^{31}P MR-Spectroscopy of the Human Myocardium Using Spatial Saturation Pulses and a B_1-Field correction

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Introduction:

The study of phosphate metabolism by means of ^{31}P MR-spectroscopy within the human myocardium is to this day not established for clinical use. The main reason for this is the complicated and time consuming post processing, which is particularly required because of the contamination of the PCr signal from tissue adjacent to the myocardium. Recently a new method [1] was presented which uses spatial saturation pulses for the suppression of the contaminating PCr signals originating mainly from skeletal muscle. Unfortunately this method still suffers from the fact that the calculated distribution of the metabolite concentration is quite inhomogeneous due to profile of the B1-fields. This can lead to misinterpretations of the acquired results. Here we would like to present a new technique which help to overcome this problem. This technique was applied to image the distribution of ^{31}P metabolites in healthy humans and first patients with myocardial infarction. The latter were additionally examined with a late enhancement protocol.

Methods:

All investigations were carried out on a 1.5 T scanner (Magnetom Symphony, Siemens). The spectroscopic measurements were recorded by using a ^{31}P/^{1}H surface coil and for the examination of the late enhancement a 12 channel coil was employed. All sequences were ECG-triggered and for the prevention of breathing artefacts spectroscopic imaging was done in prone position. For the suppression of unwanted signal from neighbouring regions saturation pulses were applied. Furthermore an acquisition weighted sampling scheme [2] was used for 3d CSI. The coil position was determined by two capillaries filled with silicone, which were fixed beneath the coil. Using the coil geometry the B1-fields of the receiver and transmitter coil were determined according to the Biot-Savart law. Before the spectroscopic post processing the CSI dataset was corrected by the coil profile of the receiver coil. This was done using a custom-built software, which was written in interactive data language (Research Systems Inc., Boulder, CO, USA).

Results and Discussion:

The presented technique enabled to measure the distribution of high-energy phosphate metabolites of the whole left ventricular myocardium.
Since the calculated B1-fields of the larger transmitter coils revealed that the distribution of the flip angles will cause only very little changes in the metabolite maps, these field maps were not taken into account for further considerations. Consequently the measured dataset was only corrected by the calculated receiver field. The whole post-processing is fully automated and could be achieved within in a few minutes.
In comparison to the uncorrected metabolite maps the distribution after B1-field correction appeared much more homogeneous for the healthy subjects (see figure 1). The results of the patient investigations allowed us to detect infarcts in the posterior and anterior myocardium. This was also in good agreement with the examination of the late enhancement.

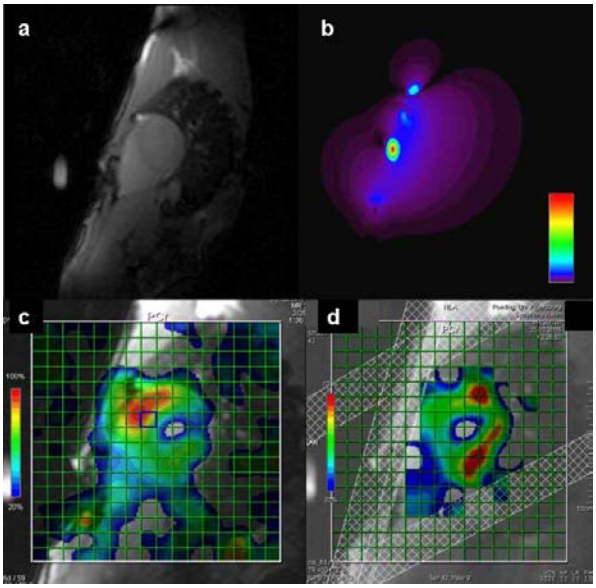

Figure 1: Short axis view of the myocardium (a) and the corresponding field distribution of the receiver coil, which was used for the spectroscopic measurements. The PCr map without B1 correction yields a higher PCr concentration in the anterior wall (c), whereas the distribution after B1-correction is more homogeneous (d).

Conclusions:

The employment of spatial saturation pulses and the correction of the metabolite maps by the B1-field of the receiver coil allows a reliable visual representation of energy metabolites within the human myocardium. The calculation of the spatial distribution of the metabolites could be achieved using a fully automated software.

References:

1. Geier O, et al. ISMRM 2006 #1979
2. Pohmann R, von Kienlin M.. Magn Reson Med 2001; 45:817-826.