MP2RAGE Imaging at 9.4T using a pTX System

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Purpose To investigate the feasibility of homogeneous, high-resolution anatomical T_1 weighted imaging at 9.4T using the MP2-RAGE sequence and exploiting the capabilities of an 8-channel parallel transmit system.

Target Audience MRI methodologists

Methods Measurements were conducted on a 9.4T whole-body MR scanner (Siemens Healthcare, Erlangen, Germany) equipped with an 8-channel parallel transmit (pTX) system. An 8-channel TX/RX coil developed in-house (unshielded loop elements on cylindrical former) was used in combination with an in-house implementation of the MP2RAGE sequence [1]. To counteract the required strong B_1 amplitude, an HS6 inversion pulse (sweep bandwidth 3.10kHz, duration 8ms) was chosen for magnetisation preparation. Sequence parameters were TR=5400ms, TI1/2=1300ms/3000ms, TE=4.8ms, twofold parallel imaging acceleration in phase encode direction (with GRAPPA reconstruction), linear k-space reordering and 0.9mm isotropic resolution. The SAR supervision scheme was based on a *worst case* approximation which limited the applicable inversion pulse voltage to 80V. The sequence was executed two times with different RF shim configurations that were applied for the excitation and the inversion, respectively. Both measurements were processed using complex data according to [1]. Finally, both datasets were combined by applying a voxelwise minimum operation to remove areas of contrast loss, which creates high intensities in the post-processed images. Additionally, both RF shim settings were measured with the AFI sequence [2] and the corresponding B_1 and B_0 maps were utilised in simulations to evaluate the inversion efficiency of the HS6 pulse.

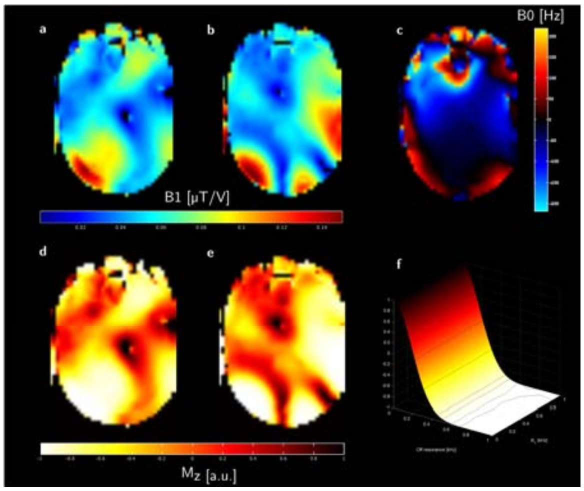

Figure 1: B_1 (a,b) and B_0 (c) maps together with inversion efficiency maps (d,e) derived from look-up table (f)

Results Figure 1 displays the B_1 efficiency of both shim configurations (a and b) together with be B_0 map (c), which was used to derive the magnetisation state after the inversion pulse (d and e) from the Bloch simulation look-up table (f). The raw MP2-RAGE images for shim setting #1 (a and b) and shim setting #2 (d and e) are shown in Figure 2 together with the MP2-RAGE post-processed images for each shim setting (c and f). Combination of both post-processed images (a and b in Figure 3) as explained above yields an almost bias free image (Fig.3c), though at the cost of doubling the acquisition time.

Conclusion

It was shown that MP2RAGE imaging at 9.4T is feasible even under the strict power limits imposed by the worst case SAR condition of parallel transmit systems. However, since it is not possible to generate sufficient inversion over the entire brain some small hyperintense areas remain in the post processed images. This could be alleviated by combining two separate shim settings at the expense of additional measurement time. One could further optimise the performance by choosing two individual RF shims for excitation and inversion and optimising the combination approach to retain the SNR gain of the two independent measurements.

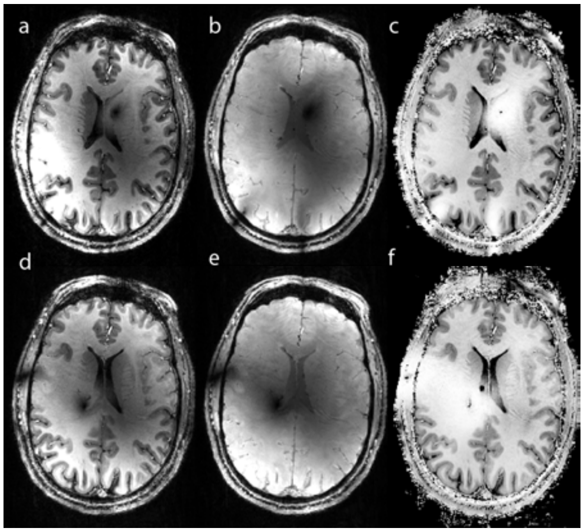

Figure 2: Raw MP2-RAGE images (a,b,d,e) from both RF shim settings (a,b and d,e) together with the MP2-RAGE post-processed image (c and f)

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References

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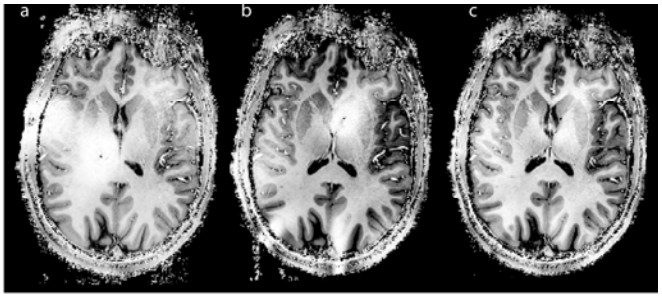

Figure 3: MP2-RAGE post-processed images (a and b) and their combination by choosing the voxelwise minimum (c). It can be appreciated that many of the residual artefacts are resolved by the operation