Design of a Four Channel Pulsatile Perfusion Bioreactor for Ex-Vivo Study of Vascular Grafts

Thomas Fair*, Reece Fratus, Dr. Lucas Schmidt, Dr. Taixing Cui, Dr. Bruce Z. Gao

Graduate Researcher, Clemson University, Ph.D. Candidate, Clemson University, Post-Doctoral Fellow, Clemson University, and Professor, Clemson University

Key Words: Bioreactor, Grafts, Cardiovascular, Particle Image Velocimetry

Cardiovascular diseases are the leading cause of death in the United States. Atherosclerosis in peripheral arteries is a major contributing factor. Autologous saphenous vein grafts are the most common bypass grafts for treating peripheral artery diseases. A quarter of these grafts fail within a year, and around half have failed within 10 years of the initial surgery. Graft failure is attributed to the development of intimal hyperplasia indicated by the migration and proliferation of vascular smooth muscle cells, fibroblasts, and the deposition of extracellular proteins.

Increases in flow, pressure, the pulse frequency, and the differential of pressure that model an arterial environment have been shown to trigger intimal hyperplasia. These tend to occur at the sites of flow disruption most often associated with the anastomotic sites. Turbid blood flow due to flow separation and flow reversal promote positive factors for intimal hyperplasia.

Perfusion bioreactors have allowed researchers to study vein grafts *ex-vivo,* creating a better understanding of vein remodeling. The goal of this project was to emulate the pressure, flow, and pulse frequency of the peripheral arterial environment. We developed a lab-built four-channel pulsatile flow perfusion bioreactor, which has the unique design features for testing varying vascular grafts and grafting techniques using optical coherence tomography and particle imaging velocimetry.