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Do Medicaments Affect the Adhesive Property of the Resin – Based Sealer – An In Vitro Study

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Abstract
Aim: *The aim of this study is to evaluate the apical sealing ability of AH Plus sealer mixed with either chlorhexidine or cetrimide and combined with both*
Materials and Methodology: *80 freshly extracted human single rooted permanent teeth were selected, which are decoronated and the root canals were instrumented. The specimens were randomly divided into four groups (n = 20) based on sealer used for obturation such as*
Group 1: using AH Plus sealer
Group 2: using AH Plus sealer with chlorhexidine
Group 3: using AH Plus sealer with cetrimide
Group 4: using AH Plus sealer with both chlorhexidine and cetrimide
And the specimens in each group were divided into two subgroups (n = 10) based on obturation technique used such as
Subgroup A: obturated with single cone technique
Subgroup B: obturated with thermoplasticized gutta-percha technique using calamus
Apical sealing ability was evaluated using dye penetration method. Teeth were split longitudinally and then horizontally markings are made at 2, 4 and 6 mm from the apex. Dye penetration evaluation was done using stereomicroscope under 30X magnification.
Results: *All the statistical analysis was done using SPSS version 16. A p-value of <0.05 was considered statistically significant. Comparison of mean dye penetration was done using ANOVA with post-hoc tukey's test. In all groups, Sub-group B had lower mean dye penetration than subgroup A. There was no significant difference in the mean dye penetration among the 4 groups in subgroup A (p=0.154) and subgroup B (p=0.798).*
Conclusion: *Within the limitations of this study, there is no significant difference in apical sealing ability of AH Plus sealer when combined with CHX and CTR or both. Thermoplasticized gutta-percha technique with calamus showed better apical sealing ability when compared to single cone obturation technique.*
Keywords: *AH Plus, cetrimide, chlorhexidine, single cone technique, calamus, apical sealing ability.*

Introduction

The success of endodontic treatment depends on the quality of the root canal preparation (cleaning and shaping) followed by a hermetic root canal filling, sealing all "portals of exit" and coronal restoration.[1] The most important objectives of endodontic treatment are the elimination of microorganisms from the root canal system and the prevention of subsequent reinfection.[2] However, in some cases the complete elimination of bacteria from the root canal system is impossible. Hence, the use of root canal filling materials with antibacterial activity can reduce the number of remaining microorganisms, prevent recurrent root canal infection, and aid the repair process of apical and periapical tissues.[3]

Root canal filling material includes core material and sealer. A great variety of endodontic sealers are available commercially; most of them are based on zinc oxide–eugenol, epoxy resin, calcium hydroxide, and glass ionomers. Sealers with adhesive property (epoxy resin based sealer) afford very good physical properties and ensure adequate biological performance.[4]

AH Plus (Dentsply DeTrey, Konstanz, Germany) is an epoxy resin-based root canal sealer with good physical properties, good adhesion to dentin, and excellent fluidity and stability in aqueous solution.[5] Apart from being biocompatible, it is not genotoxic and exhibits good tissue tolerance, sealing ability, long-term dimensional stability and antimicrobial properties.[6]

In the last decade, research has been done on incorporation of antimicrobial agents into dental materials to lend them antimicrobial activity. The incorporation of CHX and/or CTR into glass ionomer cement (GIC) is known to confer it with beneficial antibacterial properties.[7] It was recently shown that the incorporation of benzalkonium chloride and cetylpyridinium chloride into endodontic cements improves their antibacterial effect on S. mutans, Lactobacillus casei, and Actinomyces viscosus.[8] In the same line, Chlorhexidine (CHX) and Cetrimide (CTR) which are effective antimicrobial agents were incorporated into AH Plus sealer and studies by M. Estela Bailon- Sanchez et al, showed that these combinations increased the bactericidal and anti-biofilm capacity of the sealer.[9]

Though antimicrobial properties of AH plus sealer were improved by addition of CHX and CTR, further experiments concerning dimensional stability, adhesion to dentin or gutta percha, and leakage of the sealer should be undertaken before these combinations can be considered for clinical application.

