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Research Article

A Comparative Evaluation of the Change in pH of Four Endodontic Sealers Overtime and their Antimicrobial Effectiveness: *In Vitro* Study

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Abstract

Aim: To evaluate the pH value and antimicrobial activity of four -Zinc oxide eugenol, AH- plus (Dentsply, Germany), Sealapex (calcium hydroxide based, Sybron Endo, Glendora, USA) and MTA Fillapex (Angelus, Londrina, Brazil) root canal sealers at different time intervals.

Objectives: To determine the pH related antimicrobial effectiveness of four endodontic sealers.

Materials and methods: Four sealers samples were manipulated with distilled water as 1:10 ml ratio. The manipulated samples were transferred to clean dry glass beaker. The pH was assessed by using digital pH meter after mixing with distilled water at (0 hours), (6 hours), (12 hours), (24 hours). Statistical analysis was performed using ANOVA, followed by post hoc tests.

Results: The results of the study show that all the four sealers tested were alkaline in nature throughout the test periods. All the sealers showed a significant change during the time periods ($p<0.05$). There was a statistically significant change at all time intervals between Zinc oxide eugenol and AH-plus or sealapex or MTA- Fillapex ($p< 0.05$). However, there was no significant difference between AH-plus and sealapex or MTA-Fillapex ($p>0.05$).

Conclusion: Within the limitations of this study, it can be concluded that all the four sealers used in this study are alkaline in nature, with MTA Fillapex showing the highest pH and Zinc Oxide Eugenol the lowest with significant difference between the two. There was no significant difference between AH Plus and Sealapex at all time periods.

Keywords: Alkanline pH; Endodontic sealer; Root canal system

Introduction

The foremost objective of root canal treatment is to eradicate microorganism from the root canal system of tooth. Recontamination followed by retreatment is associated with persistence of microorganisms in the root canal (Table 1) [1]. About 35% of the root canal wall is left untouched in conventional root canal treatment using hand and rotary instruments. Hence the main reason behind failure of root canal treatment is incomplete eradication of microorganism in root canal system [2].

Endodontic sealer is used in obturation to come over the minor discrepancies between dentinal wall and gutta-percha to achieve hermetic seal [3]. This prevents the diffusion of any bacteria from oral environment to periapical tissues, thus contributing healing of periapical tissues. Also, pH of sealer is interconnected with antimicrobial effect and deposition of mineralized tissue, thus playing major role in root canal treatment [4]. Periapical infections cause release of lactic acids by osteoclasts and cause demineralization of hard tissues within the canal [4,5]. Alkaline pH of root canal sealer could reverse this effect by neutralizing the lactic acids production during infections. Some microorganism has ability to penetrate dentinal tubule and to organize into biofilms (Love, 2001, Radcliff, et al. 2004). This kind of behavior can be irreversibly inactivated at a pH greater than 9 resulting in disrupting their biological activity [5].

Different kinds of endodontic sealer are available, based on zinc oxide-eugenol, calcium hydroxide, resin, glass ionomer, Mineral trioxide aggregate based. Except the glass ionomer based endodontic

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Table 1: Alkanility at different time intervals.

SEALER	ZINC OXIDE EUGENOL	AH-plus	SEALAPEX	MTA-Fillapex
At mixing (0 hours)	9.18	9.82	9.67	10.59
At 6 hours	7.8	9.85	10.46	10.45
At 12 hours	8.3	9.67	10.42	11.25
At 24 hours	8.97	10.77	10.87	11.42

sealer others are used frequently [1]. The objective of the present study was to analyze the effectiveness of four different based endodontic sealers, namely Zinc oxide eugenol, AH- plus (Dentsply, Germany), Sealapex (calcium hydroxide based, SybronEndo, Glendora, USA) and MTA Fillapex (Angelus, Londrina, Brazil) root canal Sealer. The aim of the study was to evaluate the pH of the mentioned sealers at different time interval.

