Accelerated Aging of Dentin-Resin Interface Via Thermomechanical and Biochemical Challenges

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Introduction

A key factor in the survival of resin composite restorations is the stability and durability of the hybrid layer, also known as the resin-dentin interface.

Octenidine dihydrochloride (**OCT**), a highly biocompatible cationic surfactant antiseptic molecule with no known bacterial resistance, exhibits broad efficacy against gram-positive and gram-negative bacteria. OCT has been suggested as a candidate to be incorporated into resin adhesives as an antiseptic within the hybrid layer[1].

This ongoing study investigates whether in-house total-etch resin adhesive containing drug-eluting silica particles (**DSPs**) loaded with OCT imparts a protective effect when exposed to biochemical and thermocycling (**BC-TC**) challenges.

Current *in vitro* protocols used to appropriately age the hybrid layer interface *in vitro* often require lengthy incubation periods. The effects of exposing hybrid layer specimens to a BC-TC protocol *in vitro* may shorten the time required to induce hybrid layer aging.

A recently developed BC-TC protocol[2] was found to accelerate the chemical aging of the adhesive resins, significantly increasing the rate of 2,2-Bis[4(2,3-hydroxypropoxy)-phenyl] propane (**BisHPPP**) and drug release in comparison to samples aged by biochemical challenge alone[3]. The aim of this study is to test the BC-TC protocol to study the chemical and mechanical degradation of hybrid layer specimens incorporating enhanced total-etch adhesive resin formulations.

Therefore, the aim of this study is to test the BC-TC protocol to study the chemical and mechanical degradation of hybrid layer specimens incorporating enhanced OCT-loaded total-etch adhesive resin formulations.

Methods

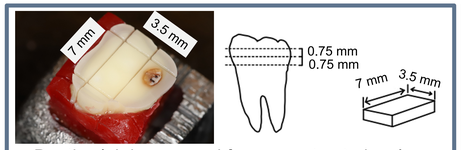
In this study, the aim is being addressed by:

i. Applying a combined biochemical and thermomechanical aging protocol to artificially age *in vitro* specimens designed to represent the hybrid layer
ii. Investigating whether incorporation of OCT-eluting drug silicone particles into resin adhesive affects fracture toughness (K_{Ic}) at hybrid-layer when exposed to simulated human salivary esterase
iii. Comparing fracture mode (**FM**) of hybrid layer interfaces fabricated using resin adhesive with and without octenidine-eluting particles after exposure to BC-TC aging protocol

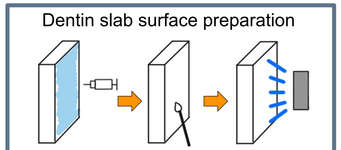
Miniature short-rod (**mini-SR**) specimens are fabricated based on methods previously described[3] to better represent predictable fracture mechanics of adhesive interfaces[4].

The BC-TC protocol was developed to study whether an aging protocol including enzymatic challenge and thermocycling would accelerate aging of mini-SR specimens[2]. To simulate biochemical degradation by saliva, the mini-SR specimens are incubated in 3 ml simulated human salivary esterase (**SHSE**).

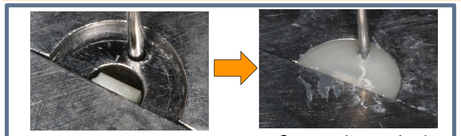
Methods - Mini-SR specimen fabrication and fracture



Dentin slab is prepared from an extracted molar

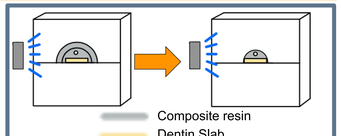


Etch, primer, adhesive

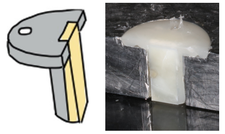


Dentin in mini-SR 1st half mold

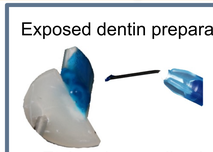
Composite packed around dentin



Light-cure top and bottom of 1st half

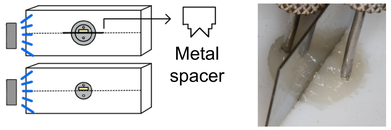


Mini-SR 1st half is completed

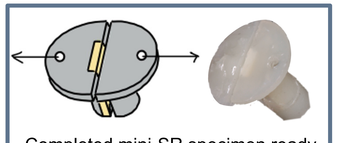


Etch, primer, adhesive

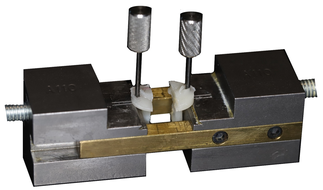
1st half loaded into mold with metal spacer



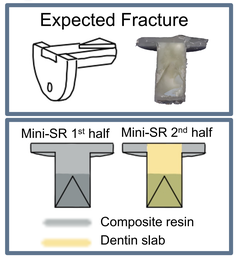
Mold for mini-SR 2nd half is filled with composite

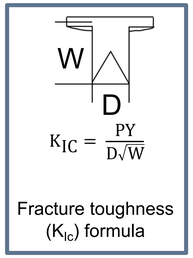


Completed mini-SR specimen ready for fracture testing



Mini-SR specimen following fracture





Fracture toughness (K_{Ic}) formula

After aging via the BC-TC protocol, degradation of the specimens is quantified by measuring K_{Ic} and FM. To determine these values, specimens are fractured using the Electroforce 5500 testing machine (TA instruments). Immediate K_{Ic} and FM are measured for four groups without incubation. Fracture groups include 40 specimens fabricated using Scotchbond Multipurpose (**SBMP**), in-house total etch (**TE**), TE incorporated with drug-eluting silica particles (**DSP-TE**), and TE incorporated with calcined heat-deactivated drug-eluting silica particles (**CDSP-TE**). Specimens incubated using the BC-TC aging protocol will be subjected to the same fracture testing.

During the BC-TC aging protocol, degradation products are measured using Ultra-performance liquid chromatography (**UPLC**) to assess rate of BisHPPP and drug release in three groups with a total of 30 specimens (TE, DSP-TE, and CDSP-TE).

Results

Comparison of mean K_{Ic} values of the 4 immediate-fracture groups revealed no significant difference between groups fabricated using SBMP, TE, DSP-TE, and CDSP-TE. Results are pending for measurement of UPLC measurement of Bis-HPPP degradation products and for measurement of K_{Ic} and FM of specimens after aging for 6 months using BC-TC protocol.

Discussion

Adhesive formulation containing OCT-eluting particles may protect the hybrid layer against enzymatic degradation. Results have shown that addition of OCT-eluting particles to adhesive does not affect fracture toughness of specimens for specimens that have not undergone BC-TC aging protocol. Data from ongoing aging followed by fracture of aged specimens will be used to determine whether OCT release defends against enzymatic degradation of the hybrid layer.

References

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