GENERATING T2- AND T1-WEIGHTED IMAGES USING RADIAL T-ONE SENSITIVE AND INSENSITIVE STEADY STATE IMAGING (RA-TOSSI)

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Target audience: Clinicians and physicists who are interested in the generation of multiple image contrasts, steady-state imaging or radial imaging.

Purpose: Balanced SSFP offers a very high signal-noise-ratio, but it unfortunately produces T2/T1-weighted images with only limited clinical applicability. To overcome this problem, the TOSSI (T-One insensitive Steady State Imaging) concept [1] was recently proposed which allows acquiring images with a pure T2-contrast. For this purpose, T1-relaxation is suppressed by using unequally spaced inversion pulses during the acquisition, resulting in a pure T2-decay.
This technique was adapted to body imaging by using a TOSSI-block for the contrast defining k-space center and a standard bSSFP-acquisition for the k-space periphery [2]. Here, a method is presented to simultaneously generate several T2-weighted TOSSI images with different contrasts as well as a standard T2/T1-weighted bSSFP image out of one single radial acquisition in a scan time similar to just one TOSSI image. Additionally, a T1-like contrast can be generated by a simple combination of these reconstructed images.

Methods: The resultant signal evolution of the combined TOSSI/bSSFP experiment is shown exemplary in Fig.1 (a). By choosing a radial trajectory as sampling scheme, each projection transverses the k-space center. Hence, a k-space weighted image contrast (KWIC) filter [3] can be applied. This allows the reconstruction of several images at different time points and thus with different contrasts, including images with TOSSI contrasts (T2-weighted) as well as a standard bSSFP contrast (T2/T1-weighted). By combining a T2-weighted image with a T2/T1-weighted image as indicated in Fig.1 (b), a T1-like contrast can be obtained additionally. For instance, this combination can be based on a simple division of these contrasts or on the analytical equations for the corresponding signals.
In vivo measurements of the brain of healthy volunteers were performed at 3.0T and 256 radial projections using a golden-ratio based profile order [4] were acquired. The TOSSI block consisted of 64 projections, with 24/8 projections per parallel/antiparallel state. Other measurement parameters were as follows: TR = 4.7 ms, matrix = 256, slice thickness = 5 mm, flip angle = 40°. For comparison of the different contrasts, a T2-weighted TSE image, a conventional Cartesian bSSFP image and a T1-weighted FLASH image were acquired.

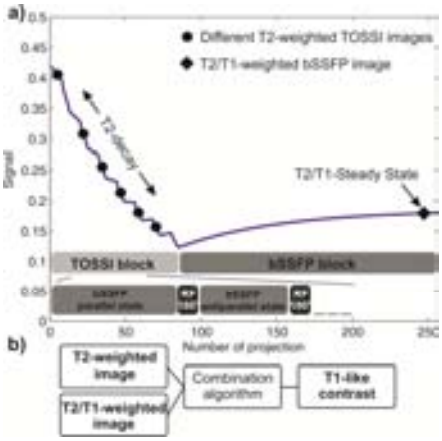

Fig. 1: (a) Signal evolution of the combined TOSSI/bSSFP experiment. Exemplary time points at which different contrasts can be obtained using RA-TOSSI are indicated. **(b)** Postprocessing to obtain a T1-like contrast.

Results: Fig.2 (a)-(c) shows the different contrasts extracted from the singleshot RA-TOSSI experiment. Correspondent images acquired with clinically established sequences are shown in Fig.2 (d)-(f). T2- and T2/T1- weighted images are very similar. In the T1-weighted images, slight differences can be seen.

Discussion: This novel technique can be extended easily to clinically more relevant multi-slice or even 3-dimensional measurements as well as to high resolution acquisitions. While acquisition times and SAR constraints can limit the usage of established techniques like TSE considerably, these issues are less relevant for the presented approach.

Conclusion: The proposed RA-TOSSI method allows generating different T2-weighted TOSSI images as well as a conventional T2/T1-weighted bSSFP contrast out of one single dataset with no expense of image quality. In addition, a T1-like image can be obtained by a simple combination step. The acquisition time for all these contrasts is equal to one single TOSSI image (~1.3s). Altogether, RA-TOSSI is a promising candidate for clinical practice, especially for situations where established protocols are hindered by long scan times as well as for high- and ultra-high field applications.

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References:

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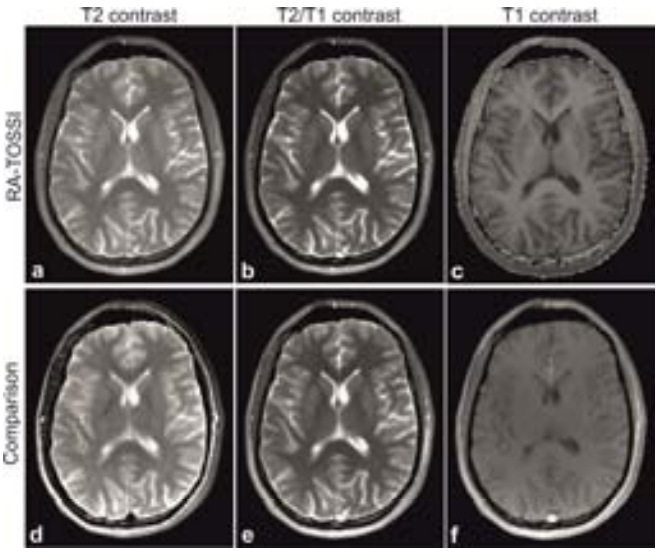

Fig. 2: (a)-(c) T2-, T2/T1- and T1-weighted images, obtained with RA-TOSSI. Acquisition time (TA) was 1.3s. (d) TSE image (TR/TE = 3000/87 ms, TA = 108 s), (e) conventional bSSFP image (TA = 1.2 s), (f) FLASH image (TR/TE = 250/2.49 ms, TA = 64 s).