

A simple method for improving bonding durability of resin cement to fiber post: the use of non-organofunctional silane

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I. Objectives

Organofunctional silane-based composite bonds are susceptible to hydrolytic degradation. A non-organofunctional silane, 1,2-Bis(triethoxysilyl)ethane (BTSE) has been used in coating processes to protect metals against corrosion due to the high degree of siloxane cross-linking, which produces hydrolytically stable bonds. This study examined a clinically feasible protocol for enhancing the hydrolytic stability of fiber post/resin composite interface using a two-step BTSE/ γ -MPTS treatment.

II. Materials & Methods

The surfaces of 24 D.T. Light-Post (Bisco Inc.) were polished and assigned to four groups: G1: one-step silanization with Monobond-S (MS) (Ivoclar Vivadent); G2: two-step silanization with 5% 1,2-Bis(triethoxysilyl)ethane (BTSE) and then MS; G3 and G4: one-step and two-step silanization, respectively, after 24% H₂O₂ etching. Four resin composite cylinders (RelyX Unicem, 3M ESPE) were bonded on each surface according to a microshear testing protocol. All bonded samples were stored in water at 37°C for 24 hours and half of them then thermocycled 5,000 times prior to microshear testing ($n = 12$). The failure modes were evaluated under optical and scanning electron microscope. Water contact angles were measured on the post surfaces before and after silanization to estimate surface hydrophobicity. The results were statistically analyzed using two-way ANOVA and Tukey's test.

III. Results

The bond strengths for G2 and G4 were significantly higher than G1 and G3 at 5000 thermocycles ($P < .001$), whereas no significant differences were found between the four groups before thermocycling ($P = .131$). All debonded samples showed some fractured fibers. No significant difference in the hydrophobicity were found between the one-step and two-step silanized post surfaces ($P = .335$).

IV. Conclusion

The use of BTSE coupled with methacryloxy-silane as a "two-step" silanization approach produced a more rigid bond between fiber posts and resin composites compared to single application of γ -MPTS.

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**Adhesion performance of “Zero-step (Self-adhesive)” composites
—Dual effects of wet condition of cavity wall and/or delayed light-cure
on the marginal integrity and wall adaptation—**

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I. Objective:

Recently, the “Zero-step (Self-adhesive)” flowable composites with simplified adhesive procedures have been getting popular. The authors have reported that these composite materials exhibited less adhesive properties compared to the conventional materials used with resin adhesive systems (4th IAD2011, 136th Meeting of JSCD). The objective of this particular study was to promote the adhesive properties in clinically usage of the zero-step composites by achieving the adequate function of the adhesive monomers contained in the zero-step composites through the wetting of cavity walls and/or the securing of conditioning time. Thus, in this study, the dual effects of wet condition of cavity walls (dry or moist surface) and/or time to light-cure (immediate or delayed cure) on the marginal integrity and wall adaptation of various zero-step composites were investigated comparing with those of the conventional materials.

II. Materials & Methods:

Four semispherical cavities (φ3 mm x 2 mm depth) were prepared in the flat labial enamel surface of an extracted bovine tooth. Each cavity was randomly restored with the following three zero-step flowable composites and a flowable composite material used with the adhesive. Zero-step composites: PrimeFil with the Primer (Tokuyama Dental, Japan), Vertise Flow (KaVo/Kerr, USA), Fusio Liquid Dentin (Pentron, USA). Conventional composite: Filtek Supreme Ultra Flowable Restorative/Scotchbond Universal Adhesive (3M ESPE, USA). The two wet conditions of cavity walls, air-dried (“dry”) or blot-dried with a cotton pellet (“moist”), and the three timings of light-cure, immediate (“imm”), 10-second delayed or 20-second delayed (“delay”) were employed in the investigation respectively combined. All of the specimens were subjected to a thermo-stress test (5°C/60°C, 30-second each, 1000 cycles). Then, all specimens were stored in a 2% methylene blue solution for 10 hours, and the marginal integrity was evaluated. Then each cavity was sectioned longitudinally, and the wall adaptation was evaluated with the application of a 15% acid fuchsin to the section. The degree of dye penetration was assessed on a scale of 0 to 8 for the marginal integrity and 0 to 4 for the wall adaptation, respectively. The obtained results were statistically analyzed by the Kruskal-Wallis test and Mann-Whitney U-test ($p=0.05$).

