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Comparative evaluation of the effect of Ethylene diamine tetraacetic acid (EDTA) and glycolic acid as final irrigation on the apical sealing ability of root canal obturation - An Invitro study

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Abstract

Aim: To evaluate and compare the effect of Ethylene diamine tetraacetic acid (EDTA) and Glycolic Acid as final irrigation on the apical sealing ability of root canal obturation.

Settings and Design: The study was an in vitro study conducted at the department of conservative dentistry and endodontics.

Methods and Material: A sample of 40 human extracted mandibular premolars with single root and single canal were selected for the study. The crowns of the teeth were removed, working length was determined. The root canals were prepared with rotary files up to F3 using the crown down technique using NaOCl, and then were rinsed with 5ml of distilled water. All teeth were then randomly assigned into two groups of 15 specimens. Group 1- Final irrigation with 17% EDTA for 1 minute. Group 2- Final irrigation with 17% Glycolic acid for 1 minute. All root canals were obturated with gutta percha and resin-based sealer. Specimens were kept in an incubator for 7 days to allow the setting of the sealer.

Statistical analysis: Data was analysed by using SPSS 24.0 version IBM USA. Quantitative data was compared using unpaired t test.

Results: Final irrigation using 17% Glycolic acid had the higher apical sealing ability than 17% EDTA. SEM examination showed better dentine adaptability for Group 2 (17% Glycolic Acid) than Group 1 (17% EDTA).

Conclusions: Final irrigation with 17% Glycolic acid for one minute produced greater apical sealing ability than final irrigation with 17% EDTA for one minute.

Keywords: Glycolic Acid, Apical Sealing Ability, Final Irrigation

Introduction

The outcome of root canal treatment mainly depends on endodontic triads. The endodontic triads consists of biomechanical preparations (cleaning and shaping), chemical root canal cleaning using irrigation solutions and intracanal medicaments, and obturation of the root canal system. Among those triads, cleaning using irrigation solutions is a crucial phase during root canal treatment. The main goal of root canal irrigation is to aid in cleaning of root canal from vital or necrotic pulp tissue remnants as well as to eliminate microorganisms and their products.[1,2]

During biomechanical preparations endodontic instruments which are used manually or mechanically will create smear plugs in the dentinal tubules and smear layers on the root canal walls. The thickness of the smear layer formed is in the ranges from 0.5 to 2 μm. Although the thickness is only a few microns, the presence of smear layers may obstruct sealer adhesion on the walls of the root canal dentin and sealer infiltration into dentinal tubules[3]. Removal of smear layer before obturation of root canal system improves apical seal. More the smear layer on dentinal walls, less will be apical sealing ability and vice versa.

Irrigation solution commonly used in the clinic is 2.5–5% of sodium hypochlorite (NaOCl). NaOCl has the capability to eliminate organic tissues but it does not remove inorganic tissues from the root canal walls; hence, other irrigation solutions require to be utilized, which is called a final irrigation solution. It's main function is to eliminate inorganic tissues of smear layers4. Ethylene diaminetetraacetic acid (EDTA) is often used in the clinic as the gold standard for final irrigation solution because of its ability to chelate with calcium ions in dentin, thus dissolving the inorganic component from smear layers[5.] However, the prolonged application time of EDTA to the dentinal walls can cause dentin erosion and reduce microhardness6. Besides, EDTA has no antibacterial properties and a pollutant7. It forms complexes with metals and that remain in the environment for many years since they are not easily biodegraded [8,9.]

Glycolic acid (GA) ($C_2H_4O_3$) or hydroxyester acid belongs to the Group of alpha hydroxyl acid also known as hydroxyacetic acid or hydroxyethanoic acid. It is a colorless, odorless, and water-soluble substance [10,11]. In a recent study, Glycolic Acid, showed similar results to Citric Acid (CA) and EDTA in smear layer removal after root canal preparations from root canal walls. Glycolic Acid has found to be less cytotoxic than EDTA[12]. In vitro and in vivo studies demonstrated that GA has the ability to induce collagen synthesis and fibroblast proliferation[13-15]. Consedaring advantages of Glycolic Acid over EDTA and Citric Acid it has been included in the study.

The aim of this study was to evaluate and compare the effect of Ethylene diamine tetraacetic acid (EDTA) and

Glycolic acid as final irrigants on the apical sealing ability of root canal obturation.

