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The pH Changes of Four Different Root Canal Sealers After Mixing at Various Time Intervals *in vitro*

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Abstract

The purpose of this study was to compare the surface pH level of four different type sealers after mixing at various time intervals in vitro. After cleaning and shaping root canals in 50 recently extracted, single-rooted human teeth, they were divided into six groups. Each of four groups was obturated with Apexit, N2, Sealapex, and Grossman sealers. The remaining groups served as controls. In group 1 nothing was added to the vial of saline solution. In group 2 canals had been instrumented but not obturated with sealer. The pH level of saline solutions was determined at intervals of 1 hour, 4 hours, 1 day, 2 days, 3 days, 1 week, and 4 weeks after teeth were placed in them. The pH levels of the five solutions were compared to each other and to that of saline solution only.

Keywords: Calcium hydroxide-based cements, root canal sealer

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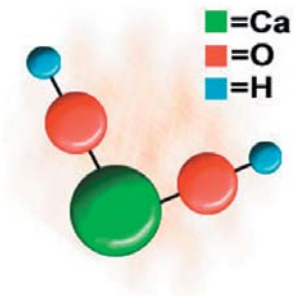
Introduction

A combination of sealing ability and biocompatibility of root canal sealer is important for a favorable prognosis in root canal treatment. There are three types of root canal sealers used in endodontic treatment. They are the calcium hydroxide-containing cements, the zinc oxide-eugenol-based cements, and resin based cements.[1] Since its introduction in dentristry, calcium hydroxide has been used for a wide variety of purposes including lining of cavities, indirect and direct pulp capping, dressing of the root canal between appointments, prevention of root resorption, repair of iatrogenic perforations, treatment of horizontal root fractures, and as a constituent of root canal sealers.[2,3] The role of calcium hydroxide in endodontics includes its ability to induce hard tissue formation, its ability to cause intratubular occlusion, its antibacterial actions, and its tissue-dissolving capability.[2,3,4]



The high pH level of calcium hydroxide in root canal fillings promotes a state of alkalinity in tissues immediately adjacent to the compound. This influence on the pH level has been shown to be nonspecific and of low toxicity because of the low solubility of calcium hydroxide.[2,5]

Granch et al. reported some root canal sealers could hamper the periapex healing processes by inhibiting cell proliferation through a selective action on different phases of the cell cycle.[6]

Tronstad et al. suggested calcium hydroxide placement in root canal elevates the pH, producing an alkaline environment in the surrounding tissues by the diffusion of hydroxide ions through the dentinal tubules.[13] High pH is bacteriocidal and inhibits osteoclastic activity as well.[3]

When dissolved in water, calcium hydroxide dissociates into hydroxide ions and calcium ions.[7] The presence of hydroxide ions in a solution makes it alkaline and, thus, antimicrobial.[8]

The purpose of this study was to compare the surface pH level of five different type sealers at various time intervals in *in vitro*.

Materials and Methods

Fifty extracted human permanent teeth with single root canals were stored in 10% formaldehyde solution. All of the teeth were cleaned and all root canals shaped to a minimum of a #40 Hedstrom file 1 mm from the anatomical apex. Irrigation during cleaning and shaping was accomplished using a 5.25% sodium hypochlorite solution.

Fifty (10 ml each) aliquots of normal saline solution were placed in screw-capped glass vials, and the pH level of the solution in each vial was determined with a pH meter (pH meter CG840 Schott). The pH meter had been previously calibrated with solutions with known pH. Groups 1 and 2 served as control groups. Nothing was placed in the vial of saline solution in group 1. Roots with canals that had been instrumented and the access opening filled with Cavit™ but not obturated were placed in the vials in group 2. The experimental groups of solutions received roots obturated with laterally condensed gutta-percha and one of four sealers.

In group 3 Apexit sealer was used (Ivoclar Vivadent, Schaan, Liechtenstein). N2 sealer (INDRAG AGSA S. A., Switzerland) was used in group 4. Sealapex (Kerr, Romulus, MI, USA) was used in group 5 and Grossman type sealer in group 6.

The pH level of solution in each vial was determined with the pH meter at 1 hour, 4 hours,1 day, 2 days, 3 days,1 week, and 1 month following placement of the root in the vials.

After the pH levels of solutions in the control and test groups were determined at the various time intervals, mean and standard deviation were calculated. The significance of differences was determined with one-way analysis of variance (ANOVA), followed by Student-Newman-Keuls (SNK) multiple range comparions.[9]

Results

The mean pH levels at the seven time intervals for all six samples are shown in Table 1 and are also plotted in Figure1.

Table 1. Mean pH levels obtained after different periods of time.

