Use of 4D-TRAK for contrast-enhanced dynamic MR venography of the head

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Introduction

MR venography (MRV) has widely gained clinical acceptance for evaluation of intracranial venous anatomy. Techniques used for studying venous system of head and neck include flow sensitive techniques such as 2D time-of-flight, phase contrast, or gadolinium-based contrast-enhanced. Because of some pitfalls of the flow-sensitive methods [1,2], CE-MRV has been the preferred method in clinical practice. Typically MR venography is performed as a single time point 3D scan due to limited acquisition speed. However, suboptimal timing and lack of kinetics are limitations. In this study we present the use of 3D CENTRA [3], Keyhole [4] and SENSE (4D-TRAK) for time-resolved MRV.

Methods

Dynamic contrast-enhanced MRV was performed in 6 subjects using a 3D FFE sequence, TR/TE 4.4/1.7, FA 30°, 8-ch SENSE head coil or 16-ch SENSE neurovascular coil on a 3T Philips Achieva MR system. CENTRA, Keyhole (16-25%), SENSE (factor 6 to 8) and half-fourier were applied yielding an average acceleration factor of 44 (range 24 to 60). Ten to 24 dynamics were acquired at an average temporal resolution of 3.4 s/frame (range 7.3 to 1.9), and 160 to 190 slices were acquired with an average acquired in-plane resolution of 0.73 x 0.64 mm^2 and reconstructed slice thickness of 1 mm. Contrast dose of 20 cc (Multihance®, Bracco Diagnostics) was injected at a rate of 3 cc/s.

Results

Dynamic MRV of the head using 4D-TRAK (fig 1) was successfully performed in all 6 subjects. The average acceleration factor of 44, although not pushed to its full possible extent for higher resolution and coverage, allowed the visualization of arterial, intermediate and venous phases of brain vessel enhancement. Anatomical detail with high resolution was obtained.

Conclusion

The classical way of performing single time point MRV suffers from limitations such as risk of non-optimal timing of acquisition during contrast enhancement, absence of temporal filling kinetics or misinterpretation due to flow-related artifacts. Dynamic MRV has benefits of providing time-resolved hemodynamic information, and possibility of separating arterial and venous phases with simple subtraction or more complex methods based on correlation [5], or contrast arrival time (CAT) maps [6]. In this study we show the usefulness and advantage of 4D-TRAK for MR venography with complete hemodynamic information of the head vessels and high spatial resolution.

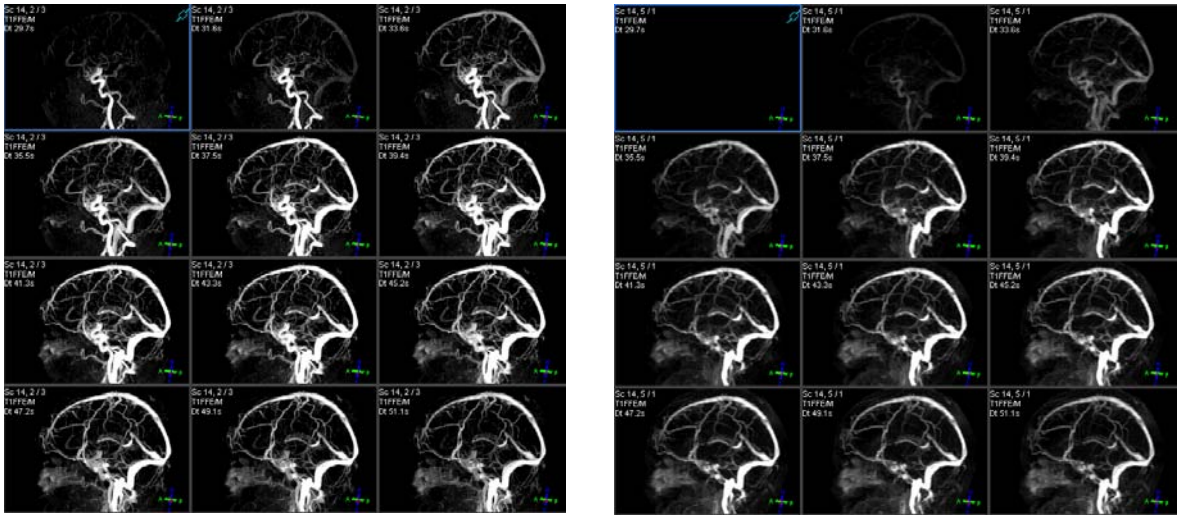

Figure 1. Contrast enhanced MRA of the head including delayed venous phase. Left: MIP of acquired image series. Right: MIP after subtraction of early arterial phase to preferentially display venous kinetics.

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