# Single-Shot Multi-Echo Imaging with Rosette Trajectories using a Sliding Window Reconstruction and Off-Resonance Correction

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## INTRODUCTION

Rosette trajectories can be considered as the single shot variant of projection reconstruction imaging and have been introduced by Noll et al. with an emphasis on their unique off-resonance behavior (1,2). Due to destructive interference in the heavily over-sampled center of k-space off-resonance signals are strongly suppressed in the reconstructed images. In the present study the possibility to use continuously repeated rosette trajectories after a single excitation to acquire multiple images with increasing T2*-weighting was evaluated. With the cyclic symmetry of the trajectory, images of any arbitrary echo time can be reconstructed retrospectively. In addition, the reconstruction can be performed at any given off-resonance frequency, thus allowing to recover signal in regions of field inhomogeneity. By exploiting these unique properties of rosette trajectories the information content extracted from a single-shot acquisition can be maximized.

## MATERIALS AND METHODS

A single-shot multi-echo imaging method using rosette trajectories has been implemented on a clinical 3T system (Siemens Magnetom Trio, Erlangen, Germany). For each echo image, 64 'projections' with 64 samples per projection have been recorded. The circular velocity of the trajectory is 3 rotations per image and the full trajectory has been repeated 4 times to acquire 4 full datasets after each excitation. The remaining parameters were: slice thickness 5mm, FOV 220mm, BW 2230Hz/px, acquisition time per echo-image 28ms. Images have been reconstructed by regridding using a experimentally measured k-space trajectory, which has been determined previously on a phantom. Additional images have been reconstructed at echo time intervals of ¼ of the single image acquisition time using a sliding window reconstruction resulting in an effective echo image spacing of 7ms for the resulting 13 echo images.

To account for off-resonance effects leading to signal loss caused by in-plane field inhomogeneities, the raw data have been frequency shifted prior to additional reconstructions using frequency shifts between –25 and 25Hz with 5Hz increments. The final images have been calculated from the different off resonance images using a sum-of-squares method.

Finally, I0- and T2* maps have been calculated on a pixel-by-pixel basis using a mono-exponential model.

## RESULTS

Images reconstructed at echo times from 14 to 91 ms are shown in Fig. 1. The increasing T2* weighting is clearly visible. Images reconstructed at different off-resonance frequencies are displayed in Fig. 2 clearly demonstrating the local field inhomogeneities within the slice. In the off-resonance corrected image (SoS) a significant part of the signal in the anterior cingulate gyrus has been recovered (arrow). T2*-maps have been calculated from the corrected images resulting in T2*-values comparable to other techniques (3) (data not shown).

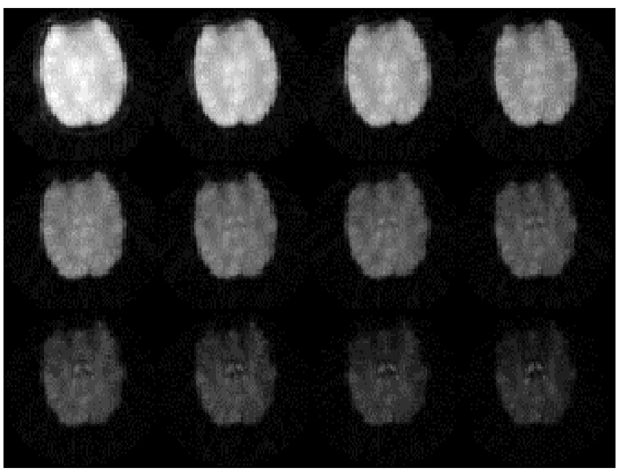

Fig. 1: Images reconstructed from a single-shot acquisition at 7 ms echo-image intervals

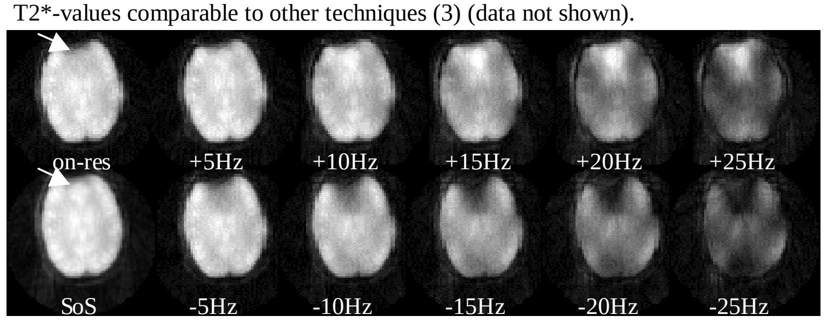


Fig. 2: Echo-image 1 reconstructed from a single-shot acquisition at different off-resonance frequencies (5Hz difference per image) together with the off-resonance corrected sum-of-squares images (SoS)

## DISCUSSION

The results demonstrate that single-shot acquisition of multi-echo images using rosette trajectories is possible with high echo-time resolution. The unique off-resonance properties of rosette acquisitions allow a significant recovery of signal loss caused by in-plane field inhomogeneities. Thus parametric maps of T2* relaxation times can be calculated from single-shot data. Remaining image blurring is most likely caused by residual inaccuracies due to noise in the experimentally measured k-space trajectory. The processing demand for the sliding-window reconstruction and the off-resonance correction, however, is significant since a high number of images is being reconstructed from a single data-set. The echo-time specificity of the single echo-images may be further optimized by the use of a filter that selects the center points in k-space, which are more and more over-sampled, only during the appropriate central part of the acquisition time for each image (acquisition-time/ k-space-radius filter).

REFERENCES

[1] D.C. Noll, *IEEE Tran. Med. Imaging* 16:372-7 (1997)
[2] S.J. Peltier, D.C. Noll, *MRM* 41:1073-6 (1999)
[3] O. Speck et al., *MRM* 40:243-8 (1998)