Comparing 1.5T and 3T field strengths in TOF MRA in patients with intracranial vessel disease.

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Introduction

The increased field strength of 3T has been found to be advantageous on blood vessel contrast in three-dimensional time-of-flight (TOF) magnetic resonance angiography (MRA) in healthy volunteers [1]. The general advantage of 3T compared to 1.5T is a doubling of the available signal-to-noise ratio (SNR), which can be traded for increased spatial resolution. In addition for TOF MRA, the longer T1 relaxation times of brain tissue at 3T may make the background easier to suppress. Since the T1 of blood also increases, by optimizing the flip angle one can obtain a good compromise between saturation of slowly flowing blood and optimal background suppression. Here we compared 3D TOF at 1.5T to a) 3T with identical resolution and sequence parameters and to b) 3T with increased spatial resolution and optimized sequence parameters (notably bandwidth, TE, TR and flip angle) in patients with intracranial vessel disease. Both 1.5T and 3T MRA sequences used parallel imaging to reduce image acquisition time and increase spatial resolution. In 3 patients digital subtraction angiography was available as gold-standard comparison.

Materials & Methods

Ten patients with intracranial vessel disease – atheromatosis, aneurysms and vasculitis – were included in the study. Acquisition parameters were as follows:

- 1.5T TOF: matrix 384x512, FOV 220x220 mm, 96 slices of .83 mm th., TR/TE=38/5.3ms, flip angle=25, SENSE R=2, BW=72.4 Hz/pixel, TA=8'00''.
- 3T unoptimized TOF: identical to 1.5T TOF.
- 3T optimized TOF: matrix 512^2, FOV 200^2 mm, 160 slices of .5 mm th., TR/TE=18/3.4ms, flip angle=20, SENSE R=2.5, BW=108.6 Hz/pixel, TA=7'52''.

Post-processing consisted of maximal intensity projections (MIP), computation of blood-to-background contrast (BBC), contrast-to-noise ratio (CNR) and signal-to-noise ratio (SNR) in several regions of interest, as well as total vessel length measurement of several small intracranial vessels. Finally, 3 independent neuroradiologists scored image quality and lesion detectabilty.

Results

From the quantitative evaluation higher field strength leads to a significant increase of the SNR, CNR and BBC compared to 1.5T (table 1), and to a significant increase in vessel length visualization. The qualitative evaluation by 3 neuroradiologists showed significant improvement of the optimized 3T TOF, compared to the unoptimized 3T and to the 1.5T TOF, in the visualization of distal intracranial vessels, small proximal vessels (e.g. the lenticulostratial and ophthalmic arteries), in the detectability of small aneurysms of the circle of Willis and atherosclerotic lesions.

In one patient with a giant aneurysm of the ophthalmic segment of the ICA, absence of signal in the proximal anterior and middle cerebral arteries was more pronounced on the 3T images, due to increased saturation of slowly flowing blood at 3T.

Conclusion

High field strength appears to have a positive influence on the objective quality of MR angiograms of intracranial vessels, leading to better detectability of vascular lesions. However in the case of large aneurysms, intra aneurismal and distal vessel signal loss can be a significant problem.

References

1. Al-Kwifi et al. 2002 MRI 20:181-7.

Table 1.

	3T unoptimized			3T optimized			1.5T		
	BBC	SNR	CNR	BBC	SNR	CNR	BBC	SNR	CNR
Average (n=10)	3.14	213.06	162.66	3.87	100.35	79.84	2.35	83.21	58.52
Stdev (n=10)	1.28	99.42	86.16	0.98	30.43	27.64	0.80	41.93	32.88

Fig 1.