Theracal

International Endodontic Journal, Volume 45, Issue 6, pages 571–579, June 2012

Chemical–physical properties of TheraCal, a novel light-curable MTA-like material for pulp capping

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Abstract

Aim To evaluate the chemical–physical properties of TheraCal, a new light-curable pulp-capping material composed of resin and calcium silicate (Portland cement), compared with reference pulp-capping materials (ProRoot MTA and Dycal).

Methodology Calcium (Ca) and hydroxyl (OH) ion release over 28 days, solubility and water uptake (weight percentage variation, Δ%) at 24 h, cure depth and radiopacity of TheraCal, ProRoot MTA and Dycal were evaluated. Statistical analysis ($P < 0.05$) of release of ion was carried out by two-way repeated measures anova with Tukey, whilst one-way anova with Tukey test was used for the other tests.

Results TheraCal released significantly more calcium than ProRoot MTA and Dycal throughout the test period. TheraCal was able to alkalinize the surrounding fluid initially to pH 10–11 (3 h–3 days) and subsequently to pH 8–8.5 (7–14 days). TheraCal had a cure depth of 1.7 mm. The solubility of TheraCal (Δ−1.58%) was low and significantly less than that of Dycal (Δ−4.58%) and ProRoot MTA (Δ−18.34%). The amount of water absorbed by TheraCal (Δ +10.42%) was significantly higher than Dycal (Δ +4.87%) and significantly lower than ProRoot MTA (Δ +13.96%).

Conclusions TheraCal displayed higher calcium-releasing ability and lower solubility than either ProRoot MTA or Dycal. The capability of TheraCal to be cured to a depth of 1.7 mm may avoid the risk of untimely dissolution. These properties offer major advantages in direct pulp-capping treatments.

Am J Dent. 2009 Jun;22(3):137-42.

Cytotoxicity of resin-based light-cured liners.

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Abstract:

PURPOSE: To evaluate the cytotoxic effects of resin-based light-cured liners on culture of pulp cells.

METHODS: Discs measuring 4 mm in diameter and 2 mm thick were fabricated from TheraCal (TCMTA), Vitrebond (VIT), and Ultrablend Plus (UBP). These specimens were immersed in serum-free culture medium (DMEM) for 24 hours or 7 days to produce the extracts. After incubating the pulp cells for 72 hours, the extracts were applied on the cells and the cytotoxic effects were determined based on the cell metabolism (MTT), total protein expression and cell morphology (SEM). In the control group, fresh DMEM was used. Data from MTT analysis and

protein expression were submitted to Kruskal-Wallis and Mann-Whitney tests at the preset level of significance of 5%.
RESULTS: When in contact with the 24-hour extract, TCMTA, VIT, and UBP decreased the cell metabolism by 31.5%, 73.5% and 71.0%, respectively. The total protein expressed by the cells in contact with VIT and UBP was lower than TCMTA and DMEM (Mann-Whitney, $P < 0.05$). When in contact with the 7-day extract, TCMTA, VIT, and UBP decreased the metabolic activity by 45.9%, 77.1% and 64.4%, respectively. All the liners expressed statistically lower amounts of proteins when compared to the control. A reduction in the number of cells was observed for all liners. The remaining cells from TCMTA group resembled those from the control group while for VIT and UBP the cells presented significant morphological alterations.

Summary:

"Despite the high toxic effects observed for Vitrebond in the present investigation, this resin-modified glass-ionomer cement did not cause inflammatory pulpal response when applied as a liner in very deep cavities prepared in human teeth.[4] Consequently, it may be suggested that the TetraCal MTA liner which caused lower toxic effects than Vitrebond could be securely used as a liner in order to protect the pulpal tissue from external noxious products. Therefore, further *in vivo* studies are still necessary to evaluate the biocompatibility of this new light-cured resin-based MTA liner. In conclusion, all the resin-based liners tested were toxic to the cultured odontoblast-like cells. However, among the materials, the light-cured resin-based MTA cement presented the lowest cytopathic effects."

J Dent Res 90 (Spec Iss A):abstract number 2520, 2011 (www.dentalresearch.org).

