Slit Nanotopography on Silicon Nanopore Membranes Resists Protein Deposition and Cell Attachment

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Background:
Silicon Nanopore Membranes (SNM) with compact geometry and uniform pore size distribution are under development for the hemofiltration unit in an implantable bioartificial kidney.[a] Key concerns for long-term membrane function are centered on protein deposition and cell attachment that can result in surface fouling and thrombotic occulusion.[b]

Methods:
In this study, we investigated the influence of surface coatings and nanotopography on protein deposition and cell growth on SNM substrates.

SNM substrates consisting a 6 x 6 mm slit-array patterned hemofiltration region area in the center surrounded by a 2 mm unpatterned, smooth border, were modified by physically adsorbing either collagen type I (Col I-SNM) or covalently immobilizing RGD peptide (RGD-SNM). Atomic force microscopy (AFM)was used to characterize the roughness of modified SNM surfaces. The propensity of protein adsorption on SNM surfaces was evaluated using fluorescein isothiocyanate labeled bovine serum albumin (**FITC-BSA)**. Human umbilical vein endothelial cells growth on both modified and unmodified (Control) SNM were analyzed using immunohistochemistry.

The surface roughness (RMS) of RGD-SNM (12.5nm) was greater than that of Col I-SNM (7.8 nm)and Control(6 nm). In unpatterned regions, FITC-BSA adsorbed strongly to the Col I as well as RGD, and RGD-SNM was found to significantly enhance cell growth (1500 % on day 7) compared to Col I-SNM (120%) and Control (100 %). In patterned area of all modified SNMs, however, FITC-BSA protein adsorption and cell growth are strongly attenuated (below 10 % on day 7). In addition, significant actin impairment and cell detachment were observed on the patterned regions.

Results:
These results suggest that RGD is superior to Col I coatings for cell attachment. However, protein deposition and cell attachment on the slit-array region was significantly attenuated despite favorable coatings. This work will inform the development of SNM-based hemofiltration unit.

[a] *Fissell W et al., Semin Dial 22: 665-670, 2009*
[b] *Conlisk A et al., Ann Biomed Eng 37: 722-736, 2009*