

Microvascular Dysfunction in PAD Patients

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Abstract

Background: Peripheral arterial disease (PAD) is characterized by atherosclerotic blockages of the arteries supplying the lower extremities, which cause a progressive accumulation of ischemic injury to the skeletal muscles of the lower limbs. Despite revascularization treatment intervention some PAD patients require follow up secondary treatment due to a continued decline in limb function, quality of life and walking parameters. Standard revascularization surgical procedures restore blood flow in the main arteries via bypass surgical grafting. Nutrient transport and oxygen transfer take place at the level of the microvasculature and capillaries. However, an assessment of the microvascular circulation is lacking. Microvascular dysfunction may impair tissue oxygenation as well as nutrient transport and may therefore be a contributor to the continued decline in limb function and walking parameters. In this study we assess the effectiveness of the standard lower limb revascularization strategies in PAD patients who may have microvascular dysfunction.

Methods: COMSOL Multiphysics® software was used to model the revascularization treatment intervention, blood reperfusion, and oxygen transfer in an artificial vascular network. An artificial graft was modeled by bypassing an atherosclerotic blockage to restore blood flow in the arterial bed. Microvascular dysfunction was modeled by inserting a small blockage in the capillaries to evaluate the effect of blood flow at the level of the microvasculature and the oxygen consumption in the capillaries. The chemical reaction module was used to model the reaction that takes place during the oxygen consumption in the capillaries.

Results and conclusion: Microvascular dysfunction, a 'no flow' phenomena that may occur at the level of the microvasculature in PAD patients may be one of the dominating factor to be studied to understand the failure of arterial function recovery. Typical invasive revascularization surgery, using artificial bypass grafts to restore blood flow, may fail to be effective if the PAD patient has microvascular dysfunction. This model identifies the need to measure the microvascular circulation in the compromised limbs of PAD patients to optimize diagnosis and treatment strategies that reflect the underlying pathophysiology.

Figures used in the abstract

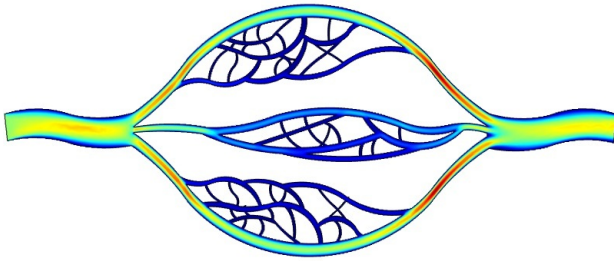


Figure 1: Blood flow and velocity profile in an artificial vascular network.

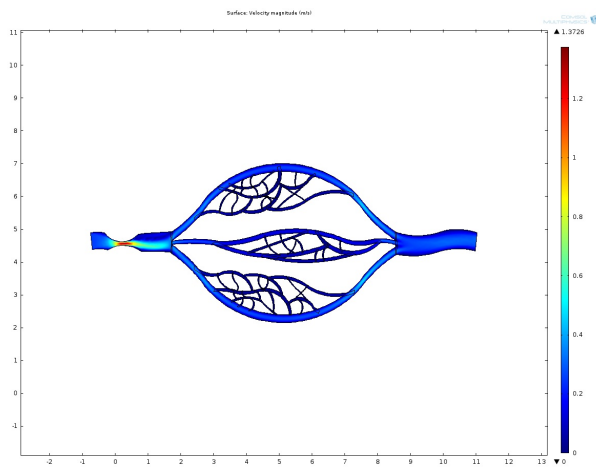


Figure 2: Vascular network with atherosclerotic blockage and altered blood flow.

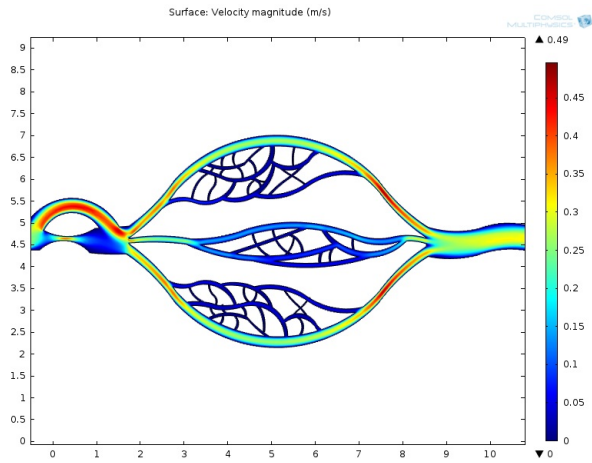


Figure 3: Vascular network with bypass graft and microvascular dysfunction.