The obturation technique advocated along with sealer is also important to achieve hermetic, three dimensional root canal filling. With the introduction of Ni-Ti rotary instruments for canal preparation, a simple and time efficient obturation technique i.e. matched tapered single-cone obturation has become popular.[10] Injected thermoplasticized GP obturation technique is another popular technique for canal obturation introduced by Yee et al. in 1977 which can replicate the intricacies of the root canal system as well as improve the homogeneity and surface adaptation of gutta percha.[11]

Hence, the aim of present study was firstly to evaluate the apical sealing ability of AH Plus sealer when mixed with either chlorhexidine or cetrimide and combined with both; and secondly to evaluate the sealing ability of AH Plus sealer when used with single cone and thermoplasticized GP obturating systems.

Materials and Methods

Eighty freshly extracted human single rooted permanent teeth with fully developed root apices, straight roots, free of cracks, caries, resorptive defects and fractures were selected for the study. After removal of the external debris, teeth were placed in 2.5% sodium hypochlorite solution for 2 hours and stored in normal saline. Teeth were decoronated by using diamond disc mounted in a slow speed straight hand piece to achieve length of 12 mm from the apex. Teeth were accessed and instrumentation was done with 11 mm working length using a crown-down technique with Rotary

Pro taper files (Dentsply Maillefer, Ballagigues, Switzerland) till final apical size F3 (#30/0.09) using X-smart endomotor (Dentsply Maillefer, Ballagigues, Switzerland). All the canals were irrigated with 10 mL of a freshly prepared solution of 5.25% sodium hypochlorite (NaOCl) and 17% EDTA solution alternatively between files and the final irrigation was done with normal saline. The canals were then dried with sterile paper points.

Obturation of canals

After root canal preparation, the specimens were randomly assigned to the following four groups (n=20) based on sealer used for obturation as:

Group I - GP using AH Plus sealer

Group II- GP using AH Plus sealer with chlorhexidine

Group III- GP using AH Plus sealer with cetrimide

Group IV- GP using AH Plus sealer with both chlorhexidine and cetrimide

And the specimens in each group were divided into two subgroups (n = 10) based on obturation technique used such as

Subgroup A: obturated with single cone technique

Subgroup B: obturated with thermoplasticized gutta-percha technique using calamus

Concentrations of 10% CHX digluconate were combined with AH Plus sealer in a ratio 1/10 (v/v). CTR powder was added to AH Plus sealer in ratios ranging from 1/100 (w/w) to obtain concentrations from 0.1%-0.5%.

Single-cone obturation technique: A single cone of gutta-percha tapered with diameter and conicity corresponding to the final shaping instrument (#30, 0.09), was tried in the root canal. After visual and tug-back control, fit of the cone is checked with a periapical radiograph. Then canal walls were coated with sealer using lentulospiral (Mani, Japan) followed by insertion of single cone till the working-length. The excess of gutta-percha was removed with a heated instrument.

Thermoplasticized Gutta-percha Technique: Obturation was done using Calamus dual 3D obturating system (Dentsply Maillefer, Ballaigues, Switzerland) by squirt technique. The canal walls were coated with sealer while excess sealer should be absorbed using an absorbent point. The catridge consisting of thermoplasticized GP is preheated to 160°C and positioned inside the canal such that it reaches 3-5 mm of the apical preparation. The GP should slowly be injected into the canal by squeezing the trigger to obturate the apical third. When backpressure was felt, the catridge is backed out. In this way entire canal is backfilled using Calamus Flow handpiece in conjunction with a 23 gauge cartridge which delivers thermosoftened gutta percha into the canal. It was then condensed using a heated plugger.

After obturation, the coronal opening was sealed with glass ionomer cement, restorative type (GC FUJI Type 2). The samples were then stored in a humid atmosphere (Incubator) at 37°C for 24 hours. Later, the surfaces of the samples were dried and two layers of coloured nail varnish was applied on the surface 2 mm short of the apex. The specimens were then suspended in freshly prepared 0.2% rhodamine dye for 72 hours. Following this, the samples were rinsed for 15 minutes under running tap water.

