

Albumin Retention by an Implanted Silicon Nanopore Hemofilter

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Background:

We are currently developing an implantable hemofiltration device using high efficiency silicon nanopore membranes (SNMs). The goal of this study was to evaluate the albumin retention characteristics of the SNMs during short term implantation in a canine model.

Methods:

SNMs were fabricated using previously established silicon nanofabrication techniques. SNMs were coated with polyethylene glycol to prevent biofouling. Membrane pore size and selectivity were evaluated prior to implantation by measuring hydraulic permeability and Ficoll sieving coefficient. SNMs (n=4) were housed in a custom made flow device and anastomosed to the abdominal vasculature in a canine. Systemic blood pressure provided the primary drive for filtration through the SNMs for a period of 3–4 days. Filtrate was collected from each SNM and albumin concentration was measured with an ACE Alera Chemistry System, Alfa Wassermann. Albumin sieving coefficient was taken as the ratio of filtrate albumin concentration to blood albumin concentration.

Results:

Pre-implant hydraulic permeability of the membranes showed an average critical pore size of 5.9 ± 0.6 nm; slightly smaller than the hydrodynamic diameter of albumin (7.0 nm). All four filtrate collection bags had clear effluent and showed average albumin sieving of 0.26 ± 0.03 . The average albumin sieving closely matched the Ficoll sieving, 0.27 ± 0.06 , at hydrodynamic diameter 4.0 nm. Though 4.0 nm Ficoll is smaller than the hydrodynamic diameter albumin (7.0 nm), it is similar to the small dimension of the ellipsoidal albumin protein (4.0 nm).

Conclusions:

These experiments demonstrate the ability for silicon nanopore membranes to retain albumin in vivo during short term implantation in a canine model. Refinement of the pore size will allow tuning of albumin retention for further testing in the in vivo model.