DMSO Resistance of Hyaluronic Acid-Based Hydrophilic Coatings

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Statement of Purpose: This study was conducted to investigate the dimethylsulfoxide (DMSO) resistance of 4 different hydrophilic coatings. DMSO is approved for several human uses, including use as a solvent in some treatment procedures for brain aneurisms. In order to insert a guide wire or catheter into the brain, many companies utilize a hydrophilic coating to prevent unnecessary damage to the vascular system. However, DMSO creates a harsh environment for some coatings because it can potentially erode the surface or cause the coating to bind to polymers dissolved in DMSO. These complications can be fatal in neurosurgical applications. Hyaluronic acid (HA) coatings are designed to be durable and lubricious, and they can be cross-linked and modified with other agents. An ideal neurological hydrophilic coating possesses lubricity, durability, and resistance to DMSO. The goal of this experiment is to determine which coatings are most resistant to exposure to DMSO and if one coating stands out as the best to use under this condition. The hypothesis of the study is that there will be no significant effects from adjusting the presence of cross-linkers and additional polymeric strengthening agents among the coatings.

Methods: The study exposed the following 4 bi-laminar hydrophilic coatings to varying solutions: G-23K/A-14, B-23KX/A-15, B-23KX^2/HP-220, and B-500/T-018. A-14 is a cross-linked topcoat consisting of hyaluronic acid, with an additional proprietary aldehyde agent. A-15 is composed of hyaluronic acid and a proprietary poly acrylic with the same aldehyde present in A-14. HP-220 is a combination of hyaluronic acid and the same proprietary poly acrylic without the aldehyde. T-018 contains only a proprietary poly acrylic, without hyaluronic acid or aldehyde agents.

The solutions in which these coatings were soaked were: 100% phosphate buffered saline (PBS), 100% DMSO, and 50% PBS/50% DMSO. After polyethylene terephthalate glycol (PETG) sample rods were coated, they were sent for ethylene oxide (ETO) sterilization. The rods were then exposed to the solutions above for 0 (control), 5, 10, 15, or 30 minutes. Testing procedures included dyeing the sample with Toluidine Blue O (TBO), then eluting the dye with a salt solution and measuring the absorbance of the eluted dye to calculate how much topcoat was on the sample, as previously described[1]. Swelling ratio was measured as the wet weight/bound hydrophilic coating ratio on a conventional analytical balance.

Results: See Figures 1 and 2 for data on bound top coat and swelling ratio. Statistical analyses were run on the data. Initially, all 4 coatings were compared using ANOVA, which revealed statistically significant differences in the treatment groups. Then ANOVA was run again on 3 coatings at a time to determine which coating, when removed from analysis, resulting in the most significant difference. It was determined that T-018 is most affected by soaking in DMSO, followed by A-14, A-15, and HP-220. When soaked in PBS, the most affected is HP-220, followed by A-14, T-018, and A-15. HP-220 in PBS/DMSO and T-018 in DMSO lost nearly 10% or more coating.

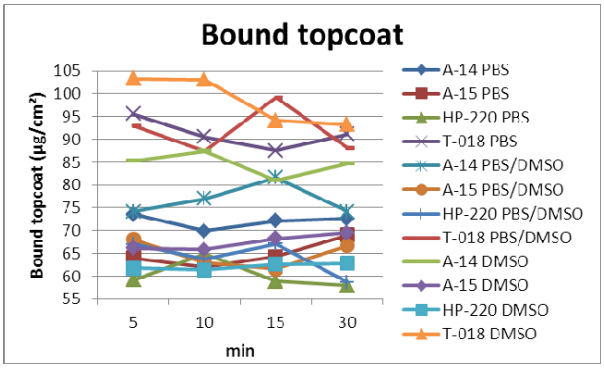

Figure 1. Bound topcoat for each coating in PBS, PBS/DMSO, and DMSO over time

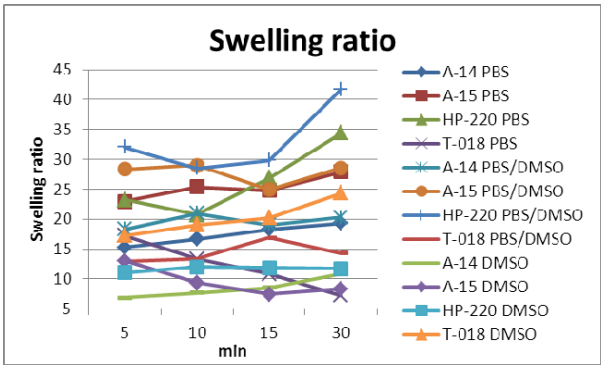

Figure 2. Swelling ratio for each coating in PBS, PBS/DMSO, and DMSO over time

Conclusions: The bound topcoat and swelling ratio of A-14, A-15, HP-220, and T-018 in the presence of DMSO are fairly resilient. T-018 is a non-HA, poly acrylic-based coating and did not perform as well as the HA coatings in this experiment. Analysis of the results shows that the most durable coating is composed of a blend of hyaluronic acid and proprietary poly acrylic. Based on the goal of determining DMSO resistance, several of the coatings in this study are candidates for neurosurgical applications that use DMSO.

References: 1. Johnston, J, "A Simple, Non-destructive Assay for Bound Hyaluronan", J Biomed Mat Res B, 53: 188-191, 2000.