Preparation of specimens for evaluation of dye penetration

The varnish layers were scrapped off and the samples were split longitudinally parallel to the long axis using a diamond disc under water coolant and markings were made at 2, 4 and 6 mm from the apex on sectioned root surface. The depth of dye penetration was examined under stereomicroscope (Magnus) at 30× magnification and dye penetration associated with different combinations of sealers was evaluated as shown in fig 1. The depth of dye penetration is measured by IMAGE PRO EXPRESS software and values are obtained in millimetres as shown in figure 2.

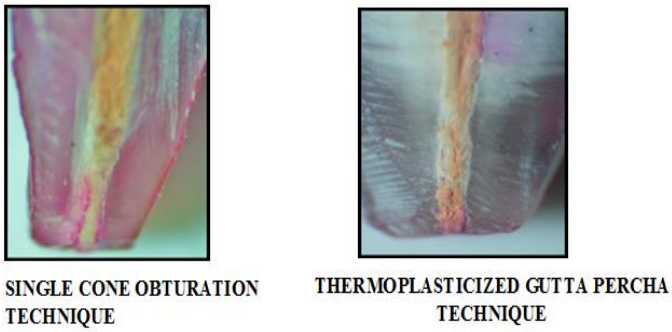
Results and Statistical Analysis

All the statistical analysis was done using SPSS version 16. A p-value of <0.05 was considered statistically significant. Comparison of mean dye penetration among four groups was done using ANOVA with post-hoc tukey's test. Comparison of mean dye penetration between the two sub-groups was done using Independent sample t test.

A summary of results is given in Table-1, Table -2, chart-1and chart-2

There was no statistically significant difference in the mean dye penetration among the 4 groups in inter group comparison which indicates that addition of either CHX and CTR or combination of both to AH Plus sealer does not affect its apical sealing ability. Intra group comparison results depicted that sub-group B has showed lower mean dye penetration than subgroup A in group 2 and 3 which indicates that thermoplasticized GP technique resulted in better sealing ability than single cone obturation technique.

Figure 1: Stereomicroscopic Images at 30x Magnification



SINGLE CONE OBTURATION TECHNIQUE

THERMOPLASTICIZED GUTTA PERCHA TECHNIQUE

Figure 2: Image Analysis with Image Pro Express for Measuring Dye Penetration

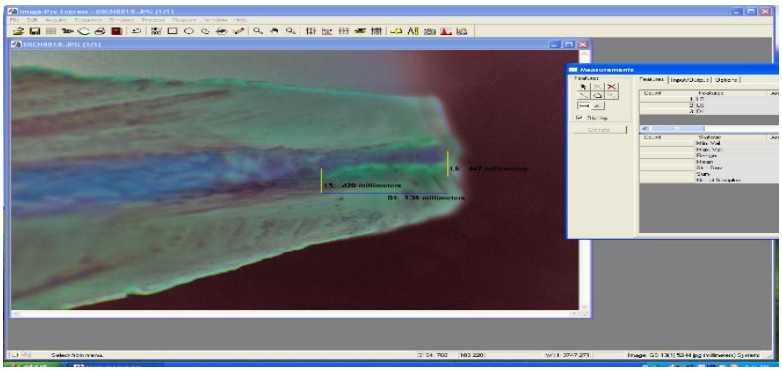


Table 1:

	Group 1		Group 2		Group 3		Group 4		p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Sub-group A	4.42	.63	5.52	1.44	5.72	1.74	3.98	1.79	0.154 (NS)
Sub-group B	3.33	1.08	3.15	.98	3.14	1.58	2.64	1.02	0.798 (NS)

Chart 1:

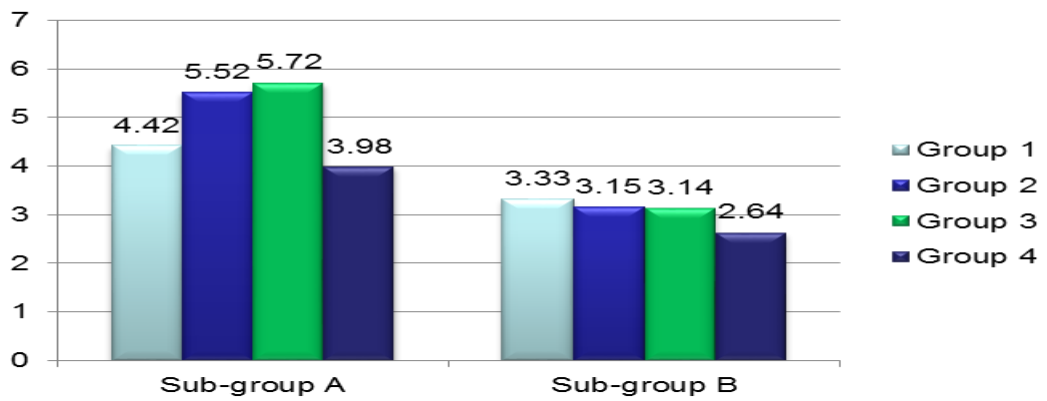
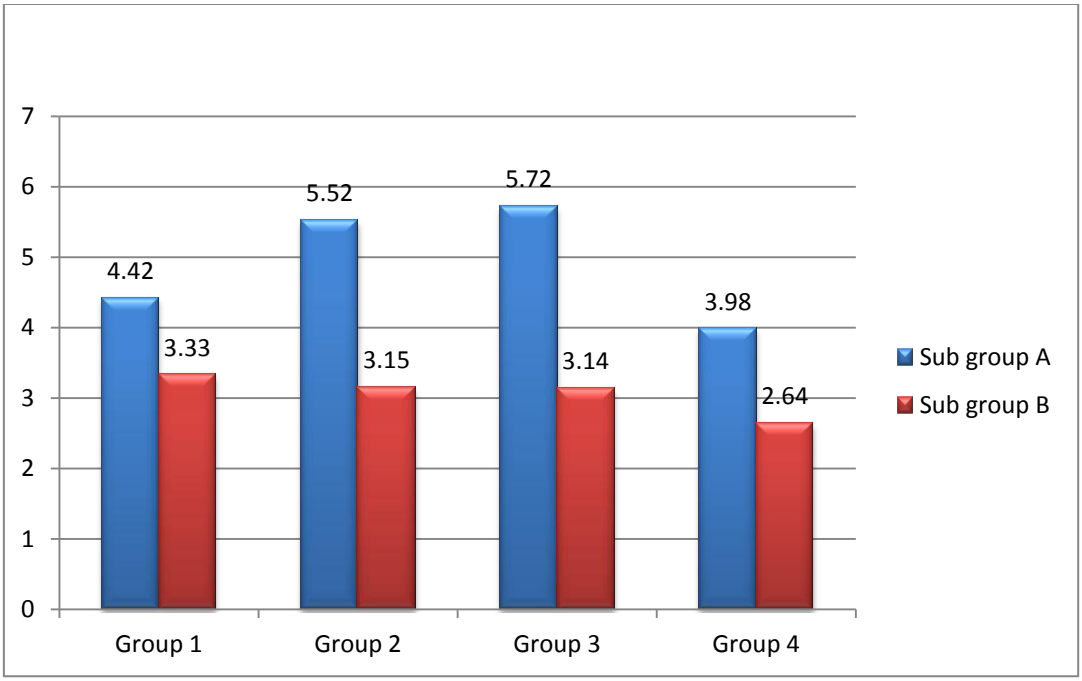


Table 2:

	Sub group A		Sub group B		p-value
	Mean	SD	Mean	SD	
Group 1	4.42	.63	3.33	1.08	0.06; NS
Group 2	5.52	1.44	3.15	.98	0.008; Sig
Group 3	5.72	1.74	3.14	1.58	0.032; Sig
Group 4	3.98	1.79	2.64	1.02	0.173; NS

Chart 2:



Discussion

The purpose of the root canal obturation is to provide a tight seal that prevents reinfection of the canal and subsequent leakage of fluid and antigenic agents into or from the periradicular tissues.[12] Nowadays, there is increasing demand for prompt, simple and efficient obturation technique, which improves clinical practice and causes less stress for patients and clinicians. Along with the obturation technique used sealer with adhesive properties to dentin walls is highly beneficial in producing a fluid tight seal.

