Use of Blood–Pool Contrast Agent for Assessment of Myocardial Injury

J. Wang[1,2], B. Xiang[1], G. Li[1,2], H. Liu[2], J. Sun[1], R. Deslauriers[1], G. Tian[1]

[1]Institute for Biodiagnostics, National Research Council of Canada, Winnipeg, Manitoba, Canada, [2]Harbin Medical University, China, Harbin, Heilongjiang, China, People's Republic of

Introduction: Blood-pool contract agents have been developed mainly for MR coronary angiography. Their efficacy for assessment of myocardial viability, however, still remains to be determined. If myocardial injury can be assessed with a blood-pool contrast agent, myocardial viability as well as coronary integrity can be evaluated simultaneously with this type of contrast agents. Since myocardial infarction is associated with loss of the capillary integrity and a significant decrease in blood flow, we hypothesized that infarcted myocardium can be delineated with a blood-pool contrast agent. The present study was to test our hypothesis with a new blood-pool contrast agent (P792).

Materials and Methods: Myocardial infarction was induced in 5 pig hearts with a 90-minute occlusion of the LAD, followed by 30-minute reperfusion. The hearts were then removed from animals and perfused in a Langendorff apparatus with pig blood. Sixty milliliters of P792 (1.9 mM) was injected as a bolus into the aortic perfusion line. Its first pass through the heart was followed using a TurboFLASH T_2*-weighted imaging. Contrast-induced changes in myocardial T_1 relaxation times were then monitored for 30 minutes using an inversion-recovery TurboFLASH sequence with 9 different inversion delays. At the end of experiment, 10 x 10^6 colored microspheres (15 ± 1.9 μm diameter) were injected into the perfusion line for measurement of regional blood flow. The pig hearts were then cut into 5-mm thick slices and stained with 2% triphenyltetrazolium chloride (TTC).

Results: It was found that at 30 minutes after contrast injection T_1 relaxation times in normal myocardium (990.0±73.8 ms) and infarct rim (980.7±138.9 ms) were not significantly different ($P>0.05$). T_1 relaxation times in infarct core (1686.5±299.4 ms), on the other hand, were significantly longer ($P<0.05$) than those of the normal myocardium and infarct rim. As a result, infarct rim could not be readily differentiated from normal myocardium on P792-enhanced T_1 maps (Figure, panel C). With T_2* imaging, we found that the wash-in slope of P792 in the infarct region (including both infarct rim and core, 6.9 ± 0.9 arbitrary unit) was significantly smaller ($P<0.05$) than that in the normal region (22.0 ± 13.7 a.u.). Moreover, P792-induced maximum changes in T2* signal intensity during its first pass (T_2*-max) was significantly less ($P<0.05$) in the infarct region (49.3 ± 14.0 a.u.) than in the normal region (79.0 ± 2.6 a.u.). Consequently, the infarcted myocardium (including both infarct rim and core) was clearly demarcated as a hypo-enhanced region on the maps of T_2*-max and the wash-in slope (Figure, panels A and B). Size of infarcted myocardium measured on the two maps (27 ± 13% of the entire heart on the wash-in slope maps; 27.8% ± 14% on the maps of T_2*-max) was comparable to that determined on TTC stained section (27.6 % ± 13.9%) (Table). Microspheres data showed that regional blood flow was significantly lower ($P<0.05$) in the infarct rim and infarct core than in the normal myocardium.

Discussion and Conclusions: Our results demonstrated that infarcted myocardium could be clearly delineated on the perfusion maps obtained with a blood-pool contrast agent because of significant decrease of blood flow in the infarcted regions. Delayed-enhanced T_1 imaging may underestimate infarct size under our experimental conditions. This could be due to a short period of reperfusion used in this study. Efficacy of blood-pool contrast agents for assessment of myocardial viability in chronic infarction is currently under investigation in our institute.

Methods / Animals	Map of T_2* Max	Map of Wash-in Slope	T_1 Map	TTC-Staining
A	7.501	7.804	5.699	7.699
B	19.77	19.80	12.76	19.56
C	34.49	33.56	27.94	33.78
D	34.61	34.77	29.35	34.62
E	42.89	42.60	17.55	42.84

Table. Infarct size (% entire heart) determined with three different mapping methods and TTC-staining

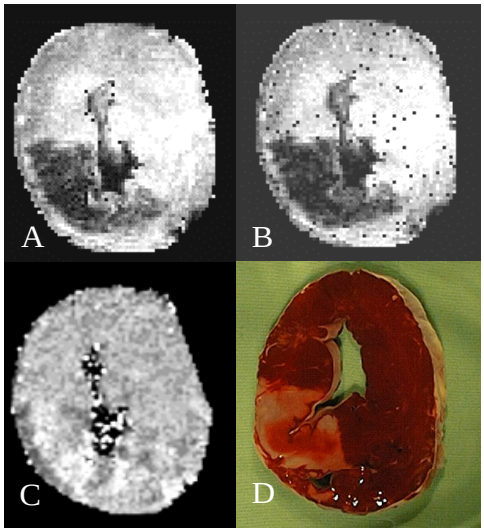

Figure . Infarcted myocardium of a pig heart measured with the maps of T_2*-max (A), wash-in slope (B), delayed-enhanced T_1 map (C), and TTC-stained section (D).