SPring-8

The Development of an Image Analysis Method for High-Resolution Observation of the Beating Heart: Looking into the Dilation/Contraction Mechanism of the Coronary Artery and Cardiac Muscle in Mouse Models of Cardiovascular Disease

The researchers at NCVC (director: Nobuo Hashimoto, Suita city, Osaka pref.), JASRI (director: Tetsuhisa Shirakawa, Sayo town, Hyogo pref.), Monash University, and University of Otago have teamed up and conducted a high-intensity X-ray-assisted study on observation and elucidation of the detailed behavior of beating hearts in mice and rats commonly used for modeling cardiovascular diseases. The main objectives of the study include observation of the dilation and contraction mechanism of the small coronary arteries, and the elucidation of motor functions of proteins that drive myocardial contraction, whereby the high-intensity synchrotron radiation X-ray available at SPring-8 played an integral role. The team has developed techniques—many of them are world firsts—along the way and elucidated molecular mechanisms of cardiovascular disease. The US specialty journal *Circulation Research* highly acknowledged these achievements and published a review article in its online publication on the 4th of January.

The techniques developed in this study concern time-resolved analysis of beating hearts in small-animals: 1) synchrotron radiation assisted high resolution microangiography capable of observing whole view of coronary responses, from the main artery to arterioles (down to approximately 30-50 μm in diameter), 2) a synchrotron radiation X-ray diffraction method that enables multiple pinpoint (dimensions 0.2x0.2 mm) assessments of contractile protein movements—the source of cardiac contraction and relaxation—in different regions of the heart. These techniques are expected to pave the way for elucidating molecular mechanisms, involving genes and proteins, that cause cardiovascular diseases, and for promoting therapeutic method development.

Reference: "Synchrotron Radiation Imaging for Advancing Our Understanding of Cardiovascular Function"
Mikiyasu Shirai, Daryl O. Schwenke, Hirotsugu Tsuchimochi, Keiji Umetani, Naoto Yagi, James T. Pearson
Circulation Research 2013 Jan 4;112(1):209-221

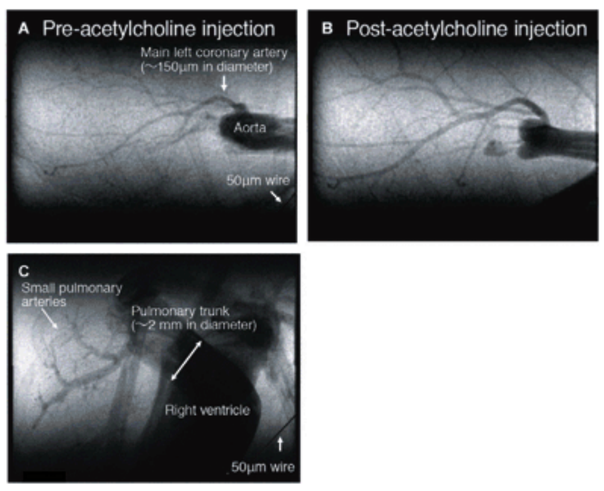

Fig. 1 In vivo coronary and cardiopulmonary microangiograms of the intact chest in an anesthetized mouse (heart rate: up to 500 beats/min): the coronary arteries (A, B) and the right ventricle and pulmonary arteries (C).

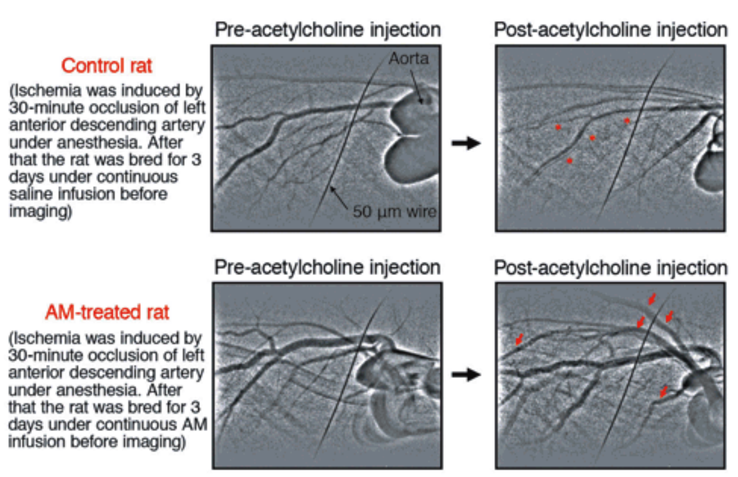

Fig. 2 Adrenomedullin (AM) improves the endothelial function of post-ischemic-reperfusion small coronary arteries of rats.

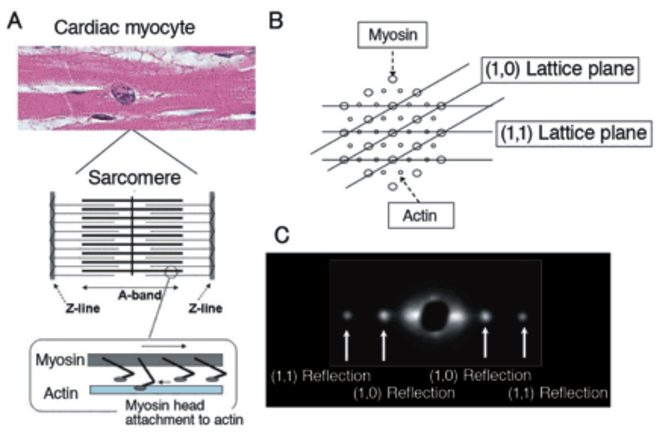

Fig. 3 Hexagonal lattice arrangement of cardiac contractile proteins and its X-ray diffraction pattern.

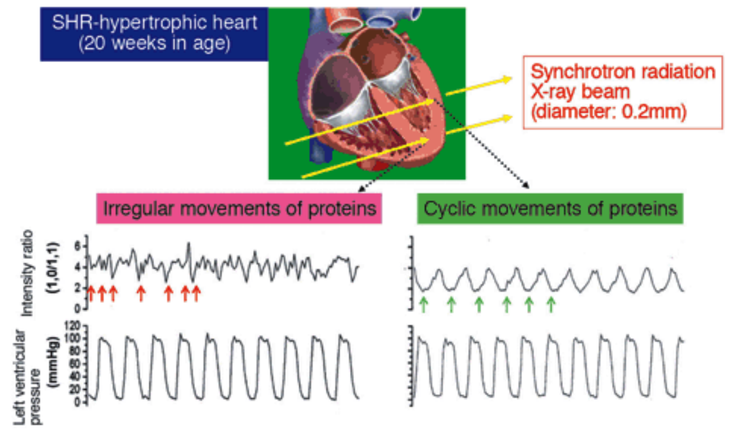

Fig. 4 Time traces of intensity ratio at different ventricular regions and left ventricular pressure, for 10-pulse period, in a spontaneously hypertensive rat (SHR).