III. Results:

PrimeFil in the “dry”+“delay” group exhibited significantly better marginal integrity and the wall adaptation than that in the “moist” group ($p<0.05$). This might be due to the contained water in the self-etching primer (Primer). The marginal integrity of Vertise Flow in the “moist”+“delay” group was excellent compared to that of Ultra Flow with Scotchbond, while the wall adaptation in the “moist” group was poor regardless of the “delayed” cure ($p<0.05$). Fusio Liquid Dentin in the “dry”+“delay” group showed better marginal integrity and wall adaptation, yet poor in the “moist” group regardless of “delayed” cure ($p<0.05$). These results demonstrated that both the marginal integrity and the wall adaptation of the zero-step composites with the “delayed” cure were better regardless of the “dry” or “moist” cavity, and that the wall adaptation in the “moist” cavity was poor despite “delayed” cure. The viscosity of the zero-step flowable composites as well as the different contained adhesive monomers may affect the degree of the marginal integrity and the wall adaptation.

IV. Conclusion:

This particular study revealed that the effects of dry or moist condition of cavity walls and/or immediate or delayed light-cure on the marginal integrity and wall adaptation varied according to the zero-step composites. Therefore, the zero-step flowable composites have to be used with sufficient attention to achieve better marginal integrity and wall adaptation.

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Effect of 4-META/MMA-TBB Resin containing CaCl₂ on dentin mineralization

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I. Objective

Recently, restorative materials with multifunctional properties have been incorporated into clinical adhesives. The antibacterial monomer MDPB (12-methacryloyloxydodecylpyridinium bromide) is good example for such a material. However, the long-term durability of resin-dentin bonds continues to require improvement to avoid occurrence of secondary caries. Incomplete resin impregnation into the collagen network leaves an exposed zone of demineralized dentin at the base of the hybrid layer. It has been known that the exposed collagen fibrils in this region are susceptible to degradation over time, leading to a reduction in bond strength. The purpose of this study was to determine whether ions released from 4-META/MMA-TBB resin containing CaCl₂ can accelerate apatite induction by a model demineralized dentin at resin dentin interface.

II. Materials & Methods

PV immobilized on agarose beads with divinyl sulfone was used as a model demineralized dentin. The eluates from 4-META/MMA-TBB and 4-META/MMA-TBB with CaCl₂ were used for making mineralizing solution. The PV-beads in mineralizing solution were incubated at 37°C, specimens were taken at several time points during the incubation. Then the PV-beads were analyzed for bound calcium by atomic absorption spectrometry. Additionally the specimens were observed using scanning electron microscope (SEM). Flat dentin surfaces in extracted non-carious human third molars were created in mid-coronal dentin perpendicular to the tooth's longitudinal axis using a slow-speed diamond saw (Isomet, Buehler, Lake Bluf, IL, USA) to remove occlusal enamel and superficial dentin. The tooth was divided into 4 groups; 4-META/MMA-TBB as a control group, 4-META/MMA-TBB with 5%, 10% and 30% CaCl₂ as experimental groups. Micro tensile bond strengths were measured with EZ Test (Shimadzu) and analyzed statistically after 24 hours, 3 and 6 months.

III. Results

Mineral induction time was decreased with increasing concentration of CaCl₂. The 4-META/MMA-TBB with 30% CaCl₂ reduced induction time compared to other groups. Micro tensile bond strength of 4-META/MMA-TBB with 5% / 10% CaCl₂ stored for 6 months in distilled water showed no significant difference compared with control group.

IV. Conclusion

These results suggest that 4-META/MMA-TBB resin containing CaCl₂ have a self-repairing potential with regard to interfacial leakage. In future, further analyses of long-term durability and self-repairing property are necessary to develop new adhesive materials.

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The effect of torsional preloading on cyclic fatigue resistance of nickel-titanium rotary instruments

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I. Object: This study was aimed to evaluate the effect of torsional preloads on the cyclic fatigue life of nickel-titanium (NiTi) instruments with different history of heat treatments by manufacturers.

