MULTISLAB MULTIBAND 3D TIME-OF-FLIGHT MAGNETIC RESONANCE ANGIOGRAPHY FOR IMPROVED CONTRAST AND REDUCED ACQUISITION TIME

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Target audience: MR physicists, Clinicians

Purpose

3D TOF-MRA is commonly used for imaging intracranial vessels. This NCE-MRA technique is based on inflow enhancement suppressing stationary tissue. Unfortunately, it suffers from time-inefficiency. [1] In this abstract, we introduce a way to overcome this problem by exciting multiple slabs simultaneously. Acquisition time will be decreased by a factor equal to the number of simultaneously excited slabs while maintaining CNR which leads to an increase in CNR efficiency. Furthermore, by reducing the thickness of the slabs in the multislab multiband (MS MB) acquisition, in-flow contrast is improved.

Methods

A standard Siemens FLASH-TOF sequence was modified as follows. To make use of MS MB excitation, the sequences' TONE (tilted optimized nonsaturating excitation) pulses were modified to simultaneously excite parallel 3D slabs. [2] TONE pulses are characteristically ramp pulses with spatially varying flip angle to equalize the signal of flowing blood. To improve the reconstruction quality, CAIPIRINHA [3] was additionally implemented by modulating the phase of the excitation pulses. We acquired 3 slabs with 32 slices/slab and MB 3 (reference 96 slices/slab) oversampled by 25% with a TR of 22ms, TE of 4.1ms, 20° flip angle, voxel size of 0.6x0.6x0.65 mm, 220x220 matrix, GRAPPA 3 acceleration along the second PE-direction, CAIPIRINHA FOV/2 shift, TONE ramp 100%. Data were acquired on a TIM Trio 3T MR-scanner using a standard 32-channel head coil. The MS MB-reconstruction was performed off-line in Matlab using a slice-GRAPPA algorithm [4] and a low resolution 3D FLASH reference scan of TA 107s and matched FOV and slice thickness.

Results and Discussion

Table 1	TA /min	CNR	eff. CNR
MS MB MRA	9:23	2.22	0.72
ref MRA	28:07	2.23	0.42

Using a MS MB factor of three, we were able to reduce the total acquisition time to a third of the reference (ref) scan time while maintaining comparable quality of imaged vessels as shown in figure 1. The additional g-noise at the centre of the MS MB image arises from the lack of independent sensitivity information from coil channels. However, increased unsaturated inflow in the MS MB acquisition even boosts the signal of the vessels which can be particularly well seen for numerous small vessels on the neo-cortex. The CNR (averages in tab 1) was calculated for 12 vessels in ROIs, shown in fig 1. The contrast was defined as the signal of the vessels minus the signal in an equally sized homogeneous region group next to the vessel. The noise was calculated as the sqrt of the sum of the according standard deviations. MS MB and ref CNR lie in the same range which results in 1.8 times CNR efficiency for the MS MB case.

Conclusions

The drawback of the time-inefficiency of a 3D TOF-MRA acquisition is overcome by introducing a MS MB acquisition technique which is reconstructable with a fast 3D FLASH reference scan. The initial findings are promising and further development will include optimization of the protocol parameters such as number of slices/slab, slice thickness, TE, TR, and choice of TONE ramp to obtain more saturation of the tissue and make maximal use of the additional inflow-effect.
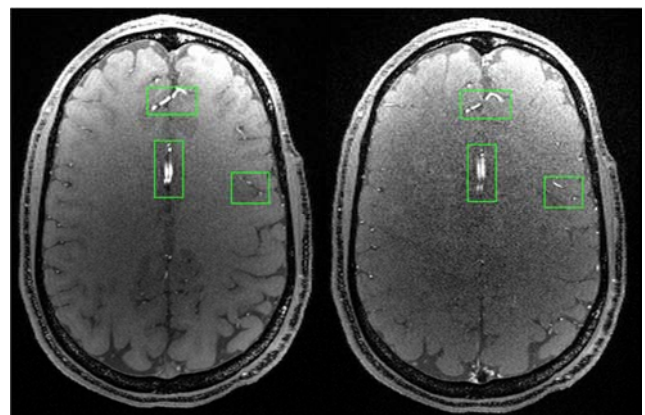

Fig 1: reference TOF-MRA image (left) and MS MB MRA image (right) with 3 selected ROIs (green)

References:
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