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Multi-Parametric Maps From Multi-contrast Steady-State Sequences on Multiple Manufacturers and Fields

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Purpose/Introduction

- **Fast steady-state sequences** provide a variety of contrasts **sensitive to various MR parameters** (TR, RF amplitudes and phases, spoiling gradient) [1] from which **multiple parametric mapping** approaches can be derived [1-5].
- Here, **multi-contrast raw images and reconstructed parametric maps** from the same volunteer are compared on **multiple manufacturers and fields**.

Subjects and Methods

- Imaging was performed on a **healthy volunteer** at **1.5 T (Philips Achieva, Siemens Avanto)** and **3 T (Siemens Verio)**.
- Whole-brain slice-selective 3D RF and gradient spoiled gradient-echo sequence allowing sequential acquisition with **different RF amplitude, phase increment, spoiling gradient direction and area** was used.
- Thirteen volumes were acquired sequentially with **different flip angles, phase increments, and effective dephasing distance between each TR** (noted a) leading a total **scan time of 6.5 min**. Choice of the **optimized parameter set** was described in [6].
- A gradient-echo phase map estimated as the complex sum of volumes with 0° and 180° RF phase increments was removed from all volumes providing **SSFP phase-induced maps** independent of TE.
- **Parametric M0, R1 and R2 maps** were calculated on a voxel-by-voxel basis by least-squares fitting complex signals to the Bloch-Torrey equation assuming uniform flip angles and a diffusion coefficient of $2.10^{-9}m^2s^{-1}$ [7].

Results

- **Mixed contrasts dependent on flip angle amplitude, phase cycling and spoiling gradient area** both on **magnitude** and **SSFP phase-cycling** induced contrasts were observed (Fig.1).
- **Good agreement was obtained at 1.5T** between Philips and Siemens, and noticeable differences were observed at 3T as expected due to different relaxation parameters. SSFP-phase maps can be easily used to rapidly assess similarities between 1.5T implementations.
- The parametric reconstruction displayed in Fig.2 accounts for gradient hardware limitation and provides **similar R1 and R2 maps at 1.5T on both systems**. At 3T, the **general trend for a smaller R1 and a larger R2** was observed as expected.

References and acknowledgements

1. Zur et al. MRM 1991-21:251. 2. Fram et al., MRI 1987-5:201. 3. Heule et al., MRM 2013-71:1137. 4. Ganter et al., MRM 2009-62:149. 5. Deoni et al., MRM 2011-65:1021. 6. Valabregue et al., ISMRM 2016-1569 7. de Rochefort, ISMRM 2015-445.

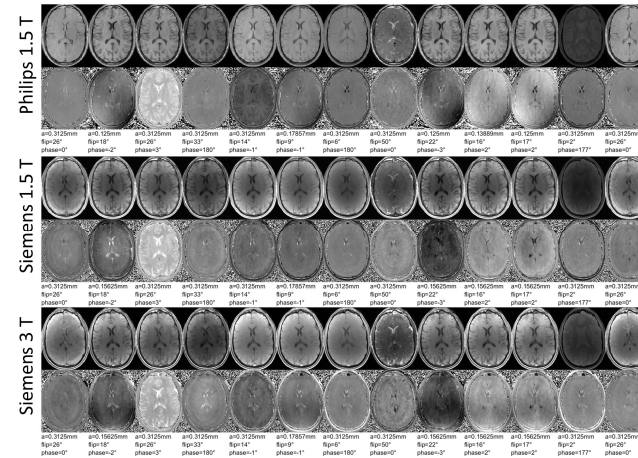


Figure 1: Sample axial slice on the same healthy volunteer on Philips 1.5T and Siemens 1.5 and 3 T. Magnitude images are shown in the first row, phase-cycling SSFP induced phase-contrast is shown in the second row. Spoiling gradient, flip angle and RF cycling phase increment are provided below each set. Corresponding slices were registered manually.

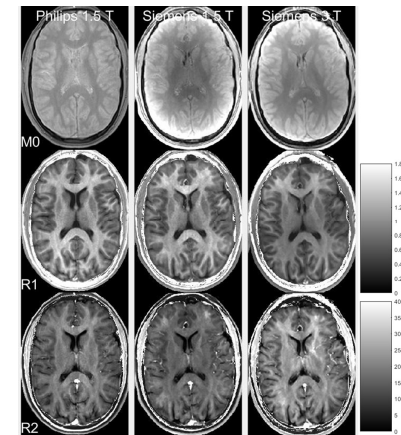


Figure 2: Reconstructed proton density M0 map (with remaining coil sensitivity profile weighting, first row), corrected from receiver coil profile inhomogeneity for Philips 1.5 T, non-corrected for Siemens 1.5 T and 3 T, R1, and R2, maps displayed with their respective same window levels (in s⁻¹).

Discussion/Conclusion

- Precise control of **RF and gradient spoiling is crucial** to obtain the same **contrasts in SSFP** sequences, as shown *in vivo* here.
- **SSFP-phase contrast** images, unexploited up-to-now, linked to relaxation, insensitive to the receive coil profile inhomogeneity, **could be used for diagnosis**.
- **Parametric maps** processed identically accounting for gradient hardware differences tend to further reduce variability at 1.5 T.
- Emphasizes the need for **sequence and reconstruction standardization** and validation to enhance the **reproducibility among sites and manufacturers** which is critically needed for more robust multi-centric studies.

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