II. Materials & Methods: Selected NiTi rotary instruments were preloaded at various conditions. Then, the number of cycles to failure (NCF) was evaluated by rotational bending in a simulated canal. Data were analyzed using multiple linear regression analysis and two-way ANOVA. Fractured instruments were examined under SEM.

III. Results: Regression analysis revealed that the kind of heat treatment was the most critical factor.

IV. Conclusion: Within the limitations of this study, certain amounts of torsional preload may improve the cyclic fatigue resistance of NiTi rotary instruments. However, that phenomenon is highly dependent on the alloy type of NiTi instrument.

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Anti-inflammatory effect of simvastatin on the dental pulp cells

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I. Object: Simvastatin, a hydroxy-methylglutaryl coenzyme A (HMG-CoA) reductase inhibitor, has been used to reduce the risk of cardiovascular disease. Simvastatin was also reported that it has a bone formation effect. Simvastatin can promote osteoblast differentiation and mineralization in MC3T3-E1 cells, and promotes odontoblast differentiation in human dental pulp cells. In addition, statin also has an anti-inflammatory effect. However, there is no study about the anti-inflammatory effect of simvastatin in dental pulp cells. In this study, the effect of simvastatin and its possible mechanism were studied.

II. Materials & Methods: Human dental pulp cells were cultured in DMEM with 10% FBS and 1% antibiotics. MTT assay was performed to evaluate the cytotoxicity of simvastatin. E. coli LPS and P.g LPS were treated to induce inflammatory cytokines. RT-PCR and Western blot were performed to evaluate the anti-inflammatory effect of simvastatin and its possible mechanism.

III. Results: There is no cytotoxicity of simvastatin on dental pulp cells. LPS induced inflammatory cytokines, such as IL-1 β and TNF- α . Simvastatin decreased the expression of IL-1 β and TNF- α which were induced by LPS. Simvastatin decreased NF- κ B (p65) expression which was induced by LPS.

IV. Conclusion: In this study, simvastatin decreased inflammatory cytokine expression in dental pulp cells and simvastatin-mediated reduction of inflammatory cytokines is thought to be the result of the inhibition of the NF- κ B pathway.

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Transient accumulation of M2 macrophages after pulpotomy with calcium silicate-based materials in rat molars

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I. Objective

Calcium silicate-based materials such as mineral trioxide aggregate (MTA) are regarded as the material of choice for capping of exposed pulps, although cellular and molecular mechanisms have not been fully elucidated regarding the pulp repair induced by these materials. In this study, we hypothesized that M2 (alternatively-activated) macrophages, which are known to promote tissue repair, participate in the reparative process of exposed pulps. To test this hypothesis, we analyzed the temporal changes in the distribution and density of cells expressing M2 macrophage-associated molecules in rat molar pulps after pulpotomy with two calcium silicate-based materials.

II. Materials & Methods

Maxillary first molars of 8-week-old Wistar rats were pulp-exposed and capped with MTA (white ProRoot MTA) or TheraCal LC (a light-curable calcium silicate-based material) for 1-14 days. Untreated maxillary first molars served as controls. After given periods, the teeth were processed for cryostat sections and subjected to either H-E staining or immunoperoxidase staining using CD68 (a general macrophage marker) and M2 macrophage markers (CD163 and CD204). The density of positively-stained cells was enumerated in surface and inner regions (0-100 μm and 300-400 μm , respectively, from the exposed surface).

III. Results

In the untreated control, cells immunopositive to each antibody were scattered throughout the pulp tissue. The two materials initially caused mild degenerative changes, followed by progressive new matrix formation and calcified bridging. At 1-2 days after MTA-pulpotomy, CD68-, CD163-, and CD204-positive cells showed an accumulation beneath the degenerative layer, and the density of these cells was significantly higher in the surface region than in the inner region ($P < 0.05$; 1-way ANOVA and Bonferroni's test). The accumulation was also observed in TheraCal LC-applied specimens. At 14 days the three types of cells displayed an almost normal distribution beneath the newly formed dentin-like matrix.