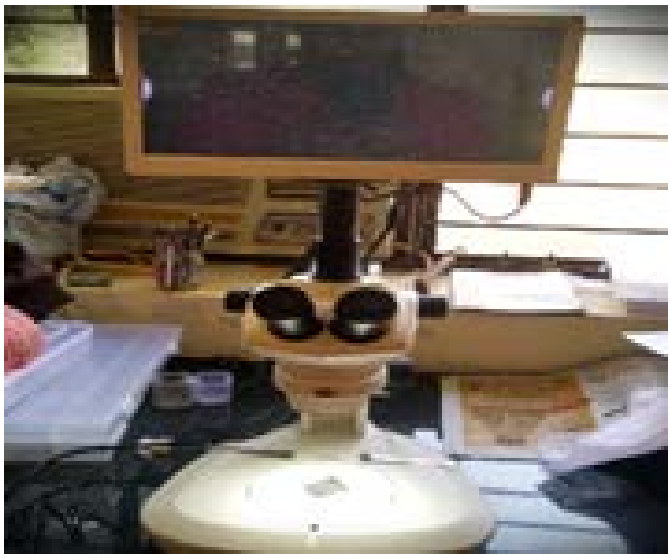
Materials and Method

In the present study, apical sealing ability was detected using two methods. One by detecting dye penetration under stereomicroscope and second by detecting sealer adaptation to canal walls using scanning electron microscope.

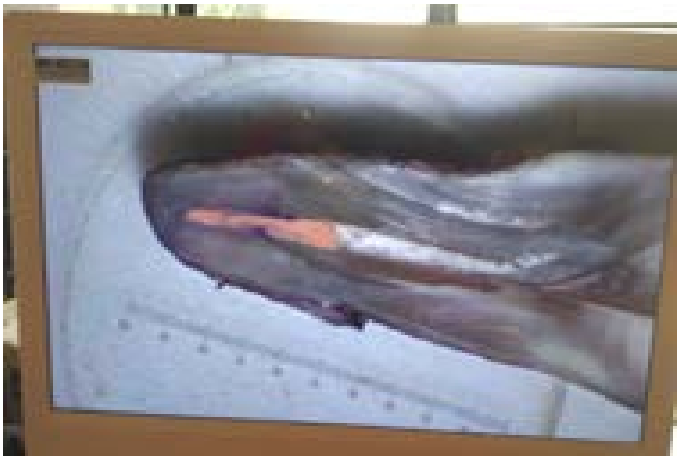
A sample of 40 human extracted mandibular first and second premolars with single root and single canal were selected for the study. The teeth were decoronated and the working length was determined by subtracting 1mm of root length. All the samples were prepared with rotary files (Protaper Universal, Dentsply Maillefer) upto F3 using the crown down technique according to manufacturer's' protocol. Throughout shaping and cleaning, 2ml of 2.5% NaOCl was used as an irrigant solution and during each change of instrument and finally all teeth were rinsed with 5ml of distilled water. All teeth for evaluation were then randomly assigned into two Group of 20 specimens. Group 1 was initially irrigated with 2.5% sodium hypochlorite and final irrigation was done with 17% EDTA for 1 minute. Group 2 was initially irrigated with 2.5% sodium hypochlorite and final irrigated with 17% Glycolic acid for 1 minute.

Finally, root canal were flushed using saline (5ml) and were dried using paper points #3. All root canal were obturated with gutta percha #F3 (Pro Taper, Dentsply Maillefer) and epoxy resin-based sealer (AH Plus, Dentsply, DE Trey, Konstanz, Germany). Radiographic images were undertaken to observe the hermetic obturation. Specimens were kept in an incubator with a temperature of 37^{o} C and 100% humidity for 7 days to allow the setting of the sealer.

Apical leakage test- Apical leakage was estimated by a dye penetration test using stereomicroscope (Olympus Corp, Tokyo Japan). After root canal obturation, thirty specimens for apical sealing ability evaluation were covered with nail polish, except for apical 1 mm of root apex on the root surface. Then all the specimens were immersed in 2% methylene blue for 7days. Following immersion, specimens were cleaned from nail polish and they were split perpendicularly to the tooth axis in the buccolingual direction to produce the mesial and distal sections. The region which had the longest methylene dye penetration was observed under a stereomicroscope (Olympus Corp, Tokyo Japan) with 10x magnification. (Figure 1) Measurement was done by millimeter scale which was attached externally to the microscope. Apical sealing ability was tested by observing the penetration of methylene blue solution from apical to the coronal direction. Measurements of methylene blue penetration were made three times of each specimen. All three measurements were averaged, and the shortest methylene blue penetration indicated the best apical sealing ability.



