Microvascular Change in Skeletal Muscle: Evaluation and Implication

Jonathan R. Lindner, MD

Non-invasive myocardial perfusion imaging techniques have been used for decades for the diagnosis of coronary artery disease and for assessing the physiologic consequences of known disease. Myocardial contrast echocardiography is one such technique that is capable of assessing coronary microvascular perfusion imaging of the heart and relies on the acoustic detection of ultrasound microbubble contrast agents that undergo cavitation in an ultrasound field as they transit the microcirculation. More recently contrast-enhanced ultrasound (CEU) has been used to assess microvascular perfusion imaging in skeletal muscle. The CEU protocols that have been developed to assess muscle perfusion involve some modifications to those that have been used to assess the myocardium. Using CEU, it is possible to assess skeletal muscle perfusion both at rest and during exercise stress in a matter of minutes.

There are several potential clinical applications of skeletal muscle perfusion imaging. The most prominent is the evaluation of peripheral artery disease (PAD). A major clinical gap in vascular medicine is the lack of methods for evaluating impairment in limb microvascular perfusion, which is the fundamental problem responsible for symptoms and tissue injury in PAD. In patients with claudication, assessment of limb perfusion during exercise could be used to assess the cumulative effects of sequential or diffuse disease, collateral perfusion, and microvascular dysfunction which is common in those with diabetes mellitus. Perfusion imaging could address the poor relationship seen between severity of symptoms and the commonly-used ABI, and the issue of falsely elevated ABIs from non-compressible vessels. Perfusion imaging could also potentially be used as a more accurate method to evaluate novel therapies for PAD, particularly those aimed at improving microvascular function. This lecture will discuss recent data indicating that CEU perfusion imaging adds incremental information to conventional non-invasive evaluation methods. There will also be a discussion on how CEU perfusion imaging in limb skeletal muscle has been used to better understand microvascular dysfunction in diabetes mellitus and hyperlipidemia, and how muscle microcirculation contributes to insulin resistance. There will also be information shared on novel

techniques for augmenting limb perfusion in PAD using shear-mediated vasodilation that occurs in response to microbubble cavitation.

Coronary Microvascular Dysfunction: Evaluation and Implication

Jonathan R. Lindner, MD

Non-invasive cardiovascular imaging is commonly used for the evaluation of suspected coronary artery disease (CAD) in symptomatic but stable patients. Approaches include those that evaluate coronary anatomy or detect ischemia during physiologic or pharmacologic stress. Techniques that are able to quantify microvascular perfusion are often positive in those who have symptoms from microvascular dysfunction rather than from epicardial artery stenosis, although many of these studies are incorrectly labeled as "false positive" studies. This lecture will focus on the pathophysiology of microvascular dysfunction, approaches used to diagnose the condition, and the prognosis and therapeutic implications of being diagnosed with microvascular dysfunction. Specifically, the lecture will include a discussion on pathways that lead to vasoconstrictor-vasodilator imbalance in microvascular dysfunction; and different non-invasive and invasive methods for its diagnosis, including echocardiographic techniques such as vasodilator stress myocardial contrast echocardiography.