UNIFORM EXTENDED FOV MR IMAGING AND HIGH B1 MRSI OF THE PROSTATE AT 7 TESLA USING ACTIVE DECOUPLING

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Introduction: At high field strengths like 7 Tesla, conventional external coils do not generate sufficient B_1 deeper in the body (e.g. prostate). More efficient external single-sided adapted dipole antennas (SiSiAD)[1] can provide sufficient B_1 for MRI. However, the B_1 level required for effective MRS in the human prostate using the current amplifier setup, can only be obtained with an endorectal transmit coil (ERC). In this work we demonstrate the low RF coupling between the external elements and the ERC[2] at 7T, that offers the possibility to combine the ERC and external elements in the same session. Since residual RF coupling can be counteracted using active decoupling [3], no high power PIN diodes are required in the ERC. Therefore, optimized MRS with uniform MRI of the human prostate at 7 T is possible.

Methods: An array of six SiSiAD antennas [1] (two on top and four below the volunteer) and a two-elements ERC[4] where used (two upper antennas connected to a 4 kW power RF amplifier each and the other six elements to 1kW amplifiers). All measurements were performed on a 7 Tesla Achieva system (Philips, Best, The Netherlands). In-vivo measurements were acquired in clinical prostate cancer patients. After performing B_1 shimming at the prostate location and determining the strength of the coupling [3], T2-weighted images (MS TSE, TSE factor 18, TE/TR=100 or 72/5000 or 2500 ms, 250x400x58 mm^3 FOV, 10 slices) were acquired when transmitting (Tx) with either the ERC or only the external array, while receiving (Rx) with all elements or only the ERC. The MRSI acquisition was obtained with all elements as transceivers (Tx/Rx) (2D nsLASER[5], TE/TR= 56/3600 ms, 100x35 mm FOV, 30x300 VOI, 5x5x5 voxel, 20x70 matrix, 2048 samples, 4000 Hz bandwidth).

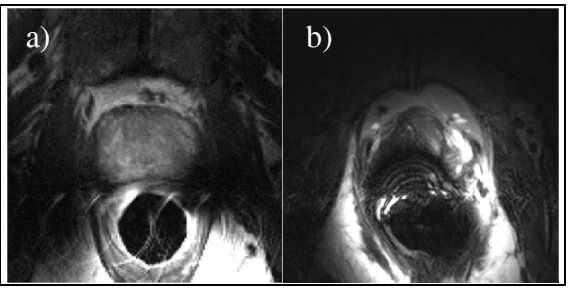

Figure 1: prostate T2-weighted images: a) Tx only with external array and Rx with all and b) Tx/Rx with ERC only. Transition bands are generated due to the high B_1 of the ERC.

Results/Discussion: When Tx is done only with the external antennas the uniformity of the T2w-images is significantly improved compared to Tx with the ERC only (Figure 1). This uniformity is maintained even when the tuned ERC is still present, while the SNR substantially improves.
When transmitting with the ERC, the strong B_1 fields can be used for MRSI, which due to the presence of the externally applied fields extends to the anterior part of the prostate. The results of the 56 ms TE MRSI are shown in Figure 2, showing clear signals of citrate, creatine, polyamines, choline and even myo-inositol+choline, taurine and scyllo-inositol at this short TE. Due to the adiabatic properties of the nsLASER sequence, the MRS signals remain uniform over the whole prostate. The contribution of the external array for transmission results in MRS signals to be seen beyond the coverage of the ERC. The temperature measurements (Fig, 2b) resulted in a maximum temperature change of less than 1^oC, during the MRSI protocol.

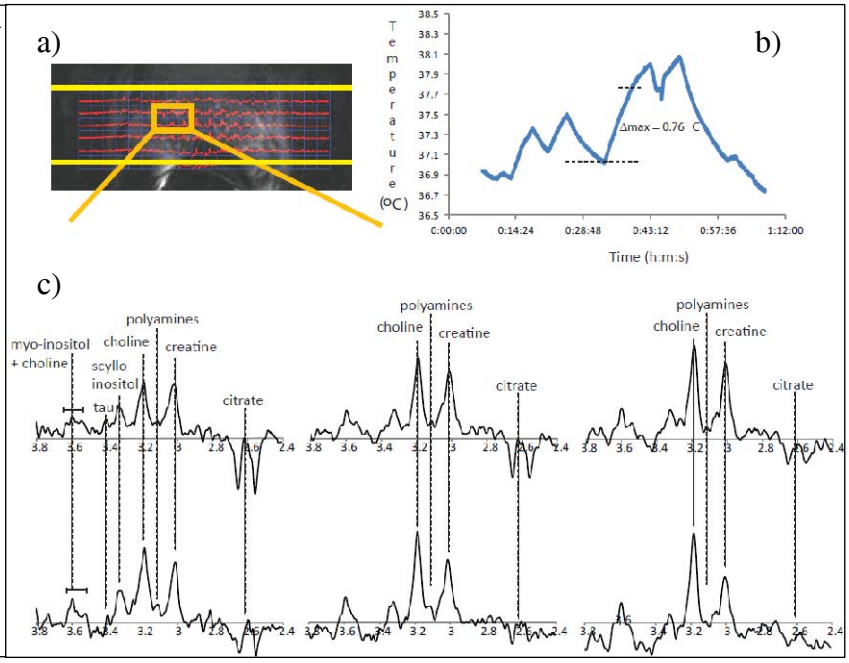

Figure 2: a) T2-weighted MRI of the prostate with selected VOI (yellow) for MRSI acquisition, using all elements for Tx/Rx; b) temperature monitoring during scan protocol. A voxel selection (orange box) is highlighted in c) showing clear peaks Cho, poly, Cr and Cit. At this short TE even peaks of mI+cho, tau and sI are observed.

Conclusions: the combination of an external array with an ERC, both used as transceivers (Tx/Rx) for uniform MRI and short TE MRSI of the prostate is feasible, due to the low coupling between the elements and the use of active decoupling at 7T. Consequently, accurate detection of metabolite levels in the human prostate can be obtained, while providing clinically relevant MRI at 7T.

References:
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