	Canals	Control	Apexit	N2	Sealapex	Grossman
1 hour	8.25	8.39	9.10	7.61	8.95	6.96
4 hour	8.29	8.17	7.94	7.99	8.50	7.14
1 days	8.23	8.02	7.73	7.65	8.31	7.47
2 days	8.20	7.95	7.63	7.61	8.30	7.60
3 days	8.05	7.77	7.51	7.61	8.24	7.61
1 week	7.76	7.71	7.39	7.46	8.07	7.54
4 weeks	7.80	7.84	7.34	7.40	7.86	7.51

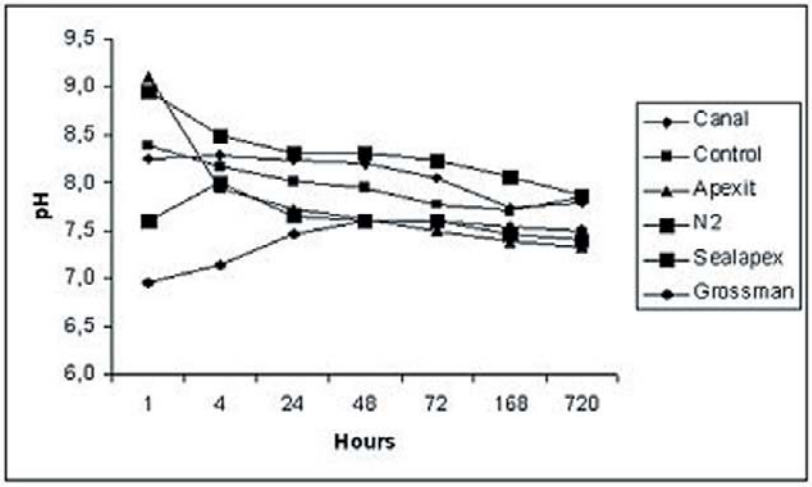


Figure 1. Mean pH levels at seven time intervals for six solutions.

One-way ANOVA was performed to determine if there were any statistically significant differnces between pH determinations for the six different solutions at seven different times (1 hour, 4 hours, 1 day, 2 days, 3 days, 1 week, and 1 month). Results show that for each of the seven intervals, ANOVA had an F probability with $p<0.001$ so the SNK tests were performed each time. At 1 hour, the Apexit and Sealapex groups had higher pH levels ($p<0.001$) than the other groups. The Grossman sealer group had significantly lower pH levels than the other five groups at one hour.

The Sealapex group had significantly higher pH levels than the other five groups, but there were no other significant differences at the four hour interval. The Sealapex group had significantly higher change in pH levels than the other groups for each of the six times except the 1 hour interval ($p<0.001$).

Discussion

Calcium release and an alkaline pH for a material that contains calcium hydroxide or oxide in its composition are extremly important for good biological and microbiological performance of the material.[10]

Calcium hydroxide is available in different forms, combinations, and proprietary compounds.[11] Calcium hydroxide may be used as a canal dressing between appointments, particularly when pulp necrosis has been diagnosed.

Duarte et al. reported that based on the method and conditions employed in their study, it was concluded the addition of calcium hydroxide to AHPlus favours a more alkaline pH of the material and a significantly greater release of calcium.[12]

When calcium hydroxide pastes are used as an intracanal dressing, the pH in dentin rises.[4,10]

Tronstad et al. suggested calcium hydroxide placement in the root canal elevates the pH, prouducing an alkaline enviroment in the surrouding tissues by the diffusion of hydroxyl ions through the denital tubules. Increased pH is bacterisidal and diffussion of hydroxyl ions through dentin into the periradicular tissues neutralizes the acid pH of the resorptive area caused by the action of the osteoclasts.[13]

Calcium hydroxide has been recommended for use as an intracanal medicament based on its antibacterial, antiresorptive, and tissue dissolving properties. When used as a intracanal medicament, calcium hydroxide has been shown to be effective in eliminating bacteria from the root canal space. Its high pH has a destructive effect on bacterial cell membranes and protein structures.[4,13]

Many studies have found that most cements show a low solubility in distilled water; a reduction in pH can produce a marked increased in solubility.1

The zinc oxide cement pH levels increased as time increased, for up to 3 weeks then the pH decreased from that time until the 7th week. The reason may be that the acid cement is degraded by an acceleration of the leaching of ions due to a low pH. Sensitivity to a particuler pH depends on how firmly the metal ions are complexed in the cement. However, the setting reaction of eugenol-based cement is reversible and their degration involves a gradual lose of eugenol and hydrolysis of zinc eugenolate chelate causing the cement revert to zinc oxide.[1]

Gordon et al. reported in their bovine pulp tissue study that saturated calcium and barium hydroxide completely inhibated alkaline phosphatase and lactic dehydrogenase activity, but calcium hydroxide preparations at lower pH levels were much less inhibitory.[5]

Ida et al. indicate the pH values of Nu-Cap, Dycal, Life, Neodyne-, and Nobudyne were lowered by the dentin wall to nearly neutral, but Calvital and Hypocal do not set up like cement. The extraction of calcium ions from these two agents may be greater than that from the others except GC-Altect, therefore, they may end up with higher pH values.[14]

Many investigators have reported various methods for determining the surface pH of cements. In our study it was necessary to utilize special microelectrodes because the pH measurement was conducted with only a small amount of water in contact with the pulp capping agent surface.[15,16,17]

Conclusion

Early pH differences among the sealers evaluated dissappear over a short period of time until no significant differences in pH were observed after four weeks.

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