In Vitro Evaluation of Apical Leakage of Root Canal Sealer Cements Containing Calcium Hydroxide

Bade SONAT, DDS, PhD

(Received 5 September and accepted 24 October 1990)

Key words: calcium hydroxide cements, hard tissue formation, apical leakage study, sealing ability of Sealapex, calciobiotic root canal sealer

Abstract

A study was performed to compare apical leakage in the root canals of teeth obturated with gutta-percha, Sealapex and calciobiotic root canal sealer. The results showed that all materials failed to produce an effective apical seal and that the degree of leakage increased with time.

Introduction

The most ideal post-canal therapy response is the coverage of the apical foramen with hard tissue. Therefore, root canal sealers must be biologically compatible and stimulate the formation of hard tissue for closure of the root apex[1-4].

Calcium hydroxide is a substance known to stimulate hard tissue formation[3-5]. For this reason, it is widely utilized in dentistry for treatment of pulp exposure[6,7] root perforations[8,9], root resorption[9] and also for root canal preparations[3,4,10], as well as its use as an apical barrier for teeth whose apices have not been closed[4,11].

Calcium hydroxide is included in the formulation of many cavity liners and canal sealers. Sealapex (Kerr Sybron, Romulus, MI) and calciobiotic root canal sealers (Hygienic Corp., Akron, OH) are a few of the calcium hydroxide-containing sealers that have been used in the last decade.

Canal sealers are considered to prevent apical leakage by obturating the root canal space as well as by stimulating the formation of hard tissue. Up to now, there have been many studies on the sealing ability of canal sealers[12-16].

COHEN et al.[12] investigated the sealing ability of calcium hydroxide and zinc oxide eugenol sealers using an electrochemical method. LIM and TIDMARSH[13] also examined this property of Sealapex and AH-26 sealers using the same technique.

ROTHIER et al.[14], ALEXANDER and GORDON[15], and HOVLAND and DUMSHA[16] investigated the sealing abilities of calcium hydroxide sealers using the dye penetration method.

Department of Endodontics, Dental Sciences Faculty, The University of Ankara, Turkey.
To whom all correspondence should be addressed: Dr. Bade Sonat, 4. Cadde 150/13 Emek, Ankara, TURKEY.

The purpose of the present study was to compare the sealing properties of both Sealapex and CRSC (calciobiotic root canal sealers) during two different observation periods.

Materials and Methods

Fifty-four single-rooted extracted human teeth were prepared, and through an access opening the pulps were removed from the canals with barbed broaches. All teeth were instrumented to a point approximately 1 mm from the apex, enlarged to size 40.

Final irrigation with a 0.5% NaOCl was performed and the canals were dried with paper points. The 54 teeth were then divided randomly into 3 treatment groups.

Group I : Sealapex and gutta-percha

GroupII : Calciobiotic root canal sealer and gutta-percha

GroupIII : Gutta-percha with no sealer.

Sealers was placed into each canal with a file, then a gutta-percha cone coated with sealer was placed in position using the lateral condensation method.

Group III was obturated with a gutta-percha cone using lateral condensation, but without any sealer.

Each access opening was sealed with CAVIT®, and all teeth were placed in saline solution at 37°C for 48 h to allow the sealers to set.

At the end of this period, the teeth were removed from the saline. The root surfaces of all specimens were coated with two layers of nail varnish and wax, except for a part 1 mm around the apex, in order to prevent absorption of the dye by the surface.

Then, each tooth group was immersed in 5% methylene blue dye solution at 37°C for two different periods (1-30 days).

After removal of the specimens from the dye, the wax was scraped off, washed with tap-water and dried in a stream of compressed air. Then each root was sectioned longitudinally through the center of the root canal. The specimens were mounted on microscope slides and examined with stereoscopic magnifying lenses under reflected illumination.

They were investigated for diffusion of the dye through the apex and along the root canal walls. The length of diffusion in each tooth was measured, and evaluated using an appropriate scale.

Results

The leakage values of teeth were measured in millimeters using a steromicroscope and photographed at different magnifications (Figs. 1-6). The results obtained are shown in Table 1. The results for leakage obtained according to this scale are listed in Table 2, and were evaluated statistically according to Mann-Whitney U test.

