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Ex vivo-investigations of the MR compatibility of temporary pacemaker leads on pig hearts at 1.5 and 3.0 T

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Introduction

Cardiac MRI has become one of the most important imaging methods in cardiac diagnostics and is frequently essential in the case of complications following surgery. However MRI is currently contraindicated in patients with epikardiale pacemaker leads. The main risk comes from heating effects by the absorption of radio frequency (RF) energy. The temperature dependence of the water resonance enables it's estimation by spectroscopic MR measurements.

Methods

Nine pig hearts with implanted myocardial leads (Plastic tines model, Dr. Osypka GmbH, Rheinfelden, Germany) were investigated by single voxel ^{1}H-MRS before and after application of commonly used MR imaging sequences. In vitro measurements were performed on a whole body MR scanner of 1.5 (N=9) and 3T (N=4) using the standard receive head coil of the manufacturer. Spectroscopic voxel were placed in the heart muscle in the vicinity of the leads. Applied MRI sequences were DWI-EPI, T1-W SE, T2-W TIRM, EPI, ToF-Angio and a TSE with maximal SAR values. ^{1}H-MRS temperature measurements were performed prior and after MRI as well as between ToF-Angio and TSE. The temperature dependent frequency-shift of the water-resonance was estimated in an additional heart, tempered between 20 and 40°C in a water bath.

Results

Despite of the disturbed the magnetic field homogeneity around myocardial leads water-creatine shift-difference could be estimated in all spectra. Between 20 and 40°C the shift difference between water and creatine resonances decreased with -0.0074 ppm/°C in accordance with values published in literature. Neither at 1.5 nor at 3 T a significant RF-heating effect was observed.

Conclusion

These initial results are encouraging for detailed investigations of the heating risk of myocardial leads in MRI including size, geometry of leads and the possibility of small temperature hot spots. Compared to phase based methods the water frequency shift enables the determination of temperature values independent of field shifts.