Materials and Methods

The total four number of root canal sealers Zinc oxide eugenol, AH- plus (Dentsply, Germany), Sealapex (calcium hydroxide based, SybronEndo, Glendora, USA) and MTA Fillapex (Angelus, Londrina, Brazil), were used as study materials. Each sealer was properly mixed accordingly to manufacturer recommendation. After thoroughly mixing 1ml of each sealer was blend with 10 ml of distilled water. Then the diluted sealers samples were put into clean dry four different test-tubes. With the help of digital pH meter, the pH values of all root canal sealers were measured. To imitate oral environment for accurate pH measurements, the pH recording was carried out at 37°C fluid temperature. In between each recording the tip of pH meter was cleaned with double distilled water to avoid counterfeit measurements. The pH measurements were carried out at 0 hours, 6 hours, 12 hours, and 24 hours before refilled the test-tubes.

Result

The results of the study show that all the three sealers tested were alkaline in nature throughout the test periods (Table 2). Among the sealers, MTA Fillapex had the highest pH from the start of the mix to up to 24 hours, while Zinc oxide eugenol had the least pH immediately after mixing. Sealapex showed a gradual rise in pH within the range of 9.6 to 10.8 (Figure 1). All the sealers showed a significant change during the time periods ($p<0.05$). There was a statistically significant change at all time intervals between Zinc oxide eugenol and AH-plus or sealapex or MTA- Fillapex ($p<0.05$). However, there was no significant difference between AH-plus and sealapex or MTA-Fillapex ($p>0.05$).

Discussion

With peculiar endodontic sealers being successively developed and commercialized by manufacturers, it's become important for the clinician to know the physicochemical properties of endodontic sealers. Endodontic sealers have qualities that are mostly governed by the kind and amount of the primary components and can operate properly under clinical situations. Laboratory investigations on the physicochemical features of endodontic sealers should help researchers better understand their clinical behavior and handling performance. In an attempt to produce a biocompatible sealer with optimal physical, chemical, mechanical, and biological characteristics, novel endodontic materials based on the physicochemical features of bioceramic cements have recently been developed. Hence, the present study was undertaken to evaluate the ph of four different sealers- Zinc oxide eugenol, AH-plus, Sealapex, MTA- Fillapex at different time periods, mainly at 0, 6, 12 and 24 hours.

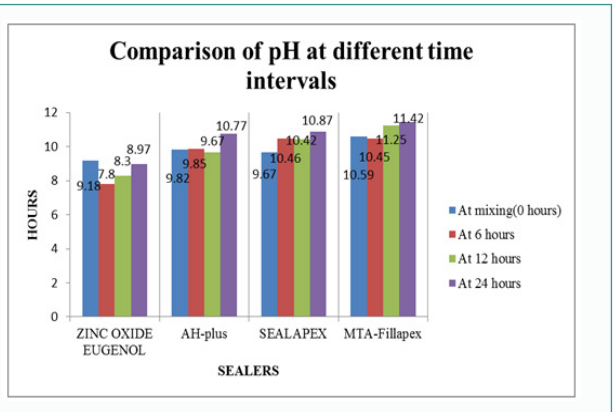

Figure 1: pH at different time intervals.

This pH reduction is due to because of buffering effect of the radicular dentine. It has been known that the *E. faecalis* can survive at a pH as high as 11.5 hence; with the lower pH value of the *E. faecalis* in the dentinal tubules could not be removed effectively. One of the distinguishing qualities of *E. faecalis* is its ability to resist alkaline pH, which normally inhibits other microbes. It has been shown that *E. faecalis* can resist a pH of 11.0 but gets killed only if the pH is 11.5. Therefore, it is important that the pH of a sealer should be as high as possible to eradicate the persistent microbes which had survived chemo mechanical preparation. In our present study, we had used four sealers mainly, Zinc oxide eugenol, AH-plus, Sealapex, MTA-Fillapex. The results of this study show that the pH of all the sealers, tested is alkaline. Amongst these sealers, the Ph OF MTA- Fillapex was highest (11.42) and the ph of Zinc Oxide Eugenol being the lowest (8.97), when observed at 24 hours.

