

3.0T contrast-enhanced, submillimeter MRA of the supraaortic arteries: does the signal gain at high field strength allow to replace the phased array coil by the quadrature body coil?

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Abstract

Purpose of the study was to evaluate contrast-enhanced MR angiography (CE MRA) of the supraaortic arteries at 3.0T using the quadrature body coil as transmitter and receiver. CE MRA was performed with randomly segmented central k-space ordering (CENTRA) in 43 patients and 5 volunteers using a large FOV (350 mm) and a high image matrix of 432 x 432 (non-zero-filled voxel: 0.66 mm³). Our experience showed that submillimeter CE MRA of the supraaortic arteries is feasible at 3.0T by using the quadrature body coil. The large FOV allowed to cover the supraaortic arteries from the aortic arch up to the circle of Willis.

Introduction

Contrast-enhanced 3D MR angiography of the supraaortic arteries with randomly segmented k-space ordering (CENTRA) has proved to provide reliable arterial phase images with high spatial resolution (512 and 1024 matrix) and high degree of venous suppression [1,2]. As CENTRA allows k-space sampling both during the upslope and tail of the contrast-time curve, acquisition times of up to 2 minutes and more are feasible without image degradation by venous enhancement. In addition, this technique has shown high diagnostic accuracy for detection of supraaortic artery disease as compared with DSA [2]. However, specific phased-array neurovascular coils were required to allow submillimeter resolution at 1.5T

With the advent of compact, actively shielded 3.0T magnets, high field imaging has become practical in a clinical setting. As the signal scales proportionally with the field strength, 3.0T holds potential benefits for high resolution MRA [3,4]. However, large FOV imaging at high magnetic field is challenging due to the increased susceptibility and the field inhomogeneities. In CE MRA of the supraaortic arteries, we examined whether the increased signal-to-noise (S/N) available at 3.0T would allow to replace the phased-array neurovascular coil by the standard quadrature body coil while maintaining the high spatial resolution and whether the large FOV that was used in our routine 1.5T protocol would be feasible also at 3.0T.

Methods

In a prospective study, 43 patients and 5 volunteers were examined on a commercially available 3.0T MR unit (Intera, Philips Medical Systems, Best, The Netherlands) with a strong gradient system (maximal gradient amplitude, 30 mT/m; slew rate, 150 mT/m/sec.). 3D CE MR angiograms using CENTRA were acquired with the quadrature body coil using a FOV of 350 mm that covered the supraaortic arteries up to the circle of Willis.

2D real-time fluoroscopy was used with a test bolus of 2 cc of gadopentetate dimeglumine (Gd-DTPA, Magnevist, Schering, Germany) to manually trigger CE MRA (20 cc @ 1.5 – 2.0 cc/sec. followed by a saline solution flush of 30 cc). The high image matrix of 432 x 432 over the 350 mm FOV yielded a non-zero filled voxel size of 0.81 mm x 0.81 mm x 1.0 (0.5) mm (0.66 mm³). Acquisition parameters were as follows: 3D T1 gradient echo-sequence with TR/TE = 5.7/1.93 msec.; flip angle, 30°; bandwidth per pixel, 462.9 Hz; RFOV, 70 %; acquisition time, 1:54 min. For quantitative analysis, S/N and contrast-to-noise ratio (C/N) were calculated. For qualitative analysis, image quality was rated by two radiologists in consensus. Vascular disease was identified and compared with digital subtraction angiography (DSA) in 5 patients. 3.0T and 1.5T CE MRA were intra-individually compared in the 5 volunteers.

Results

3.0T CE MRA was successfully performed in 48/48 subjects (100%). The FOV covered the supraaortic arteries from its origins in the aortic arch up to the circle of Willis (Figure1). Mean S/N and C/N were 26.63 ± 4.29 and 19.35 ± 5.32, respectively. Mean image quality was 3.53 ± 1.32. Intraindividual comparison between 1.5T and 3.0T CE MRA in the volunteers revealed no significant difference (p>0.1) in image quality. Vascular disease was correctly identified in the 5/5 patients with DSA correlation.

Conclusion

Submillimeter CE 3D MRA of the supraaortic arteries is feasible at 3.0T even if replacing the phased-array coil by the quadrature body coil. A large FOV of 350 mm is possible at 3.0T covering the supraaortic arteries from the aortic arch up to the circle of Willis and yielding an image quality that is comparable to 1.5T CE MRA with a phased-array coil. The ability to perform high spatial resolution CE MRA of the supraaortic arteries over a large FOV at 3.0T using the quadrature body coil may allow for more flexibility in cerebrovascular MR studies, i.e. combining supraaortic CE MRA with e.g. MR imaging of the chest or head and neck without the need of dedicated phased-array coils and repositioning of the patient.

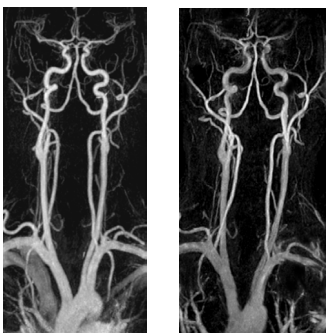


Figure 1: MIP images of CE MRA in a 27-year old volunteer: intraindividual comparison of a phased array coil acquisition at 1.5T (left image) and a quadrature body coil acquisition at 3.0T (right image) using a 432 x 432 matrix over 350 mm, respectively. The signal gain at 3.0T allowed to replace the phased-array coil by the quadrature body coil while maintaining the image quality.

References

- [1] Willinek WA, Gieseke J, Conrad R et al. Randomly segmented central k-space ordering in high-spatial-resolution contrast-enhanced MR angiography of the supraaortic arteries: initial experience. *Radiology* 2002;225:583-585.
- [2] Willinek WA, Gieseke J, von Falkenhausen M, et al. CE-3D MRA of the supraaortic arteries at 512 and 1024 matrix: the use of randomly segmented central k-space ordering (CENTRA). In: Proc 10th Meeting ISMRM. Honolulu, 2002.
- [3] Bernstein MA, Huston J III, Lin Chen, et al. High-resolution intracranial and cervical MRA at 3.0T: technical considerations and initial experience. *Magn Reson Med* 2001;46:955-962.
- [4] Al Kwifi O, Emery DJ, Wilman AH. Vessel contrast at three Tesla in time-of-flight magnetic resonance angiography of the intracranial and carotid arteries. *Magn Reson Imaging* 2002; 20: 181-187