Apatite-forming Ability of TheraCal Pulp-Capping Material

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Objective: A liner must perform as a barrier and protect the dental pulpal complex. Calcium-silicate MTA materials recently used for pulp capping demonstrate the ability to form hydroxyapatite when immersed in simulated body fluid (Gandolfi et al. 2009, 2010). TheraCal is a light-curable resin formula which contains CaO mineral oxides, designed to be used as liner and pulp capping material that demonstrates good biocompatibility/absence of cytotoxicity. The aim of this study is to evaluate the ability of this material to form hydroxyapatite when immersed in a phosphate-containing solution. Method: TheraCal (Bisco Inc, USA), Control paste (without mineral oxides) (Bisco Inc, USA), ProRoot MTA (Dentsply, USA) were used. Sample discs (n=10 for each material) were prepared. The materials were placed in a PVC mold (8mm dia x 1.6mm) and light-cured on both surfaces for 20 seconds (per manufacture) using a LED light, after the application of a transparent polyester strip. The discs were de-molded, immersed in 10mL of a phosphate-containing solution (Dulbecco's Phosphate Buffered Saline, DPBS) in a sealed container and stored at 37°C. The surface chemistry, morphology and formation of apatite on samples surface after 1, 7, 14 and 28 days of immersion in DPBS was assessed by ESEM-EDX, micro-Raman and FT-IR techniques. Results: TheraCal demonstrated the capacity to form

apatite on its surface after 24 hours immersion in DPBS, as did ProRoot MTA. Amorphous apatite (952 cm-1 Raman band) was detected within the first 24 hours, while a more crystalline apatite (960 cm-1 Raman band) was noticed at 7days (see Figure). No deposit was detected on the Control. Conclusions: TheraCal is a calcium-releasing material able to induce the formation of apatite and represents a promising material in direct pulp-capping clinical/surgical procedures. The ability to form apatite may play a critical/positive role in new dentin formation.

J Dent Res 91 (Spec Iss A):abstract number 264, 2012 (www.dentalresearch.org).

Effects of Adhesives on Calcium-Release, PH and Bonding of TheraCal

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Objectives: The purpose of this study was to evaluate the effects of dental adhesives on calcium-release, PH and shear bond strengths of pulp-capping material, TheraCal (Bisco).

Methods:

Twenty-five light-cured TheraCal discs (diameter 20mm, thickness 1mm) were prepared, coated with various adhesives (Control without adhesive, One-Step(TE), All-Bond3(TE), All-BondSE, Exp Universal Adhesive(SE); Bisco) and light-cured, and stored in de-ionized water (20mL, 37ºC, 24hours). Their pH and calcium concentration (n=5) were measured with a pH/ISE meter, PH and Calcium Ion Selective Electrodes (Thermo-Scientific Orion), respectively**.** Shear bond strength (n=5) on dentin was tested using the #5-gel cap method (bonding area 15mm^2). Twenty-five human dentins were polished by 320SiC paper and rinsed with water. Ten dentin samples (TE groups) were etched (15sec by 37%H_3PO_4) and rinsed with water. The adhesives were applied to the dentin surface except control and light-cured according to manufacturer's instructions. 1mm of TheraCal was applied and light-cured (20sec/500mW/cm^2). A #5 gel post was filled with Universal Bisfil composite (L/C) and placed on TheraCal. Excess material was removed, and the post was light-cured (40s@ 500mW/cm^2) on two sides. Bonded specimens were stored in de-ionized water (37ºC, 24 hours), and tested by Instron tester (crosshead speed 5mm/min). The data were analyzed statistically by one-way ANOVA and Tukey Tests ($p<0.05$).

Results: The test results are shown in the table below. For each row, means with different letters are statistically different at $p<0.05$.

Average (Standard Deviation)	Control-No Adhesive	One-Step	All-Bond3	All-BondSE	Exp Universal Adhesive
Calcium-Release (µg/cm^2)	284.3 (0.0)^a	79.6 (23.8)^b	31.2 (15.5)^c	44.9 (16.4)^c	5.7(2.0)^d
pH	8.32(0.03)^a	8.04(0.18)^b	5.48(0.26)^d	7.73(0.22)^c	6.01(0.50)^d
Bond Strength(MPa)	0.8(0.4)^a	11.1(3.14)^{cd}	8.16(1.1)^{bc}	7.7(0.5)^b	11.4(1.74)^d

Conclusions: The bond strengths of TheraCal were significantly increased by the adhesives tested ($p<0.05$). The pH of TheraCal was slightly decreased with adhesives. TheraCal coated with adhesives was still able to release calcium.