IV. Conclusion

After the pulpotomy of rat molars with calcium silicate-based materials, M2 macrophage-associated molecule-expressing cells transiently accumulated just beneath the degenerative layer. This suggests that M2 macrophages participate in the initial phase of pulpal healing after the application of calcium silicate-based materials.

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Dental treatment under general anesthesia: overview of clinical characteristics of special needs patients

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I. Object:

This study aimed to analyze the clinical characteristics of patients who received dental treatment under general anesthesia (GA-dental treatment) due to their cognitive and behavior impairment.

II. Materials & Methods:

Based on nonprobabilistic consecutive sampling from August 2007 through April 2014, information was collected from a total of 475 patients who received GA-dental treatment at the Clinic for Persons with Disabilities, Seoul National University Dental Hospital, Seoul, Korea. Demographic characteristics (gender, age, disability, medication, GA history, residency type, caregiver, meal type, oral hygiene maintenance, and cooperation level) and dental status (operating duration, DMFT, malocclusion, periodontal disease, tooth defects, and treatment protocols) of the patients were evaluated under approval of Seoul National University Dental Hospital Institutional Review Board. DMFT values and malocclusion levels were compared among the patients using ANOVA and Sheffe's post-hoc test, and chi-square test, respectively. Correlation between patients' clinical characteristics and operation factors were analyzed using Pearson's correction test.

III. Results:

The patients were 27.1 ± 15.2 (7 - 83) years old and had disabilities such as intellectual disorders (55.4%), developmental disorders (17.9%), brain disorders (16.6%), and neurocognitive disorders (4.6%) and others (5.5%). Their mean DMFT (DT) values were 8.6 ± 6.8 (5.2 ± 5.2) and differed among disability types ($p < 0.05$). Incidence of malocclusion was higher in patients with intellectual and brain disorders than others ($p < 0.05$). The operation time (191.4 ± 91.2 min) was significantly correlated with the DT values and the number of teeth with endodontic treatment ($p < 0.05$).

IV. Conclusion:

Special needs patients requiring GA-dental treatment due to their lack of cooperation showed their unfavorable oral condition. Dental practitioners are subjected to restricted time and additional cost under a GA setting. Efficient treatment planning and decision-making can be facilitated by evaluation of patients' clinical characteristics.

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“Periodontal biosensor”: A pilot study

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I. Objective

Periodontal biosensor consists of fiber-optic surface plasmon resonance sensor (FO-SPR sensor) and antibody against periodontal biomarker. The advantages of FO-SPR sensor compared with conventional method are real-time, non-labeling and rapid detection of immune response. Human hemoglobin, which is one of the periodontal biomarker, are known as a candidate biomarker in the diagnosis of periodontal diseases.

In this study, we investigated the possibility for detection of human hemoglobin in saliva derived from periodontitis patients using periodontal biosensor.

II. Materials & Methods

Self-assembled monolayer (SAM) was constructed on the sensor surface using the scaffold protein (ORLA91). Mouse anti-hemoglobin subunit beta monoclonal antibody was immobilized with SAM constructed on the sensor surface. Two step reactions were used to detect purified human hemoglobin in phosphate buffered saline (PBS). Firstly, rabbit anti-hemoglobin polyclonal antibody conjugated gold nanoparticle was added to the purified human hemoglobin in PBS (standard solution) to form the immune complex. Second, the sensor was inserted into the standard solution to capture the immune complex. Time course assay and generation of standard curve using the serial dilutions of standard solution were carried out in order to quantitate the concentration of human hemoglobin in saliva.

III. Results

Within the concentration range of human hemoglobin (10 ng/ml, 1 µg/ml, 100 µg/ml, 200 µg/ml), the signal of antigen-antibody reaction was increased in a time-dependent manner at each concentration. Furthermore, when the human hemoglobin concentration was determined at 1 minute after starting measurement, the signal was increased in a concentration-dependent manner ($y = 0.37x - 0.05$, $R^2 = 0.9956$). The concentration of human hemoglobin in saliva was able to quantitate using the two step reactions in this pilot study.

IV. Conclusion

It was suggested the possibility that periodontal biosensor may serve as an effective alternative for clinical diagnosis of periodontitis using saliva.

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