Cine Magnetic Resonance Imaging of Myocardial Ischemia and Reperfusion in Mice

Zequan Yang, MD, PhD; Brent A. French, PhD; Wesley D. Gilson, MS; Antwone J. Ross, MS; John N. Oshinski, PhD; Stuart S. Berr, PhD

Studies of acute myocardial ischemia/reperfusion injury in genetically manipulated mice have been impeded by the technical challenges of instrumenting small animals (<40 g) and assessing cardiac function at such rapid heart rates (>500 bpm). To address these problems, 4 C57BL/6 mice (28 to 30 g) were anesthetized with pentobarbital and intubated for surgical instrumentation of the major left coronary artery with pneumatically controlled balloon occluders. The distal end of the tubing from the balloon occluder was exteriorized at the back of the neck. One week later, each mouse was anesthetized with pentobarbital and fitted with surface ECG electrodes, and an extension tube was added to the balloon occluder. Mice were imaged on a Varian Inova 4.7T MR scanner using a Helmholtz radiofrequency coil. An ECG-triggered, 2D gradient echo sequence with an echo time of 3.9 ms and a flip angle of 20 degrees was used to obtain 12 phases per cardiac cycle at a final resolution of 100×100×1000 μm³.

Baseline cine images consisted of a series of 7 contiguous, 1-mm-thick, short-axis slices spanning the heart from apex to base. A myocardial stunning protocol consisting of a series of four 4-minute coronary occlusions interspersed with 4 minutes of reperfusion was then executed from a remote position outside of the magnet. Contiguous, short-axis cine MR images were successively acquired in the midventricular to apical regions of the left ventricle during each of the 4 balloon inflations. As shown in the Figure and the accompanying cine images, the use of remotely controlled coronary occluders, combined with high-field MRI for the noninvasive assessment of cardiac function, should prove valuable for elucidating the role of specific genes in the pathophysiology of ischemia/reperfusion injury using genetically manipulated mice.

From the Departments of Biomedical Engineering (Z.Y., B.A.F., W.D.G., A.J.R., J.N.O.) and Radiology (S.S.B.), University of Virginia Health System, Charlottesville, Va.
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