233h Evaluation of Polymer and Self-Assembled Monolayer Coated Silicone Surfaces to Reduce Neural Cell Growth

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The development of silicone catheters has vastly improved the treatment of hydrocephalus. Unfortunately, the functionality of the catheters is compromised by cell obstruction. In this study silicone surfaces coated with biopolymers (heparin and hyaluronan) and self-assembled monolayers (octadecyltrichlorosilane-OTS and fluoroalkylsilane -FAS) were employed to investigate the effect of these coatings on astrocyte and choroid plexus cell growth in vitro.

Chemical vapor deposition method was used for coating FAS on silicone. OTS was coated on silicone after plasma treatment. Heparin and hyaluronan were coated with photo-immobilization method on OTS modified silicone surfaces. Contact angle measurements confirmed that the hydrophobic and hydrophilic properties of these coatings were stable on the silicone surfaces for at least 30 days, indicating that coatings were stable during cell culture (approximately 14 days). Choroid plexus cells and astrocytes were obtained from the brains of 1-2 day old Sprague-Dawley rat pups. The enriched choroid plexus cells and astrocytes were cultured for two weeks and one week respectively on the unmodified and modified silicone samples secured with teflon rings in polystyrene 12-well plates. Since the silicone samples were opaque and visual inspection of cell growth on silicone samples was difficult, the polystyrene 12-well plate surface was used as a control to determine the stage of confluence for cell cultures. Cells were counted using a hemocytometer, which provides an indirect measure of cell growth and adhesion, since attachment to a substrate is a requirement for prolonged survival in culture.

Compared to unmodified silicone, FAS ($p<0.05$) coated surfaces significantly reduced astrocyte proliferation, while no significant difference in astrocyte growth was observed on OTS (Figure 1). Heparin ($p<0.001$) and hyaluronan ($p<0.001$) coated surfaces resulted in an increase in astrocyte growth in comparison to unmodified silicone surfaces. A similar trend was observed for choroid plexus cell growth on heparin ($p<0.05$) and hyaluronan ($p<0.05$) coatings compared to unmodified silicone surfaces. However, no significant reduction in choroid plexus cell proliferation was observed on FAS or OTS coated surfaces compared to unmodified silicone surfaces. Low cell growth may be attributed to hydrophobicity of the surfaces (FAS 112.2 ± 2.6^{0}, OTS 102.2 ± 1.3^{0}). Furthermore, atomic force microscopy measurements revealed that unmodified silicone had the roughest surface while coatings decreased the surface roughness of silicone. However, surface roughness did not play an important role on cell growth. Unmodified silicone with the roughest surface (RMS 153.8 ± 46.1) exhibited low cell growth compared to heparin and hyaluronan with surface roughness of 104.0 ± 20.7 and 96.8 ± 18.2 respectively. FAS (RMS 81.1 ± 26.4) and OTS (RMS 88.8 ± 12.5) coatings had comparatively smoother surfaces but the lowest cell growth of all the samples. The results of this study indicate that silicone shunts coated with the self-assembled monolayer (FAS) may be suitable for future clinical applications to improve the treatment of hydrocephalus.

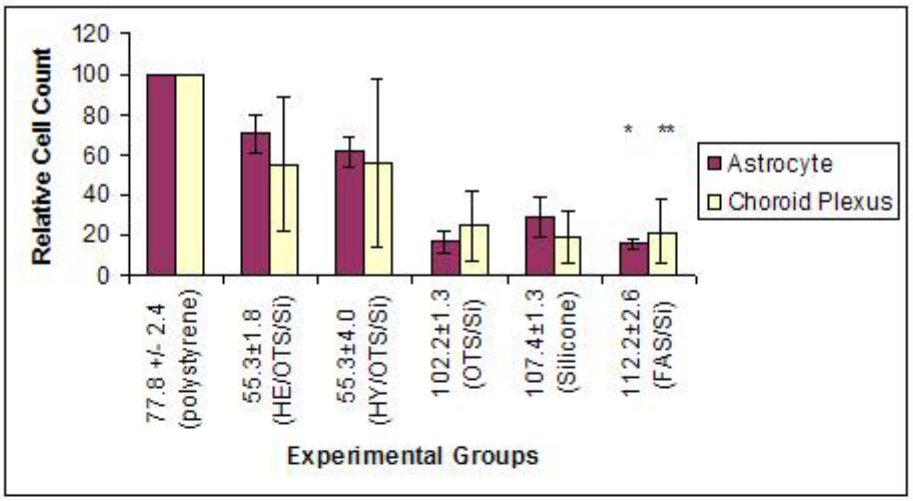

Figure 1. Effect of surface coatings on astrocyte and choroid plexus cell growth

The numbers of growing cells are expressed as a % of cell counts (mean $\pm$ SD) on polystyrene 12 well plates. The numbers on the x-axis represent the contact angle measurements of the silicone samples and the polystyrene surface. Self-assembled monolayer coated surfaces with hydrophobic properties exhibited the lowest cell growth compared to surfaces with hydrophilic properties. (* Significantly lower astrocyte cell growth on FAS compared to unmodified silicone, heparin, and hyaluronan coatings; $p < 0.05$, ** significantly lower choroid plexus cell growth on FAS compared to heparin and hyaluronan coatings; $p<0.05$)