Surface Modified Poly(vinyl alcohol) Vascular Grafts Maintain Hemocompatibility

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Statement of Purpose: The biomaterials available for vascular grafts have not changed significantly in over 30 years. While the clinical standard, ePTFE, is suitable for vascular bypasses of large vessels (>6mm in diameter), small ePTFE grafts fail due to thrombosis and intimal ingrowth, which lead to graft narrowing and eventual occlusion. Compliant biomaterials such as poly(vinyl alcohol), PVA, have the potential to reduce intimal occlusion. While maintaining a non-thrombogenic surface. Yet to encourage in vivo cellularization for long term implantation, the surfaces of PVA must be modified to support cell growth. Biochemical coatings and surface patterning of biomaterials have the potential to encourage support cell growth. These hemocompatibility studies suggest the potential that PVA grafts hold for synthetic small diameter vascular graft replacement. Future work will explore in vitro and in vivo cellularization and longer-term performance for preventing tissue ingrowth in vivo.

Methods:

PVA biomaterial grafts: An aqueous solution of crosslinker sodium trimetaphosphate (STMP) and sodium hydroxide were added to aqueous PVA solution (10% w/v). This PVA-STMP solution was cast on 4 mm diameter cylindrical molds, which were either smooth or patterned (Figure 1). The patterns consisted of longitudinal micron lines or convex microlens. The cRGD covalent coating was attained by mixing the peptide sequence of Cys-Cys-Arg-Arg-Gly-Asp-Try-Leu-Cys into the PVA-STMP solution prior to casting.

Hemocompatibility testing: Femoral AV shunts in non-human primates were used to quantify hemocompatibility of PVA vascular grafts (Figure 1) with and without cyclic RGD (cRGD) covalent coatings, we used an ex vivo shunt model of non-anti-coagulated blood flow to quantify platelet adhesion and fibrin incorporation.

Results:

The cRGD binding moiety enhanced with steric hindrance, the cRGD peptide, which is a modified derivative of the RGD binding moiety enhanced with steric hindrance, improved cell attachment on the cRGD-coated PVA.

Conclusions: The unmodified PVA grafts have excellent hemocompatibility properties. In an ex vivo shunt model in the absence of any anti-coagulation these PVA biomaterials had minimal platelet adhesion. The surface patterned PVA grafts also had no significant platelet attachment. Platelet adhesion did increase on the biochemically modified PVA surfaces, but in a pattern dependent manner. Previous studies indicated improved endothelial cell attachment on the cRGD-coated PVA. The cRGD peptide, which is a modified derivative of the RGD binding moiety enhanced with steric hindrance, improved cell attachment by binding \( \alpha_v \beta_3 \) integrins on endothelial cells. These hemocompatibility studies suggest the potential that PVA grafts hold for synthetic small diameter vascular graft replacement. Future work will explore in vitro and in vivo cellularization and longer-term performance for preventing tissue ingrowth in vivo.