At the end of the first day, no significant difference was evident between the apical leakage values for Sealapex and CRSC sealers ($P>0.05$). According to the scale, Sealapex and CRSC sealers showed apical leakage values of 1 mm and 2

Table 1: Evaluation scale

0	0	No leakage
0~1 mm	1	Leakage up to 1 mm
1~2 mm	2	Leakage up to 2 mm
2~3 mm	3	Leakage up to 3 mm
3~4 mm	4	Leakage up to 4 mm
4~5 mm	5	Leakage up to 5 mm
5~6 mm	6	Leakage up to 6 mm
6~14 mm	7	Leakage of more than 6 mm

Table 2: Leakage values of teeth at the 1st and 30th days

Day of examination	Materials		
	Sealapex and gutta-percha	CRSC and gutta-percha	Gutta-percha without sealer
Day 1	001112223	011122223	133456677
Day 30	234445567	234556777	677777777

mm, respectively (Figs. 3,4). The leakage values of the teeth filled only with gutta-percha were found to be significantly higher than those filled with Sealapex and CRSC sealers ($P<0.05$).

At the end of the 30th day, there was a significant increase in the leakage values of all teeth (Figs. 5,6). However, there was no significant difference between the teeth filled with Sealapex and those filled with CRSC sealers ($P>0.05$). Again, as in the case of the first day, the teeth filled only with gutta-percha showed significantly higher leakage than those filled with Sealapex and CRCS sealers ($P<0.05$). The observed leakages spread to all tooth tissues in those filled only with gutta-percha (Fig. 6).

Discussion

Neither of the two calcium hydroxide-containing sealers investigated in this study was found to be totally effective for apical sealing.

ZMENER[17] compared Sealapex and CRSC with Tubliseal, and found that none of the sealers was effective for total sealing, the amount of leakage increasing with time. The increasing dye penetration with time observed in our study was thus in accordance with Zmener's results.

According to HOVLAND and DUMSHA[16], there was no significant difference in leakage between Proco-Sol, Tubliseal and Sealapex sealers.

JACOBSEN et al.[18] stated that there were no differences among Roth root canal cement, calciobiotic root canal sealer and Sealapex with regard to leakage, and that there was an increase in leakage with time in all groups. LIM and TIDMARSH[13] found that Sealapex exhibited significantly less leakage than AH-26 up to the 12th week, but that this difference was not significant thereafter.

The above workers observed that the amount of leakage increased with time for many root canal sealers. Our results also support this finding[13,16,18].

The extent of leakage *in vitro* in the root canal systems treated with the two root canal sealers investigated in this study showed no significant difference. However, both sealer groups leaked significantly less than the control group filled with gutta-percha only. These results support previous findings that a sealer used with gutta-percha prevents apical leakage of the root canal system[16].

FISHER and MCCABE[19] also demonstrated that calcium hydroxide-containing materials have high solubility values. Both calcium hydroxide-containing materials investigated in this study showed increased leakage with time, and this was attributed to their high solubility.

The conditions usually prevalent in the mouth are not sufficiently reproduced by *in vitro* studies. Under *in vivo* conditions, root canal treatment stimulates the formation of hard tissue at the apex and causes obstruction. This is an important factor which decreases the leakage of sealers. Therefore, before deciding that a sealer is unsuitable in terms of its leakage value, *in vivo* studies should also be performed.

References

[1] GROSSMAN L. I.: *Endodontic Practice*, 10th Ed., Lea and Febiger, Philadelphia, 1981

[2] COHEN, S. and BURNS, R.: *Pathways of the Pulp*, CV Mosby, St. Louis, 1980

[3] HOLLAND, R., SOUZA, V., NERY, N. J., BERNA BE, P. F. E., MELLO, W. and OTO BONI FILHO, J. A.: Apical hard tissue deposition in adult teeth of monkeys with use of calcium hydroxide, *Aust. Dent. J.*, **25**, 189-192, 1980

[4] HOLLAND, R. and SOUZA, V: Ability of a new calcium hydroxide root filling material to induce hard tissue formation, *J. Endodont.*, **11**, 535-543, 1985

[5] STEWART, G. G.: Calcium hydroxide-induced root healing, *JADA*, **90**, 793-800, 1985