AH Plus, an epoxy resin–based root canal sealer, was selected in this study because several in vitro, in vivo and clinical studies indicate its suitability for endodontic therapy due to its biocompatibility, good tissue tolerance, sealing ability, and long term dimensional stability.[9]

In the present study there was no significant difference in sealing ability of AH Plus sealer when CHX and CTR were added as they are used in low concentrations which does not effects the physical properties of sealer. Matilde Ruiz-Linares et al in their study elucidated that the addition of CHX, CTR, and combinations of both to AH Plus does not alter the physical properties specified by ANSI/ADA requirements. They observed that AH Plus with CHX + CTR provides values closer to AH Plus alone in terms of setting time, flow, solubility, and radiopacity.[13] The present results also corrabates with the work of Arias-Moliz MT et al who assessed the microstructure of the AH Plus sealer with or without benzalkonium chloride (BC) compounds and proved that they exhibited the typical morphology of AH Plus with the results of physical tests like setting time, solubility and micro-hardness remained consistently within the ANSI/ADA limits for endodontic cements.[14]

Dye penetration method was used to assess the microleakage as it is a simple, easier and cost effective method.[15] This method permits comparison of the apical leakage under identical experimental conditions, and provides a realistic imitation of clinical conditions.[16] Rhodamine-B dye was used in this study due to its small particle size, better penetration, water solubility, diffuse ability, hard tissue non-reactivity. As methylene blue dye it is not affected by alkaline material.[17]

Stereomicroscopic examination was chosen for this study as it provides a 3 - D view of the surface to be examined, requires no pretreatment of the specimen (as in the scanning electron microscopic examination) and is associated with an image analysis software, which aids in eliminating human errors, in the interpretation of the sealing ability and adhesiveness of the sealer to dentine walls or sealer-gutta-percha interface on various levels of sectioning.

The results of the present study show more dye penetration values for single-cone obturation technique which can be attributed to the root canal anatomy of premolar tooth where the single cone has failed to fill the canal space completely. The root canal preparations with NiTi rotary systems are more conical than manual preparations.[18] A matched taper single-cone obturation technique may be more effective in narrow round canals, as observed by Gordan et al and Daniele et al who stated that the single-point technique is simple but its application must be limited to round canals that have assumed a precise shape given by the instrumentation procedure.[19] Effectiveness of the single-cone technique is based on the cement or sealer which provides an effective seal in both thick and thin layers and in sufficient quantity that it can fill all the gaps between the master gutta-percha cone and the walls of the canal. As the volume of sealer is higher relative to the volume of cone it promotes void formation and reduces the quality of the seal.[20]

Thermoplasticized gutta percha technique is to continuously and progressively carry a wave of warm gutta percha from the apical constriction to the orifice producing a 3- dimensional obturation.[21] The lesser dye penetration values for this technique were accredited to the hydraulic properties of pre- warmed or softened GP introduced into the canal system which is less "sealer dependent". Studies by Cheryl et al, Goldberg et al showed the ability of thermoplasticized material because of its plasticity to flow laterally & vertically into root canal walls and ramifications, providing excellent surface adaptation ensuring a dense root fill.[22,23]

Natera M et al also demonstrated in their study that the modified injectable gutta-percha obturation technique (MIGP) technique appeared to replicate the canal defects at the apical third better than continuous wave technique (CWT), with fewer voids in between the canal walls and the gutta-percha mass.[24] Damasceno et al also evaluated the apical microleakage of the single-cone technique compared with Thermocompactor (TC) system without master cone when used with AH Plus sealer and elucidated that "alpha" phase of GP in TC technique was more flexible, adherent, well adapted to canal walls. The single cone technique uses "beta" type of GP which is more consistent but less adhesive and shows less condensation in the apical third of root canal due to the diameter of the capacitors which often do not reach this area.[10]

Though themoplasticized GP technique provides better adaptation to canal walls and ramifications, it is important to maintain a proper apical stop to prevent extrusion of GP. Futher studies are still required to evaluate the effect of consecutive heat application to condense the GP on the periodontal ligament and surrounding bone.

Conclusion

Within the limitations of this study, there is no significant difference in sealing ability of AH Plus sealer when combined with CHX and CTR or combination of both. Thermoplasticized gutta percha technique with calamus resulted in better apical sealing ability than single cone obturation technique.

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