A



B

C

Figure 1: A. stereomicroscope (Olympus Corp, Tokyo Japan.10x). B & C. Methylene blue penetration was observed under a stereomicroscope with 8x magnification. The penetration of the dye was observed in the apical region.

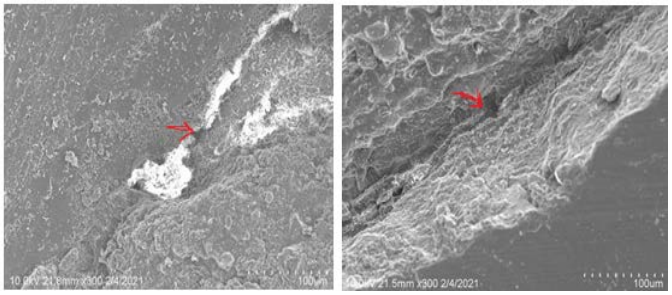
SEM evaluation for adaptation of sealer with dentinal wall

Five specimens from each Group were prepared for Reserved 5 specimen from each Group were prepared for SEM Examination. The root were grooved longitudinally and split in buccal and lingual halves. Both fractured halves of each root were mounted on aluminum stubs, vaccum dried, coated with 20nm of gold and then examined under SEM (Figure 2). Sealer adaptation to dentinal wall were examined from apical to coronal and micrographs were taken at x300 and x1000 magnification. The adaptation to dentinal walls were examined from apical to coronal and micrographs were taken at 300x and 1000x magnification to achieve a representative areas

containing both gap-containing and gap-free region and visualize a broader aspect of sample.

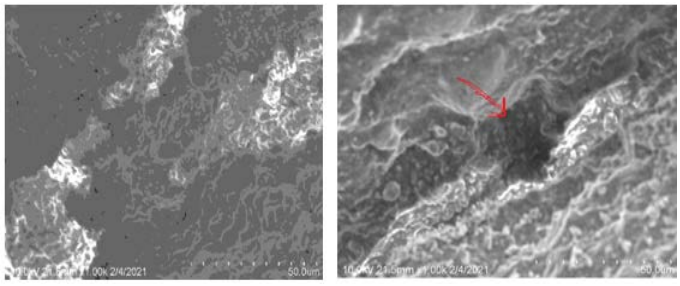
Under SEM, two-three representative areas from apical third of each sample were focused and core-sealer interfacial gap containing and gap free zones were measured.

Figure 2: Scanning Electron Microscope



17% Glycolic Acid X300 17% EDTA X300

Figure 3: SEM images of Root Dentin- Final Irrigation with 17% Glycolic Acid and 17% EDTA (x300)



17% GA X1000 17% EDTA X1000

Figure 4: SEM images of Root Dentin - Final Irrigation with 17% Glycolic Acid and 17% EDTA (x1000)

Statistical analysis and methods

Quantitative data for dye penetration using stereomicroscope was collected by using a structure preform. Data thus was entered in MS excel sheet and analysed by using SPSS 24.0 version IBM USA. Quantitative data was expressed in terms of mean and Standard deviation. Comparison of mean and SD between two Group will be done by using unpaired t test to assess whether the mean difference between Group is significant or not. Descriptive statistics of each variable was presented in terms of mean, standard deviation, standard error of mean. A p value of <0.05 was considered as statistically significant whereas a p value <0.001 was considered as highly significant.

Results

Table 1: Shows the mean microleakage (mm), SD and SE for each study Group.

	N	Mean	Std. Deviation	Std. Error	Range	Minimum	Maximum
17% EDTA	15	4.91	0.44	0.11	1.70	3.90	5.60
17% Glycolic Acid	15	4.41	0.91	0.23	3.00	3.10	6.10

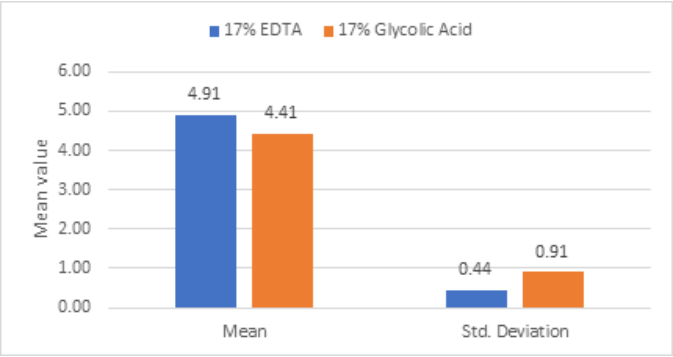
The mean value of dye penetration for the 17% EDTA Group was 4.91 ± 0.44 mm, and for 17% Glycolic Acid Group was 4.41 ± 0.91 mm.

