Researchers develop, validate tool to visualize 3D architectural properties of atherosclerosis plaques

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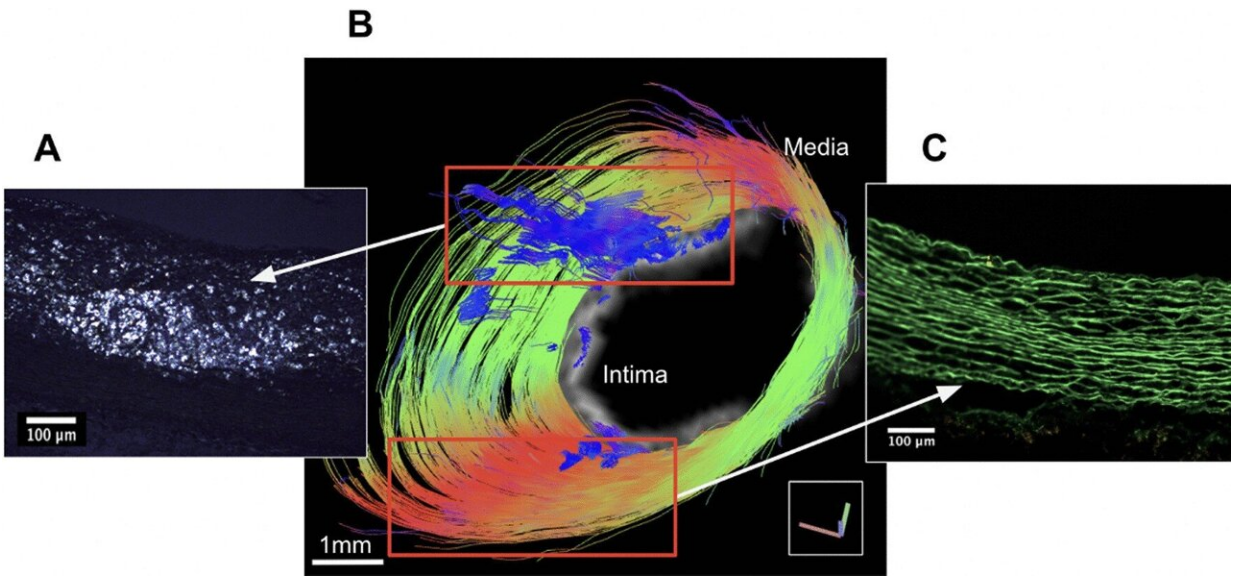

Architectural visualization of high resolution, meso-scale heterogeneity in pathologic thoracic aorta section in our rabbit model of atherosclerosis using Q-space CMR. A Illustrates the presence of a highly disorganized, isotropic, lipid-filled region detected by PLM. B Representative image of an aorta section without rupture, the green and red region of the pathologic aortic vessel wall is shown in the enlargement derived using CMR. The blue region shows a disordered region of the vessel wall containing CE, as shown by PLM in (A). C PLM of elastin tissue fibers demonstrating lipid-free, anisotropic, diffusion-restrictive organization. Color code in the CMR panel indicates the orientation of anisotropy. CE, cholesterol esters; CMR, cardiovascular magnetic resonance; PLM, polarized light microscopy. Credit: *Journal of Cardiovascular Magnetic Resonance* (2022). DOI: 10.1186/s12968-022-00897-7

Atherosclerosis is a long-term arterial vessel wall disease characterized by the build- up of lipid- rich and inflamed plaques. It often goes undetected, but highly inflamed plaques disrupt and form a blood clot attached to the vessel wall adjacent to the flowing blood. This acute event (atherothrombosis) can lead to heart attack or stroke.

Boston University investigators, working with researchers from Warren Alpert Medical School of Brown University and the Providence VA Medical Center, now have developed and substantiated an advanced magnetic resonance imaging (MRI) tool to reveal new structural insights into atherothrombosis, the leading cause of mortality in the Western world.

Using an experimental model, they combined magnetic resonance imaging (MRI) and mathematical analysis to architecturally define features of fatty material that forms plaques in the arteries not visualized with conventional MRI or histology alone.

"This method uniquely detects regions of arteries at risk of rupture or atherothrombosis, thus increasing the accuracy of diagnosis and assessment of treatment outcomes in individuals with atherosclerotic disease," explained corresponding author James A. Hamilton, Ph.D., professor of physiology & biophysics at Boston University Chobanian & Avedisian School of Medicine.

As atherosclerosis progresses, damaged smooth muscle cells (SMC) become inflamed and disorganized. While current bio-imaging techniques focus mainly on plaque features adjacent to the flowing blood, they are unable to capture highly detailed deeper cellular elements and fibrous disorganization across the entire vessel.

In regions with normal vessel wall and low inflammation, researchers observed long-range coherence of SMC and collagen fiber orientation parallel to the vessel wall, whereas in highly inflamed regions, blood clots and underlying vessels were characterized by highly random properties with many short tracts that were perpendicular to the vessel wall.

According to the researchers, this research represents an important step forward by the Hamilton group, in a decade-long collaborative project that has designed MRI methods to identify high risk plaques that are being testing clinically.

These findings appear in the *Journal of Cardiovascular Magnetic Resonance*.

More information: Erik N. Taylor et al, Lipid and smooth muscle architectural pathology in the rabbit atherosclerotic vessel wall using Q-space cardiovascular magnetic resonance, *Journal of Cardiovascular Magnetic Resonance* (2022). DOI: 10.1186/s12968-022-00897-7