Predicting Clot Formation in Implanted Hemofilters

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Background:

A common mode of failure of a vascular device is clotting related to the local hemodynamic environment. Computational fluid dynamics (CFD) models can be used to predict flow fields, and we have used this approach to model flow in an implantable hemofilter using a realistic flow waveform. We hypothesized that CFD simulations of blood flow would demonstrate pathophysiologically-relevant flow patterns that coincide with locations of clot formation.

Methods:

We designed an implantable blood conduit to test hemofiltration membranes *in vivo*. Blood flow in the device was modeled with pulsatile flow boundary conditions based on *in vivo* ultrasound measurements. Regions of recirculation and slow near-wall flow were identified in each computational model. Hemofilter models were implanted in large animals anastamosed to iliac artery and vein for 30 days, or until thrombosis, then explanted.

Results:

CFD simulations predicted two persistent recirculation regions: one along the outer wall of the proximal curve, and one zone of near-wall recirculating/slow flow along the inner wall of the distal bend (Fig. 1). Of 42 implants, 2 showed localized clot formation and two more diffuse thrombosis. Clot formation was identified in the same two areas in which CFD models predicted recirculation (Fig 1).

Conclusion:

Pulsatile flow simulations predicted pathophysiologically relevant flow patterns in the same regions in which clot formation occurred. In the future, similar physiologically realistic simulations may prove useful for eliminating recirculation regions in subsequent device design.

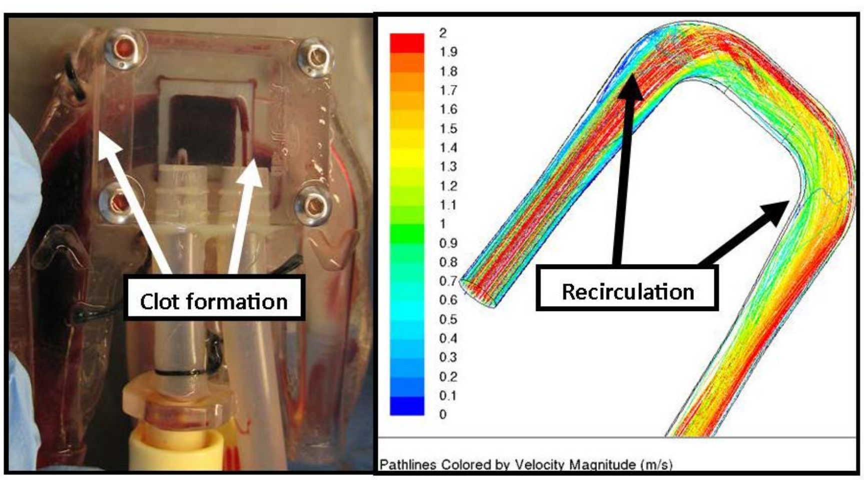

Figure 1