MYOCARDIAL T1 CAN DIFFERENTIATE BETWEEN INTRACELLULAR (IC) AND EXTRACELLULAR (EC) WATER IN PERFUSED RAT MYOCARDIUM

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Introduction. It is a common assumption in MRI of myocardium that longitudinal relaxation is a monoexponential process revealing a single value for tissue T_1[1,2]. Accordingly, water exchange across the cardiac cell membrane has been regarded as rapid. By applying a double exponential function for analysis of T_1 data our group has recently shown two components in normal and manganese (Mn^{2+}) enriched rat myocardium and a preferably slow exchange of water across the sarcolemma[3,4]. Since these relaxographic analyses were performed in excised and ischemic tissue, the aim of the present study was to establish whether two T_1 components are also present in perfused myocardium.

Materials and Methods. Rat hearts were made cardioplegic to avoid motion artifacts and perfused with Krebs buffer containing 20 mM KCl. MR relaxography was performed *in situ* (Maran Ultra, Resonance Instruments Ltd, 23 MHz, 37°C). T_1 values were measured along the long axis of the perfused heart using a 1D profile-Saturation Recovery method. In some experiments $MnCl_2$ (25 μM) was infused prior to the cardioplegic state. After perfusion myocardium was excised, and T_1 was again measured (within 5 min). In another series of experiments diffusion-T_2 (D-T_2) and T_1-T_2 correlations were measured in excised tissue using combined Pulsed Gradient Spin Echo/CPMG and Inversion Recovery/CPMG methods.

Results. Measurements showed that we clearly identify two T_1 components in perfused myocardium (Figure 1). In Mn^{2+} enriched hearts there is a pronounced decrease in the shortest component, and due to water exchange there is also a slight decrease in the longest component. In pilot experiments we found no significant change in T_1 values at varying coronary flow rates (CFR) 0-6 mL/min. Two T_1 components with the same values as during perfusion were also identified in the excised tissue. In separate experiments T_2 was also resolved in 2 main components. T_1-T_2 correlation measurements showed that the shortest T_2 component is associated with the shortest T_1 value, while D-T_2 correlation measurements showed that the longest component is suppressed at high diffusion weighting, in accordance with results obtained recently in our lab[5]. Based on the overall findings we assign the two T_1 components to ic (short) and ec (long) water compartments.

Conclusions. We identified two T_1 components in perfused rat myocardium, which we assign to ic and ec water compartments. Based on results from perfused hearts enriched with Mn^{2+} and from diffusion-relaxation experiments in excised tissue a slow water exchange between compartments is confirmed. The present study indicates that differentiated MR imaging of ic *vs* ec water may be possible.

References.

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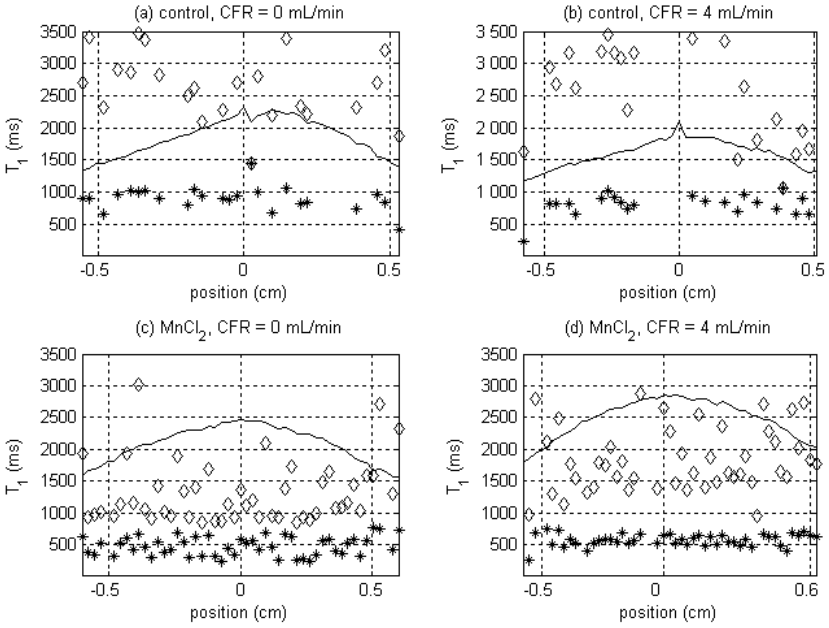

Figure 1 Measured T_1 values during perfusion, analyzed using a two-component model. Average values (short T_1/long T_1) (in ms) are 908/2670 (a), 809/2544 (b), 480/1310 (c) and 562/1837 (d). The relative fraction of the shortest component was 0.55± 0.15 in all experiments. The solid line is the intensity of the magnetization profile.