrast, in the study by Elika et al , the application time was 15 minutes before subjecting for microhardness testing. This was in agreement with the study by Goldberg et al.[36,37] who suggested the application time of 10–15 minutes to obtain optimal results, which is more realistic in terms of clinical practice. Paulino et al showed greatest decrease in microhardness using a commercially available Dual Rinse HEDP which is due to the long working time of the solution as recommended by the manufacturer[23]. These results were in agreement with Tartari et al. (2015) study, where editronic acid significantly reduced dentin micro-hardness, although irrigation solutions interacted longer, HEBP did not interact with NaOCl at the same time and Knoop microhardness test was used instead of Vickers[14].

The location of radicular dentin affects the microhardness as there is an inverse correlation between tubule density and microhardness[38]. In all the studies three indentations were given at apical, middle and cervical third and microhardness Dentine hardness value decreases as the indentations tested are made closer to the pulp and there was a decline in microhardness from superficial to deep regions[38]. Carrigan et al. (1984) showed that tubule density decreased from cervical to apical dentine[39] and Pashley et al. (1985) reported an inverse correlation between dentine microhardness and tubular density[38]. This histological pattern probably contributes to the hardness reduction at the cervical region of the root due to the reducing thickness of dentin layer towards the apex. In contrary, these results cannot be extrapolated to clinical practice, because during an endodontic therapy, instruments usage and difficulty to perform irrigation to the apical region influence the microhardness values[14].

Dentin microhardness was evaluated using Vickers microhardness test except in the study by Tartari et al. where microhardness was estimated using Knoop hardness number. Vickers hardness test is widely accepted as the Vickers indenter penetrates approximately twice as far into the specimen and hardness value is constant, within statistical precision and test load range[20,24,]. The hardness measurements obtained by the Knoop method are practically insensitive to the elastic recovery of the material, which made this test much more appropriate for the analysis of surface microhardness[14]. Superficial dentin, closer to the pulp was assessed during this method.

Although the softening effect exerted by etidronate on the dentine walls could be of clinical benefit to allow rapid root canal preparation, the alteration to dentine may affect adhesion, as well as the sealing ability of sealers to the treated dentine surfaces, and may predispose to teeth fracture. Thus, further well designed randomized in vitro and in vivo studies are required to relate the effect of etidronate on dentin microhardness.

CONCLUSION

The strong chelating solution leads to decrease in dentin microhardness and erosion of peritubular and intertubular dentin. Based on this narrative review etidronate shows minimum alteration in the microhardeness of dentin when compared to stronger chelating agents like EDTA, Citric Acid, maleic acid, MTAD and peracetic acid. HEBP being a weak chelating agent has optimal effects on dentin microstructure and it can be used in association with NaOCl, without its interference in its action. The actions and effects of HEBP in different concentrations on root canal dentin to further evaluate its effectiveness as an irrigating and chelating agent in dental procedures is required.

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