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Effect of Different Chelating Agents on The Wettability of The Root Canal Sealers on Root Dentin – A Comparative In-Vitro Study

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Objective: To evaluate the effect of different chelating agents on the wettability of the root canal sealers on root dentin.

Materials and methodology: 40 freshly extracted human maxillary anterior teeth were selected. Tooth Samples were standardized to root length of 15mm, decoronated and then were split longitudinally to obtain two halves. The Specimens were then trimmed to obtain flat dentin bars of 2mm thickness each. Later Specimens were randomly assigned to 4 groups of 20 each based on irrigation regimen. Group 1: 3% Sodium Hypochlorite (Naocl) +17% Ethylenediaminetetraacetic acid (EDTA); Group 2: 3% Naocl +0.2% Chitosan citrate; Group 3: 3% Naocl +10% Glycolic acid; Group 4: 3% Naocl +Distilled water. Each group was further subdivided into two subgroups of 10 each based on the sealer used, subgroup A-AH plus and subgroup B-Cera seal. Specimens were treated with controlled volume of experimental sealers and subjected to contact angle measurement.

Results: The wettability of both root canal sealers on root dentin were found to be best after treating root dentin with group 3 i..e, Glycolic acid followed by chitosan citrate, EDTA and distilled water. Among both subgroups AH plus showed better wettability irrespective of irrigation regimen used.

Conclusion: Within the limitations of the study, it can be concluded that Glycolic acid when used as a chelating agent showed better wettability of both AH plus and Cera seal root canal sealers compared to other tested solutions.

Clinical Relevance: An increase in wettability of root dentine helps in better sealer penetration which helps in increasing the prognosis.

Keyword: A-AH, EDTA, Hp-DLSC

Introduction

Success in endodontics is achieved by the elimination of microorganisms, their byproducts, and a three-dimensional obturation of the canal (1). Maximum portions of canal walls remain unblemished by manual or rotary instrumentation during instrumentation of the root canals (2). Mechanical instrumentation of the root canal creates an amorphous smear layer that covers the intraarticular dentinal tubules and walls (3). The penetration of irritants, intracanal medicaments, and sealers into the dentinal tubules is also hindered by the presence of smear layer over the dentinal walls of the root canals (4). Hence, removal of smear layer is mandatory in root canal therapy.

Various chelating agents such as Ethylene diamine tetraacetic acid (EDTA), citric acid, Bio pure® MTAD® (Dentsply Sirona, York, PA, USA), and QMix 2in1 (Dentsply Sirona) have been used for the removal of canal wall smear layer (5,6). For effective removal of smear layer, the sequential use of EDTA and sodium hypochlorite (NaOCl) has been advocated. There exist various drawbacks with the use of EDTA such as diminished efficacy in the removal of smear layer in the apical third of the canal space, diminution in dentin microhardness, and cytotoxicity. (7,8,9) In addition, the bond strength of resin cements to radicular dentin is also reduced after application of EDTA. (10)

Chitosan is a natural polysaccharide with molecular weight ranging from 1000,000 to 3000,000 having excellent properties of bio compatibility, bio degradability, bio adhesion, and nontoxic to human body. (11)

Glycolic acid (GA) is an alpha hydroxy acid (AHA) extracted from sugar cane, sweet vegetables. It is commonly used in dermatology. It is suitable for enamel and dentin etching in restorative procedures and as efficient as EDTA in removing smear layer from root canals walls. Due to its positive characteristics, GA may be a suitable agent to remove the smear layer from the root canal walls with minimal negative biological effects. (12)

AH Plus, an epoxy-based root canal sealer, has got several advantages such as good mechanical properties, high radiopacity, reduced polymerization shrinkage, low solubility, and a high degree of stability on storage. (13,14) Recently, a novel sealer, Cera seal marketed by meta biomed. It has an active bio silicate technology and forms a strong void-free seal with outstanding adhesion to gutta percha points and root dentin. It displays higher cell viability and induced greater cell attachment and migration released significantly more Ca2+ and favored hPDLSC differentiation and mineralization. (15)

Contact angle acts as a good indicator of the spreading nature of the liquid on the solid surface as it measures the wetting behavior of a liquid on a solid surface. The wetting angle so formed has a three-phase boundary where there is intersection between liquid, gas, and solid. Higher the values of contact angle, poorer are the wetting. Existence of smear layer on the root canal walls affects the wettability of the sealer. (16) Hence, proper wetting of sealer can be achieved by complete eradication of smear layer from the radicular dentin. Hence, the aim of the study was to compare the effect of 0.2% Chitosan citrate ,10% glycolic acid ,17%EDTA on the wettability of AH plus and cereal sealers.

