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Lipid detection in pig arteries using intravascular photoacoustic imaging

Jieying Mai[1], Yingchun Cao[1], Ayeeshik Kole[2], Michael Sturek[2], Ji-Xin Cheng[1,3]
[1] *Weldon School of Biomedical Engineering, Purdue University, West Lafayette, IN 47907, USA*
[2] *Department of Cellular & Integrative Physiology, Indiana University School of Medicine, Indianapolis, IN 46202, USA*
[3] *Department of Chemistry, Purdue University, West Lafayette, IN 47907, USA*

ABSTRACT

Heart disease is the leading cause of death in the United States and worldwide. Each year over 370,000 people died from coronary artery disease in America. As the primary form of coronary artery disease, atherosclerosis behaves as lipid-rich plaque development inside an artery wall. Vulnerable plaques are those prone to rupture, which may result in thrombus or even death. Typical hallmarks of a vulnerable plaque include thin fibrous cap, a large lipid-rich necrotic core and inflammatory infiltrate. The identification and accurate detection of these lipid depositions in the arterial wall is crucial in the diagnosis of atherosclerosis. However, none of the current clinical imaging tools can provide accurate and reliable detection of the lipid-rich necrotic core in human arteries. Intravascular photoacoustic (IVPA) imaging is an emerging technique that can provide lipid-specific detection with depth resolution. Our research focuses on applying the catheter-based IVPA imaging technique for lipid-laden plaque detection within the artery of an Ossabaw swine model. A high sensitivity IVPA imaging system developed in our lab was performed to imaging the carotid arteries from the pig model ex vivo. The imaging results showed that the exact location and size of the lipid core can be identified, which agrees with the gold standard histology result. We also compared the results of our IVPA system with the commercial near infrared spectroscopy (NIRS) imaging system. They both successfully indicated the lipid appearance at the same location. However, our imaging modality provided more information of the lipid including lipid core size, depth and distribution. This is a significant improvement of plaque burden estimation and the diagnosis of atherosclerosis in the human artery.

KEYWORDS

Atherosclerosis, vulnerable plaque, lipid core, intravascular photoacoustic imaging, lipid detection.