[6] PITT FORD, T. R.: Pulpal response to a calcium hydroxide material for capping exposure, *Oral Surg. Oral Med. Oral Path.*, **59**, 194-197, 1985

[7] TAGGER, M. and TAGGER, E.: Pulp capping in monkeys with Realit and Life, two calcium hydroxide bases with different pH, *J. Endodont.*, **11**, 394-399, 1985

[8] BEAVERS, R. A., BERGENHOLTZ, G. and COX, C. F.: Periodontal wound healing following intentional root perforations in permanent teeth of *Macaca mulatta, Int. Endodont. J.*, **19**, 36-44, 1986

[9] FRANK, A. L.: Resorption, perforation and fractures, *Dent. Clin. North Am.*, **18**, 465-487, 1974

[10] MARTIN, D. M. and CRABB, H. S. M.: Calcium hydroxide in root canal therapy, *Br. Dent. J.*, **142**, 277-283, 1977

[11] JAVELET, J., TORABINEJAD, M. and BAKLAND, L. K.: Comparison of two pH levels for the induction of apical barriers in immature teeth of monkeys, *J. Endodont.*, **11**, 375-378, 1985

[12] COHEN, T., GUTMANN, J. L. and WAGNER, M.: An assessment *in vitro* of the sealing properties of calciobiotic root canal sealer, *Int. Endodont. J.*, **18**, 172-178, 1985

[13] LIM, K. C. and TIDMARSH, B. G.: The sealing ability of Sealapex compared with AH-26, *J. Endodont.*, **12**, 564-566, 1986

[14] ROTHIER, A., LEONARDO, N. R., BONETTI, I. and MENDES, A. J. D.: Leakage evaluation *in vitro* of two calcium hydroxide and two zinc oxide-eugenol-based sealers, *J. Endodont.*, **13**, 336-398, 1987

[15] ALEXANDER, J. B. and GORDON, L. M.: A comparison of the apical seal produced by two calcium hydroxide sealers and a Grossman-type sealer when used with laterally condensed gutta-percha, *Quint. Int.*, **9**, 615-621, 1985

[16] HOVLAND, E. J. and DUMSHA, T. C.: Leakage evaluation *in vitro* of the root canal sealer cement Sealapex, *Int. Endodont. J.*, **18**, 179–182, 1985
[17] ZMENER, O.: Evaluation of the apical seal obtained with two calcium hydroxide-based endodontic sealers, *Int. Endodont. J.*, **20**, 87–90, 1987
[18] JACOBSEN, E. L., BEGOLE, E. A., VITKUS, D. D. and DANIEL, J. C.: An evaluation of two newly formulated calcium hydroxide cements: A leakage study, *J. Endodont.*, **13**, 164–169, 1987
[19] FISHER, F. J. and MCCABE, J. F.: Calcium hydroxide base materials. An investigation into the relationship between chemical structure and antibacterial properties, *Br. Dent. J.*, **144**, 341–344, 1978

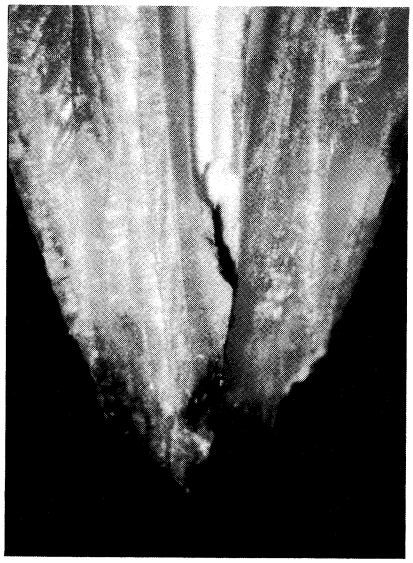


Fig. 1. A sample filled with Sealapex displaying leakage along the entire root canal