An alkaline pH may contribute to osteogenic potential, biocompatibility, and antibacterial ability of root canal sealers [6-10]. The MTA Fillapex sealer demonstrated the higher alkalinity (pH=11.42 at 24 hrs), epoxy resin-based sealers tested (AH plus) showed a fair alkalinity, the Sealapex sealers reported an initial weak alkaline pH (9.67) followed by a neutral pH (8.97) for Zinc oxide eugenol. Recent studies indicated that the resin-based sealers like AH plus are characterized by a slightly neutral pH. This concept was confirmed by Faria-Júnior et al. [4] the neutral pH and its low solubility may reduce the antibacterial activity of the sealer.

MTA fillapex reported an initial neutral pH (10.59) that was followed by a moderate alkaline pH (11.42). Various studies supported these findings about MTA based sealers: their pH is ranging between 10-12 for some weeks after setting [7,11]. The initial pH of MTA-Fillapex was somewhat alkaline (pH=9.3), but it rapidly decreased to 7.76 after one week.

A strong alkaline pH is supposed to encourage a prolonged setting time and a long-lasting antibacterial effect that eliminates the residual microorganisms survived along dentinal walls. Silva et al. suggested that MTA-Fillapex, due to high alkalinity, is able to release hydroxyl ions, thereby causing a high Ca2+ ion release. The alkaline state may help to build hard tissue by activating alkaline phosphatase, neutralise lactic acid produced by osteoclasts, and inhibit the dissolution of mineralized components of teeth, as well as prevent bone deterioration and tissue regeneration through the creation of hydroxyapatite [12]. In Lee et al. [13] study the pH value of three different bioceramic-based root canal sealers remained significantly higher than that of epoxy resin-based sealers for 24 hours, with the highest alkaline pH measured from MTA Sealer for the entire period of evaluation.

In another study conducted by Kapralos et al. [14] a variety of different biofilm models had been used to evaluate the effectiveness of endodontic irrigants, against the antibacterial activity of endodontic sealers of biofilms. Also, a study conducted by Mario Leonardo et al. [15] had checked antimicrobial activity of different sealer materials. However, our results were also contrary to this study, as we had evaluated the ph of different sealer materials at different time periods.

Table 2: Comparison of mean difference of pH value after 24 hours (Sig p<0.05).

(I) Sealers	(J) Sealers	Mean Difference (I-J)	Std. Error	Sig.	t
ZINC OXIDE EUGENOL	AH-plus	-1.46500*	0.37581	0.013	-4.745
	SEALAPEX	-1.79250*	0.37581	0.003	-3.87
	MTA-Fillapex	-2.36500*	0.37581	0	-7.07
AH-plus	SEALAPEX	-0.3275	0.37581	1	-1.547
	MTA-Fillapex	-0.9	0.37581	0.203	-3.922
SEALAPEX	MTA-Fillapex	-0.5725	0.37581	0.921	-2.732

Also, in a study conducted by Poggio et al. [16] the pH of MTA Fillapex showed higher ph values over time. The results were similar to the present study, as in our study, the ph value of MTA Fillapex increased gradually. Although, our results were also contrary to this study, as the sealer materials like Sealapex and AH plus had decrease in Ph values over time. However, in our study, the ph value of Sealapex and AH plus increased gradually over time from the start of the mix till 24 hours.

Our study was similar to the study performed by Zhou et al. [17]. In that they had assessed pH change in different sealer materials along with other physical properties. In this study, they had observed that MTA Fillapex had alkaline ph after setting, compared to other materials. Also, our results were similar to the study conducted by Faria Junior et al, in that they had observed that the ph of AH plus increased gradually from the start of the mix upto 24 hrs.

Our results were contrary to the study performed by Arunajatesan et al. in that the ph of AH-plus sealer was the lowest. Also, in our study, the pH of AH-plus gradually decreased from the start of mixing up to 24 hours. However, in our study, the pH values increased gradually. Henceforth, further studies are required to gain variable information regarding sealers.

Conclusion

Within the limitations of this study, it can be concluded that all the three sealers used in this study are alkaline in nature, with MTA Fillapex showing the highest pH and Zinc Oxide Eugenol the lowest with significant difference between the two. There was no significant difference between AH Plus and Sealapex at all time periods.

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