Simultaneous MRI acquisition of Both Knee Joints with Multitransmit Technology at 3T

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INTRODUCTION:

Multitransmit technology was introduced to overcome local SAR limitations and eliminate focal hotspots with a more uniform flip angle for scanning at 3.0 Tesla [1]. With these advantages, the clinical scan protocol can be improved by decreasing TR without getting a higher local SAR and it can be expected to improve the homogeneity of images. The purpose of this study is to objectively assess imaging performance of multitransmit technology compared to traditional, single channel technology in MR scans of both knees simultaneously. Typically, knee scans are performed on a single knee. Sometimes, it can be advantageous to scan both knees simultaneously to provide a reference for the affected knee. For this work, two knees are imaged simultaneously, which illustrates the advantageous of multitransmit technology.

MATERIAL AND METHODS:

A 32channel cardiac coil was selected to test the imaging quality with multitransmit. To qualitatively compare with clinical images, scans with an 8 channel knee coil were also performed. Imaging took place on a 3T MR system (Philips Achieva, Cleveland, Ohio). Ten healthy knee volunteers (25±4 years) were scanned. An axial, proton density-weighted multi-shot turbo spin echo sequence (TSE) fat-suppressed sequence was chosen (TR/TE=1400/15ms; TSE factor=7; FOV=300x300mm^2; matrix size=576x576; slice thickness=2mm; slice number =10; NSA=4). Two scans with (local SAR=39% of the maximum allowable) and without (local SAR=65%) multitransmit were performed. Noise images were generated by acquiring data without delivering RF pulses to generate SNR maps. The total acquisition time, including the noise images for both scans with and without multitransmit was 13min 20secs. Dual TR B_1 maps with a TR difference of 100ms were acquired. Color coded SNR maps were produced by dividing every pixel in of the signal image by the standard deviation of a local region in the noise image. B_1 frequency shift maps were calculated from the dual TR B_1 maps.

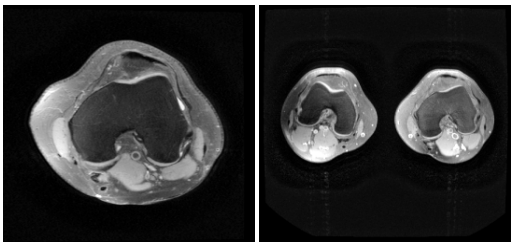

Fig. 1: Knee imaging with left knee using 8 channel knee coil (left) and simultaneously with two knees using 32 channel cardiac coil (right).

RESULTS AND DISCUSSION:

Fig. 1 shows the knee images acquired with the 8 channel knee coil (left) and the 32 channel cardiac coil (right). Similar anatomical structures can be seen in both. Cardiac coil scans with multitransmit reduced the SAR by 40% (from 65% to 39%) compared to the scans without. The color coded SNR maps were produced (Fig. 2 with multitransmit, left; without, right). It can be seen that the SNR distributions with and without multitransmit are fairly similar. But the areas surrounding the infrapatellar fat pad and cartilage are more homogeneous in the multitransmit image (black arrows). This may be due to the better flip angle distributions. The signals show some difference comparing two knees in both with and without multitransmit sequences. This is more likely to be of the result of using the cardiac coil, which is not designed for scanning lower extremities. It may be corrected with a knee coil that is designed for scanning both knees simultaneously. Fig. 3 shows the B_1 frequency shift maps of 10^{-3}Hz (with multitransmit left; without, right). Multitransmit shows a relatively homogeneous B_1 frequency distribution across the bone marrow and muscle regions. The difference of B_1 frequency shift values of two knees appears to be less with multitransmit which is due to flip angle optimization.

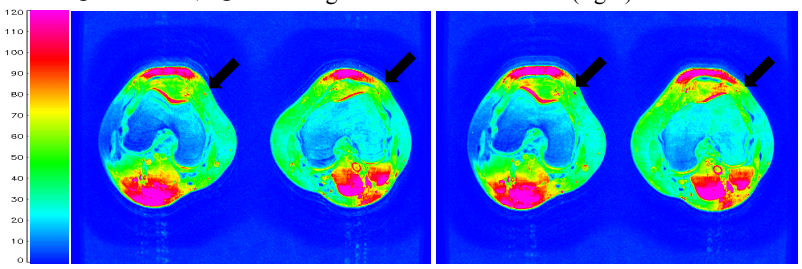

Fig. 2: Color coded SNR maps with (left) and without (right) multitransmit. the areas surrounding the infrapatellar fat pad and cartilage are more homogeneous in the multitransmit image (black arrows).

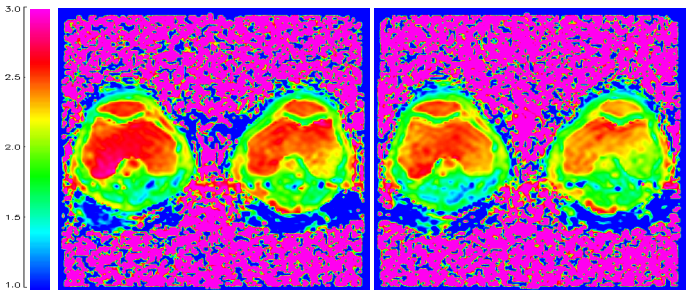

Fig. 3: B_1 frequency shift maps with (left) and without (right) multitransmit in units of 10^{-3}Hz. Multitransmit shows a relatively homogeneous B_1 frequency distribution across the bone marrow and muscle regions. The difference of B_1 frequency shift values of two knees appears to be less with multitransmit.

CONCLUSIONS:

MR imaging of knees with multitransmit technology at 3T (using a 32 channel cardiac coil) reduced the local SAR substantially and improved the image homogeneity.

REFERENCES:

[1] Bob van den Bergen et al. Phys. Med. Biol. 2009, 54: 1253-1264.