Cardiac MRI in Mice @ 11.7T: Comparison of a 4-Element Array Coil and a 2-Element Cryo Coil

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Introduction: With the steadily increasing availability of mouse models of cardiovascular diseases, the interest in imaging of the cardiovascular system has raised accordingly. Due its size and its rapid motion, imaging of the heart with sufficient anatomic and dynamic detail is still challenging often resulting in extensive scan times to provide sufficient SNR. Recent technologies for improving SNR include the use of multi-element array coils and more recently even cryogenic coils, which are supposed to reduce the overall SNR by reduction of the ohmic noise of the receive coil.

It is the objective of this work to investigate the SNR performance of a 4-element cardiac coil array in direct comparison to a 2-element cryo coil.

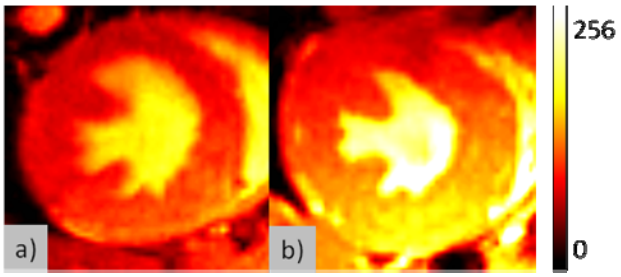

Figure 1: SNR maps for the 4-element cardiac array coil (a) and the cryocoil (b)

Materials and Methods: Three wildtype mice (B6/C57) were enrolled in this study. In each mouse a comprehensive cardiac functional examination was performed on an 11.7T small animal MRI (BioSpec 117/16, Bruker Biospin). The MR protocol was performed under isoflurane anesthesia (1.5% concentration), comprising a quick survey scan in three orthogonal orientations for planning of the subsequent scans, which include the acquisition of three short axis views (apical, equatorial, basal) and two long axis acquisitions in 2- and 4-chamber geometry. Functional imaging was performed applying a self-gated acquisition approach (IntraGate©, Bruker). For ensuring sufficient data for the reconstruction of 15 cardiac phases, 100 repetitions were acquired by a steady-state fast gradient echo technique. Image parameters were as: TE / TR = 1.7/6.7ms, flip angle = 12°, spatial resolution = 0.1x0.1x0.5mm³, pixel bandwidth = 585Hz. Resulting acquisition time per slice was 2m5s. No parallel imaging was used.

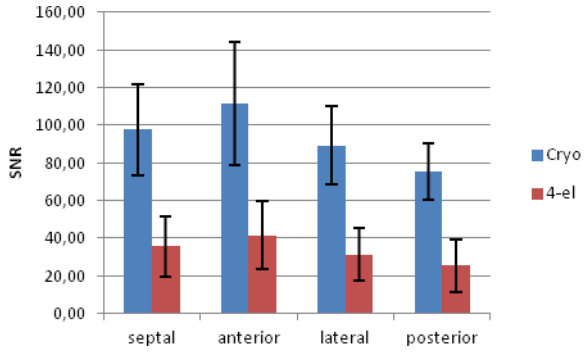

Figure 2: SNR for the 4-element cardiac array coil and the cryocoil

The mean SNR values over the myocardium and independently for the anterior, septal, lateral and posterior wall were calculated by the quotient of the mean value of a manually drawn region of interest and the background noise. Statistical relevance of the results was analyzed by an unpaired Student's T-test assuming a heteroscedastic variance of the two samples.

Results: The scan protocol could be completed in all mice. Reconstruction yielded sufficient image quality for evaluation of the contractile motion in all cases. Clear differences in the SNR can be appreciated in all regions of the myocardium (fig. 1). The mean gain in SNR with the cryo probe was 2.8, with individual improvements (fig. 2) of 2.65 (anterior), 2.75 (septal), 2.85 (lateral) and 2.95 (posterior). All improvements were highly significant (p-value < 0.01). Interestingly, the strongest gain was obtained in the posterior region of the myocardium indicating a more homogeneous sensitivity profile of the 2-element coil, which can also be appreciated in the 2-chamber view (fig.3).

Discussion and Conclusion: The data clearly suggests that even at 11.7T, a significant improvement of SNR can be obtained by application of a cryo coil. The high SNR gains between 2.65 and 2.95 are supposed to enable high-resolution imaging of the heart or even volumetric functional imaging at reasonable imaging times.

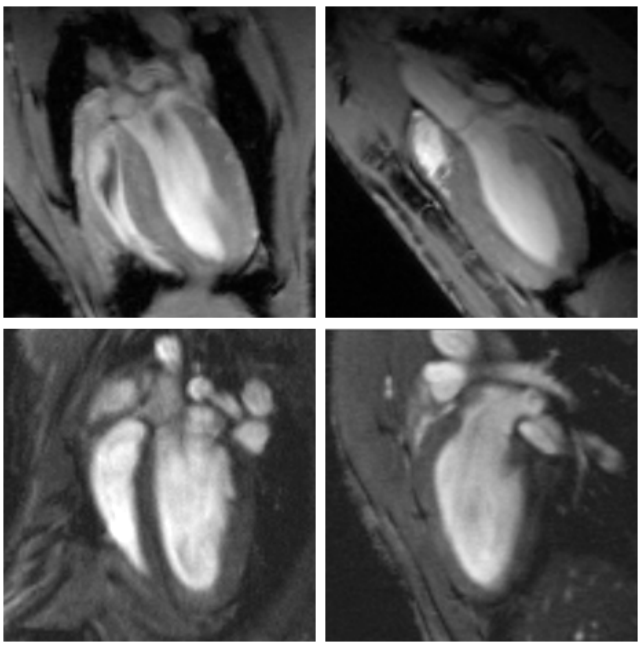

Figure 3: 4- (left) and 2- (right) chamber view acquired with the Cryo coil (top) and the 4-element cardiac coil (bottom).