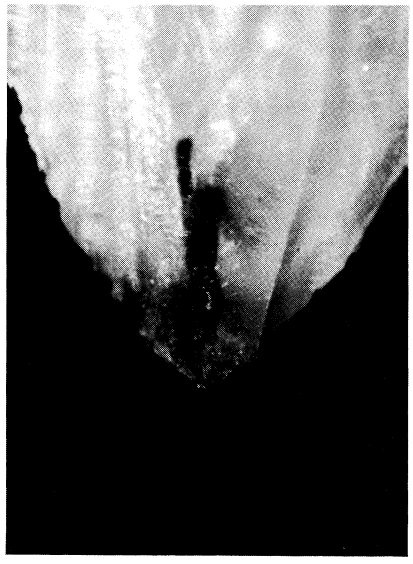


Fig. 2. A sample filled with CRSC displaying leakage along the entire root canal

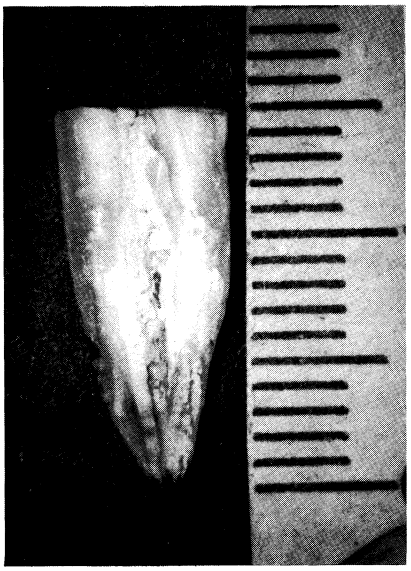


Fig. 3. A sample filled with Sealapex showing leakage for up to 1 mm (after 1 day)

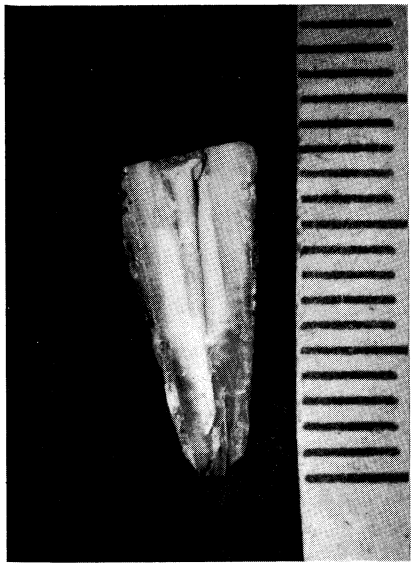


Fig. 4. A sample filled with CRSC showing leakage for up to 2 mm (after 1 day)

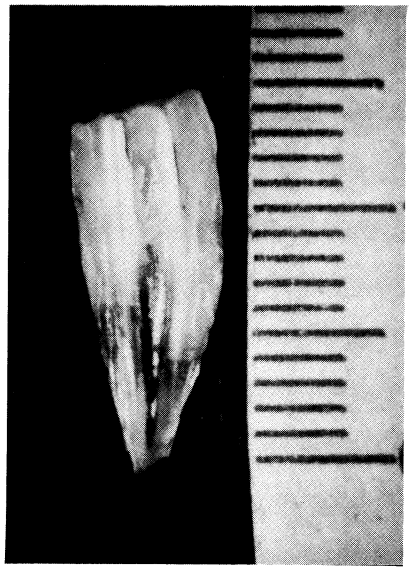


Fig. 5. Leakage beyond 6 mm in samples treated with CRSC. The leakage extends to the root canal sealer and dentin, and covers the dentin and cement (after 30 days).

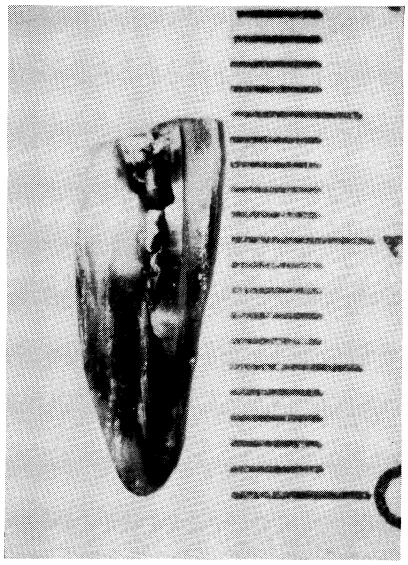


Fig. 6. Leakage covers the whole tooth in a specimen filled with gutta-percha only (after 30 days).