Materials and methods

Forty extracted single rooted human teeth were used in study. Criteria for tooth selection included: with no visible caries, fractures or cracks on examination, internal or external resorption or calcification and fully formed apex were selected in study. teeth were

decoronated with low-speed diamond disc under water coolant. Roots were then split longitudinally to yield 80 dentin sections. The sections were flattened with the help of sandpaper (100 grit) to obtain smooth flat surface for analysis. For standardization they were cut with a diamond disc to obtain segments of 10 mm. teeth were grouped into 4 groups based on irrigation protocol.

On the basis of root canal sealer used group A, B, C, D were subdivided into

A1, A2,

B1, B2,

C1, C2,

D1, D2

Irrigation protocol

Group A: Samples were treated with 10 mL of 3% sodium hypochlorite for 3 min followed by rinsing with 10 mL of distilled water. They were then irrigated with 10 mL of 17% EDTA solution for 3 min. Because of the self-limiting effect of EDTA, solutions were renewed every minute thus achieving more effective action, final rinse with 10 mL of distilled water and then blot dried.

Subgroup B1-AH Plus

Subgroup B2-ceraseal

Group B: Samples were treated with 10 mL of 3% sodium hypochlorite for 3 min followed by rinsing with 10 mL of distilled water. They were then irrigated with 10 mL of 0.2%chitosan citrate solution for 3 min.

Subgroup B1-AH Plus

Subgroup B2-ceraseal

Group C: Samples were treated with 10 mL of 2.5% sodium hypochlorite for 3 min followed by rinsing with 10 mL of distilled water. They were then irrigated with 10 mL of 10% glycolic acid solution for 3 min.

Subgroup C1-AH Plus

Subgroup C2-ceraseal

Group D: Samples were treated with 10ml of 3%Naocl for 3min followed by rinsing with 10 mL of distilled water.

Subgroup D1: AH Plus

Subgroup D2: ceraseal

The sealers were loaded in an insulin syringe, and controlled volume (0.1 mL) of each sealer was placed on dentin disks. Specimens of each group were mounted on a plain glass surface in the contact angle measuring device. Images of droplets of each sealer were digitalized by scanner. Subsequently, the height (h) and width of the base (b) of each droplet was measured with the device. The measured units were used for the calculation of contact angle equation (a = 2 arc [cos 2 h/b]) and were subjected to statistical analysis by one-way analysis of variance and Student's t- test.

Results

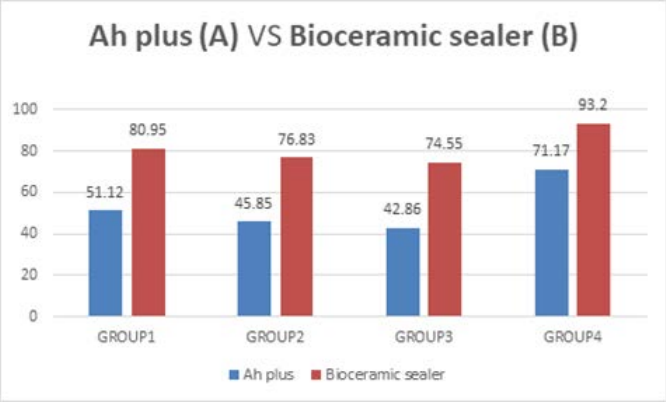
Irrigants used as the final rinse had a highly significant effect on the wettability of AH Plus on root canal dentin. Wettability of AH Plus sealer was better when root canal dentin was treated with 10%glycolic acid, compared to 0.2% Chitosan citrate, 17%EDTA, Distilled water. There is statistical difference between all groups. wettability of AHPLUS was better than Ceraseal irrespective of chelating agents used.

