Low Cost Control System for Reproducing In Vivo Pressure and Flowrate at the Benchtop

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Background:

Blood and other fluids in vivo are pulsatile and oscillatory. Medical devices for implantation in the vasculature must be rigorously tested for hemolysis and thrombus formation at the benchtop prior to implant. Accurate in vitro testing requires flow systems that recapitulate in vivo fluid dynamics. We engineered a low cost fluidic control system to mimic in vivo pulsatile flow and pressure.

Methods:

Hardware for the fluidic control system included a microcontroller, pressure regulator, pressure transducer, and peristaltic pump. Hardware was controlled via a custom program developed using National Instruments Lab View allowing independent input of time dependent flow and pressure conditions. The pressure regulator was controlled by closed loop feedback from the pressure transducer. Dampening of the feedback enabled the system to maintain an average pressure despite pulsatile perturbations from a pump. In vivo and bench top flowrates were measured with Doppler ultrasound (SonoHeart Plus, SonoSite). A phantom device with flow conduit was designed to record flowrates using the same ultrasound that was used in vivo.

Results:

Comparing ultrasound images from a canine, we were able to choose pressure and flow parameters approximating in vivo flow at the benchtop. The pressure feedback loop parameters were adjusted to maintain a mean pressure of 100 mmHg (matching the mean arterial pressure of a canine) despite perturbations from the pump. Figure 1A shows flowrate vs. time in a canine model measured by Doppler ultrasound. Figure 1B illustrates our ability to mimic in vivo pulsatile flow using the same ultrasound device. Parts, excluding the pump, totaled $560. We were able to engineer a low cost system to adjust flowrate and pressure simultaneously to accurately model in vivo flow and pressure at the benchtop.

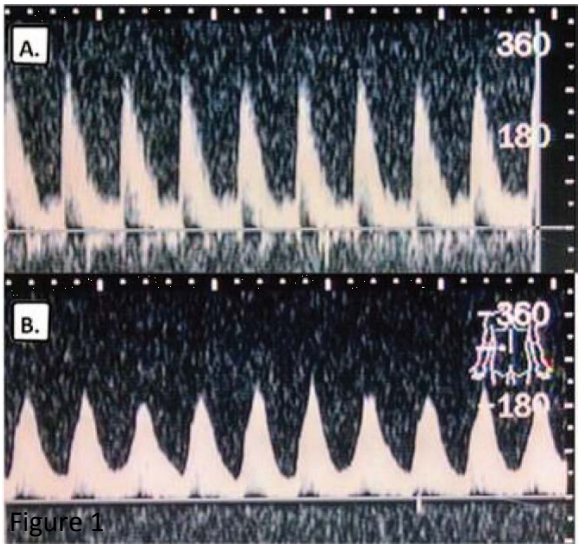

Figure 1