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Dimensional Stability of a Calcium Phosphate Cement (CPC)

A. Piotrowski, M. Schaub, **A. Erdrich**, and M. Gerlach, Heraeus Kulzer GmbH, Wehrheim, Germany

Introduction:

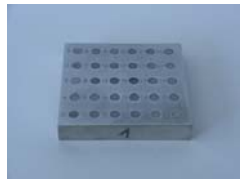
Although the currently used techniques in endodontic treatment are mostly satisfactory, the treatment can be improved by a filling material that is totally biocompatible: Inadvertent extrusion of the material at the root apex would be harmless, if highly adaptable it will adhere to the root canal surface, dimensional stability and easy insertion into the root canal are advantageous [1].
Brown and Chow [2] developed a cement based on the calcium phosphate compounds tetracalcium phosphate, $Ca_4(PO_4)_2O$ (TTCP) and dicalcium phosphate anhydrous, $CaHPO_4$ (DCPA) for dental or medical application. This kind of root canal sealer was described by several in-vitro-studies [3], [4],[5] with regard to obturation characteristics or in-vivo-studies [1], [6].

Objectives:

An experimental CPC was developed based on Brown and Chow [2] and was modified by Ta_2O_5 for radio opacity. As reaction liquid during mixing, H_2O is used instead of a glycerine-water mixture of 1:2 which was used in [3] or [4] to activate the cement. The material could be applied as a root canal sealer/filler, as root repair material or for direct pulp capping. The dimensional stability of the cement in this water rich environment is important if not essential for a satisfying dense seal as well as a tight porosity of the set material.

Methods:

For the study, 30 holes with a drilled diameter of 4 mm and a depth of 6 mm in a metal mould were filled with the activated cement. The following different powder to liquid ratios (P:L) of the CPC were mixed – 5:1 - 3.6:1 - 2.9:1 - 2.1:1 - 1.7:1 – and five samples of each material prepared. Other materials tested: ProRoot MTA (MTA, Dentsply), Apaxit (AP, Ivoclar Vivadent), AH Plus (AH, Dentsply) and Endomethason (EN, Septodent). Those were handled according to manufacturers' instructions. The expansion or contraction from surface equity of the mould was measured with a surface laser scanner (UBM, Germany). Measurements run after setting of the cement and after storage of 0.5, 1, 2 & 3 months in calcium phosphate saturated water at 37 °C. Differences in averaged surface levels were calculated and compared to zero point measurement after setting.



Figures 1 a/b: Surface laser scanner and metal mould for the specimen

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Results:

The dimensional change of the CPC depends on powder-liquid ratios for mixing and showed a low expansion by a P:L ratio of 5:1. After water storage CPCs with P:L 3.6:1, 2.9:1 and 2.3:1 resulted in slight shrinkage (< 0.15 %), whereas CPCs with lower P:L ratio showed increasing shrinkage within the first 3 months.
The dimensional change of the root canal sealer AP and AH is also below 0.15 %.
EN showed expansion and the highest dimensional changes (more than 1 % after 2 and 3 month).

Time [month]	Dimension Change [10^{-3} %] (SD)									
	CPC (5:1)	CPC (3.6:1)	CPC (2.9:1)	CPC (2.3:1)	CPC (2.1:1)	CPC (1.7.1)	MTA	AP	AH	EN
0.5	119 (145)	-10 (31)	23 (10)	-62 (15)	-94 (34)	-99 (20)	29 (35)	-129 (72)	-11 (15)	457 (32)
1	186 (152)	-2 (31)	32 (74)	-42 (71)	-70 (76)	-132 (69)	-27 (22)	-74 (68)	-144 (89)	681 (129)
2	111 (100)	-55 (19)	-15 (18)	-12 (5)	-156 (25)	-219 (40)	88 (127)	-92 (31)	23 (16)	1538 (275)
3	368 (292)	86 (72)	-104 (48)	-133 (28)	-144 (34)	-146 (80)	69 (138)	-109 (29)	35 (28)	1457 (313)

Table 1 : Dimension change of the specimen versus time after storage in calcium phosphate saturated water

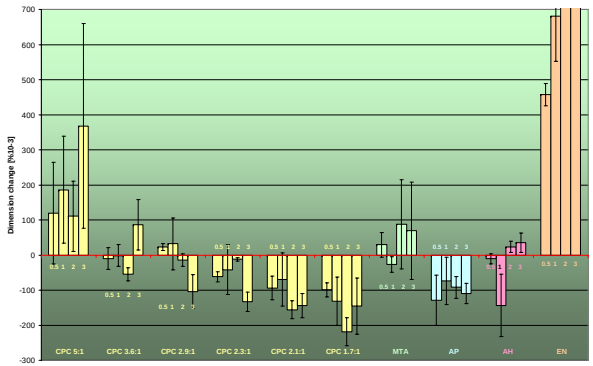

Figure 2: Dimension change depending on storage time in calcium phosphate saturated water

Conclusions:

The experimental CPC has a convenient consistency within the powder:liquid ratio of 3.6:1 to 2.1:1. This could be applied as a root canal sealer. Within this mixing ratio the CPC has an acceptable dimensional stability (less than 0.15 %), which is comparable to commercially available endodontic materials (e.g. AP, AH). For a possible application as root repair material (e.g. apical plug during apexification) the CPC require a firm consistency which is obtained by a high powder-liquid-ratio (e.g. 5:1). The experimental CPC support the apex sealing behaviour with a low expansion.

References:

[1] Chohayeb, A.A., Chow, L.C., Tsaknis, P.J. Evaluation of Calcium Phosphate as a Root Canal Sealer-Filler Material" J. Endo. 13 (1987), 384-387
[2] Brown, W.E., Chow, L.C. A new calcium phosphate setting cement. J Dent Res 62 (1983), 672
[3] Chau, J.Y.M., Hutter, J.W., Mork, T.O., Nicoll, B.K. An in vitro study of furcation perforation repair using calciumphosphate cement. J Endo 23 (1997), 588-592
[4] Krell, F.K., Wefel, J.S. A calcium phosphate cement root canal sealer – scanning electron microscopic analysis. J Endo 10 (1984), 571-576
[5] Cherng, A.M., Chow, L.C., Takagi, S. In vitro evaluation of a calcium phosphate cement root canal filler/sealer. J Endo 27 (2001), 613-615
[6] Hong, Y.C., Wang, J.T., Hong, C.Y., Brown, W.E., Chow, L.C. The periapical tissue reaction to a calcium phosphate cement in the teeth of monkeys. J Biomed Mater Reasearch 25 (1991), 485-498