Table 2: Comparison between 17% EDTA and 17% Glycolic acid

Group		N	Mean	Std. Deviation	T	p	Inference
Apical sealing ability	17% EDTA	15	4.91	0.44	2.910	0.046	significant
	17% Glycolic Acid	15	4.41	0.91		(<0.05)	

Group 1 (17% EDTA) proved to have more amount of microleakage than Group 2 (17% Glycolic Acid). There was a significant difference between Group 1(17% EDTA) and Group 2 (17% Glycolic Acid) ($P < 0.05$).

Bar diagram showing Comparison between 17% EDTA and 17% Glycolic acid



Tables 1 and 2 show that the final irrigation using 17% Glycolic acid had the higher apical sealing ability than 17% EDTA. And both irrigation solutions had a statistically significant difference ($p < 0.05$).

Scanning Electron Microscope Examination

The SEM study was carried out for dentine adaptability. SEM evaluated gap free and gap containing zone Among the sealer (AH Plus) dentin interface. SEM examination showed better dentine adaptability for Group 2 (17% Glycolic Acid) than Group 1 (17% EDTA).

Discussion

This study demonstrated that final irrigation with 17% Glycolic acid for one minute produced greeter apical sealing ability than final irrigation with 17% EDTA for one minute. (Yuri Dal Bello et al 2019) demonstrated the Glycolic Acid with one-minute application time has potential to remove smear layer with no Statistical differences compared to those of 17% EDTA and Citric Acid12. The values of Apical sealing ability and Dye penetration after final irrigation for one minute with 17% EDTA in our study are in accordance with study conducted by (Diatri Ratih et al.) 20206. Glycolic acid

is hydrophilic; hence, it can maintain tight contact and can be adsorbed to the root canal dentin. Asharf et al.[16] reported that to obtain a good apical sealing ability required smear layer elimination from the internal surface of root canal dentin. The smear layer formed must be removed as it can block the irrigation material and prevent sealer infiltration into either the dentinal tubules or fibrillar spaces of intratubular dentin of the root canal[17].

The smear layer also consists of bacteria and its products as well as the necrotic tissues, which may cause bacteria to enter deeper into the dentinal tubules, and it can prevent adaptation between obturation material and root canal walls, resulting in poor apical sealing ability[18]. This study used adhesive material of epoxy resin as a sealer. Bonding of this type of the sealer to the root canal wall is predominantly influenced by the existence of smear layers because smear layers are able to disturb the adhesion of adhesive materials to root canal walls[19]. Final irrigation with GA has shown potential to demineralize dentin and remove smear layer in previous studies. 17% Glycolic acid showed the similar ability to remove smear layer compared to 17% EDTA, Also GA does ndt increase dentin erosion[20]. In this study 17% GA has been used instead of 5% or 10%, which demonstrated probable alterations in superficial dentin properties, like microhardness and roughness; These alterations are intended because they facilitate the bio mechanical preparations under clinical conditions[21],while rough surface can facilitate adhesive penetration and improve the micro mechanical bonding[22],however, with no flexural strength change which may increase the risk of vertical tooth fracture[23].

17% GA showed greater microbial reduction than 17% EDTA And 17% Citric Acid (Gambin et al. 2020)[24]. The cytotoxic results indicated that 17% EDTA has more cytotoxic effect than 17% GA10.

The scanning electron microscope showed that AH Plus resin sealer had adapted better to dentine in Group 2 (17% GA) than Group 1 (17% EDTA). Both Group showed poorer adaptation in the apical third than the coronal And middle thirds of the root canal. Nevertheless, no final irrigation solution had capability to completely remove the smear layer mainly at the apical third, which may be due to the reduction of the diameter And increase of the depth of the root canal[25].To overcome this disadvantage, irrigant agitation devices, such as sonic or ultrasonic irrigation, can be applied to improve removal of the smear layer[26].

Conclusion

Within the limitations of this study, it was concluded that the apical sealing ability and sealer adaptation to dentinal walls were observed to be good; when 17% Glycolic acid is used as a final irrigating solution as compared to 17% EDTA. This study supports the potential use of GA as an alternative final irrigation solution for root canal preparations. Further studies are needed to establish an ideal clinical protocol for use of Glycolic Acid.

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