Metabolic imaging of healthy and infarcted myocardium using ^{31}P chemical shift imaging with spatial saturation pulses

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Introduction:

Due to the complicated and time consuming post-processing, ^{31}P -MR-spectroscopy of the human myocardium is still restricted to some specialized centers [1, 2]. Particularly the contamination from tissue adjacent to the myocardium, such as skeletal muscle, makes the usage of straightforward data evaluation impossible. The present study explored a 3D CSI-technique which suppresses the contribution from adjacent organs to the myocardial signal by means of spatial saturation pulses. The goal of this study was to apply this sequence to human myocardial ^{31}P spectroscopy and image the distribution of ^{31}P metabolites in healthy humans and first patients with myocardial infarction. For the later the findings were compared to those of the examination of the delayed uptake of contrast agent in the infarct area (late enhancement).

Methods:

All measurements were performed on a 1.5 T scanner (Magnetom Symphony, Siemens) using a ^{31}P /^{1}H surface coil for the spectroscopic measurements and a 12 channel coil for the examination of the late enhancement. To prevent breathing artefacts all spectroscopic measurements were carried out in prone position in combination with ECG-triggering. ^{31}P signals from chest wall, liver and large vessels were suppressed by saturation pulses (figure 1). Furthermore an acquisition weighted sampling scheme [3,4] was used for the 3D chemical shift imaging. For the late enhancement examination an IR 2d turbo-gradient echo sequence (TR =7.5 ms; TE 3.4ms, flip angle 25°, TI individual) was used.

Results and Discussion:

It was possible to measure the high-energy phosphate metabolites PCr and ATP of the whole left ventricular myocardium in short axis orientation. The spatial distribution of the metabolites could be determined by means of the software already included in the scanner within five minutes. The PCr distribution was clearly visible as a ring which fitted very well to the myocardium in the short-axis images. The patient study showed an obviously reduced PCr-signal in the anterior-septal myocardium, which correlated well with the late enhancement defined infarcted area (figure 1). This implies a strong reduction of the metabolites in the infarct area.

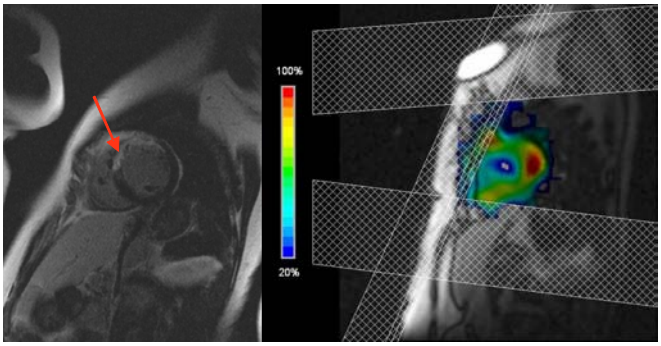

Figure 1: Late enhancement in a myocardial infarction of the anterior septal wall (left) and the corresponding CSI examination. In the area of late enhancement a strong reduction of PCr is visible.

Conclusions:

The employment of spatial saturation pulses allows for the visual representation of the myocardial ^{31}P metabolites and the detection of the reduction of the energy metabolites within an infarcted myocardium. The results of first patient examinations show a good correlation with the results using the late enhancement technique. The saturation of signals from tissue adjacent to the myocardium facilitated the reconstruction process and drastically decreases the time from data acquisition to the display of metabolic images.

References:

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