Table 1:

Groups	VARIABLE	N	Mean	Std. Deviation	Std. Error Mean
GROUP 1 NAOCL+EDTA	Ah plus (A)	10	72.7300	6.54371	2.06930
	Bioceramic sealer (B)	10	80.9500	4.68313	1.48093

GROUP 2 NAOCL +CHITOSAN CITRATE	Ah plus (A)	10	50.1000	2.53990	.80319
	Bioceramic sealer (B)	10	74.5400	9.14527	2.89199
GROUP 3 NAOCL+GLYCOLIC ACID	Ah plus (A)	10	45.8500	5.60045	1.77102
	Bioceramic sealer (B)	10	76.8600	9.08346	2.87244
GROUP 4 DISTILLED WATER	Ah plus (A)	10	42.8600	2.43274	.76930
	Bioceramic sealer (B)	10	92.8200	1.70216	.53827

Figure 1:



Above Graph shows lower contact angle was observed for both AHPLUS and Ceraseal sealers was 10% glycolic acid, followed by 0.2% Chitosan citrate,17%EDTA and distilled water

Discussion

Optimum adhesion requires intimate contact between the sealer and substrate to facilitate molecular attraction and allow either chemical adhesion or penetration for micromechanical surface interlocking. Adhesion of a root canal sealer depends on the wetting ability of the sealer. For optimal wettability, the liquid should have the lowest possible contact angle with the surface. (18) The surface possessing a lower contact angle or greater surface free energy presents with high wettability, which means that the spreading and interaction of sealer is better in a solid presenting with high surface energy, thus resulting in the formation of a lower contact angle. (19)

The results of this study demonstrated that both AH plus and ceraseal sealers showed better wettability when glycolic acid was used to treat the root canal dentin. This could be due to the better chelating action of 10% glycolic acid when compared to0.2% Chitosan citrate, EDTA and distilled water. Due to the acidic nature of glycolic acid, demonstrating its better demineralizing effect over a shorter duration of time. (12) It has been demonstrated that removing the smear layer from root dentin surface leads to increase in surface roughness due to more pronounced opening of dentinal tubules. An increase in surface roughness reduces the contact angle, which could be another reason for both the sealers showing better wettability when irrigated with glycolic acid.

Followed by GA, both AH Plus and Bio Root RCS sealers showed good wettability with 0.2%chitosan citrate. When compared to GA, EDTA showed poor results in wettability of both the sealers. The presence of excessive amount of OH^- due to high pH in EDTA leads to low dissociation of smear layer hydroxyapatite. (20) This phenomenon reduces the number of calcium ions which EDTA can chelate, resulting in limited effectiveness of EDTA on the wettability of sealers. Furthermore, the increased pH value (compared to MA) negatively affects and decreases the breakdown of hydroxyapatite, in spite of being fully deprotonated and having good affinity for calcium ions.

Controlled volume (0.1 mL) of each sealer was used for recording all the measurements in this study and the reason for use of the controlled volume of sealer being volumetric changes that could affect the value of contact angle. (21) Because the surface tension coefficient of liquid is influenced by change in temperature and humidity, the entire experimental procedure was carried out under standard environmental conditions.

A captive bubble or sessile drop technique can be used for the measurement of contact angle, the latter of which was used in the present study. The advantage of using this approach was to maintain a dry environment during the measurement of contact angle of a liquid drop on flat surfaces.

Ceraseal sealer was used in this study because it is one of the novel bio ceramic sealers which has shown to have good biological properties. (15,22) Because AH plus sealer is known to be the gold standard, it was compared with Bio Root RCS for its wettability.

Because the hydration state of the dentin surface has also shown to affect the contact angle, the samples in the current study were dried using blotting paper. Dentin surfaces were polished thoroughly to achieve reduction in the influence of roughness on the surface energy of root dentin wall, thus leading to the reduction of its influence on the measurement of contact angle. (18)

Conclusion

Within the limitations of this study, it can be concluded that glycolic acid when used as final irrigant showed better wettability of both AH plus sealer and Ceraseal compared to other tested solutions.

Ethical Approval: Has been approved by the ethical committee.

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