Antimicrobial and Mechanical Properties of Bioactive Glass Reinforced Dental Composites

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Statement of Purpose: Over the last fifteen years many results have been published documenting composite failure rates and the primary reasons for composite replacements**.** Results of most of work highlight secondary marginal caries to be the most common reason for restoration replacement [1, 2, 3]. The second most common reason is partial or complete fracture of the composite restoration. One of the most commom reasons for secondary caries is bacterial biofilm (plaque) development at the tooth-filling interface which can lead to demineralization of tooth tissue due to acidic by-products of bacteria in plaque [4, 5] (ex. *Streptococcus mutans*).
The purpose of the study is to determine if bioactive glass (BAG) filled restorative composites maintain adequate mechanical properties when aged in a simulated oral environment containing bacteria, and if they have antimicrobial properties.

Methods: BAG (65%SiO_2, 31%CaO and 4%P_2O_5 mol%) containing samples were produced using a resin matrix BisGMA:TEGDMA with constant 72wt% total filler but varying BAG content from 5–15% with the balance being strontium glass. Control samples were also produced with 67%Sr-glass+5%OX50 silica.
Lyophilized cultures of *streptococcus mutans* (ATCC 25175) were grown in BHI media at 37°C. Inoculum was placed intocryotubes with particulate BAG and incubated aerobically for 1, 2 or 4hrs at 37°C. Viable colony counts were determined by serial dilution in reduced transfer fluid and plating onto BHI agar plates with aerobic incubation for 48hrs at 37°C.
Compact tension and bending beams samples were made by light-curing the composite from both sides (Triad II) in molds. Flexure strength, fracture toughness and fatigue crack growth were evaluated after two different aging treatments: 1) 24 hours in deionized water and 2) 60 days in trypticase soy agar broth
with *streptococcus mutans* bacteria. Results were compared to a commercial composite (Heliomolar) using ANOVA/Tukey's test(α=0.05).

Results: BAG fillers showed a lower viable colony count than the control (0%BAG) (Fig.1) and the composites had significantly improved mechanical properties
over Heliomolar for both aging treatments. BAG composites were toughened by enhanced crack deflection and crack bridging far behind the crack tip giving superior performance over Heliomolar. Aging (24h vs. 60 days) had no significant effect on flexural strength of either material. Sixty days soaking decreased fracture toughness of Heliomolar, 5%BAG, and 10%BAG (Fig.2) and softened the matrix of all samples based on the crack growth data, however, BAG retained superiority over Heliomolar.

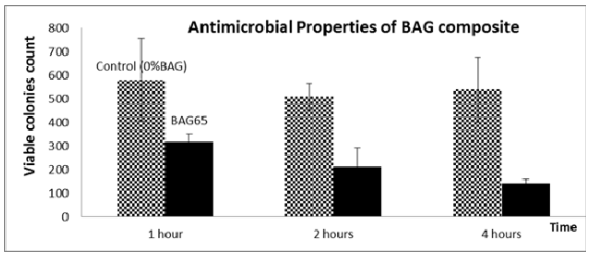

Fig.1 Antimicrobial Properties of BAG composite

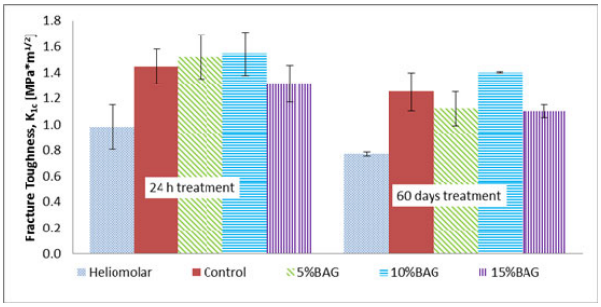

Fig.2 Fracture toughness for different soaking treatments

Conclusions: Dental composites containing BAG have antimicrobial characteristics and adequate mechanical performance, and stability for dental restorations.

References:

[1] Ostlund J, Möller K, Koch G. Amalgam, composite resin and glassionomer cement in Class II restorations in primary molars--a three year clinical evaluation. Swed Dent J. 1992;16(3):81-6.
[2] Mjör IA, Dahl JE, Moorhead JE. Placement and replacement of restorations in primary teeth. ActaOdontol Scand. 2002 Jan;60(1):25-8.
[3] Marks LA, Weerheijm KL, van Amerongen WE, Groen HJ, Martens LC.DyractversusTytin Class II restorations in primary molars: 36 months evaluation. Caries Res. 1999 Sep-Oct;33(5):387-92.
[4] Mjör IA, Toffenetti F. Secondarycaries: a literature review with case reports. Quintessence Int. 2000 Mar;31(3):165-79.
[5] Loesche WJ. Microbiology of Dental Decay and Periodontal Disease. In: Baron S, editor. Medical Microbiology. 4th edition. Galveston (TX): University of Texas Medical Branch at Galveston; 1996. Chapter 99.