Dynamically Changing Field-of-View in the Comprehensive Neurovascular Exam

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Introduction: Radiological assessment of neurovascular disease processes often requires multiple contrast-enhanced and non-contrast enhanced exams over a large FOV. We define a comprehensive neurovascular exam (CNVE) as the high resolution imaging of four major vessel groups: the aortic arch and great vessel origins, the carotid artery bifurcations and vertebral-basilar system, the intracranial arterial system, and the venous system of the brain. The ultimate goal of this work is to image all of these territories with high quality using a single standard dose of contrast material. To that end we hypothesize that by dynamically changing (scaling/shifting) the field-of-view (FOV) during an acquisition, high spatial resolution and high SNR images of the carotid arteries and intracranial venous system can be obtained. The proposed imaging protocol consists of: (i) a large FOV, low-dose, time-resolved acquisition that provides diagnostic information of contrast bolus dynamics including transit times and directionality of flow and serves as a timing bolus [1,2], and (ii) a high spatial resolution contrast-enhanced exam that implements dynamic change of the FOV in order to image the carotid arteries and then the intracranial venous system.

Methods: The CAPR pulse sequence [3] was modified such that the FOV (S/I) can be changed at a desired time during the acquisition. The size of the S/I FOV can be altered, and the center of the FOV can be shifted without motion of the patient table. Based on the low-dose large FOV study the user sets the time post contrast injection at which the FOV is to change. Although the change of FOV can be performed on a TR-by-TR basis, the actual time to switch the FOV was 0.15 sec as necessitated by dummy cycles of the sequence at the new FOV to reach steady state.

The acquisition parameters for the large FOV time-resolved acquisition were sagittal orientation, TR/TE 4.03/1.78 msec, flip angle 30º, BW ±62.5 kHz, matrix 256x160x88, FOV 35x28x17.6 cm^3 to give an acquired spatial resolution of 1.37x1.75x2.00 mm^3 and frame time of 2.15 sec. The low-dose contrast injection consisted of 2 ml Multihance administered at 3 ml/sec followed by 20 ml saline at 3 ml/sec.

The high spatial resolution dynamic-change-of-FOV acquisition used 4x 2D SENSE-accelerated elliptical centric sampling. The acquisition parameters were sagittal orientation, TR/TE 4.93/2.25 msec, flip angle 30º, BW ±62.5 kHz, matrix 320x320x124, FOV 25x25x17.6 cm^3 to give an acquired spatial resolution of 0.78x0.78x1.4 mm^3 and scan time of 37.8 sec. The two imaging FOVs were (a) a 25 cm FOV centered about the carotid bifurcation and (b) a 25 cm FOV covering the head. The injection protocol consisted of 18 ml Multihance administered at 3 ml/sec followed by 20 ml saline at 3 ml/sec. The start of the acquisition was timed to the contrast bolus arrival at the level of the carotid bifurcation. After the 37.8 sec acquisition of the carotid arteries, the FOV was seamlessly shifted superiorly to cover the head, and another loop of the above scan was acquired for the venogram. Volunteer studies were performed on a 3T scanner (GE, 14.0/15.0) with an eight-channel Neurovascular array (GE).

Results: Fig. 1 shows oblique MIPs from the large FOV, low-dose time-resolved exam. This is a representative example of the high image quality obtained with only 2 ml of contrast material and an accelerated acquisition. Fig. 2 shows oblique MIPs of the carotid arteries (Fig. 2a,b) and the intracranial venous system (Fig. 2c,d) obtained from the same scan with the high resolution acquisition and dynamic change of FOV. High quality diagnostic images comparable to each of the current standard clinical exams were obtained in each of the FOVs.

Conclusion: By dynamically changing the FOV, high quality images of multiple vascular territories can be acquired in a single scan and a single injection of contrast material. This technique may allow for improved image quality and increased scan efficiency in the CNVE. The dynamic change of FOV technique has also been applied to the time-resolved CAPR acquisition to allow for seamless switching from imaging over a large FOV to a smaller, more focused FOV in a single scan.

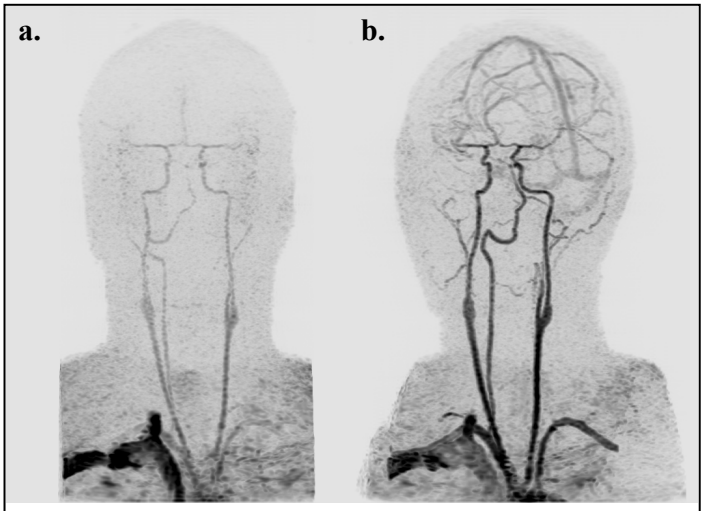

Fig 1. Oblique MIPs from the large FOV, low-dose (2 ml) time-resolved CAPR acquisition.

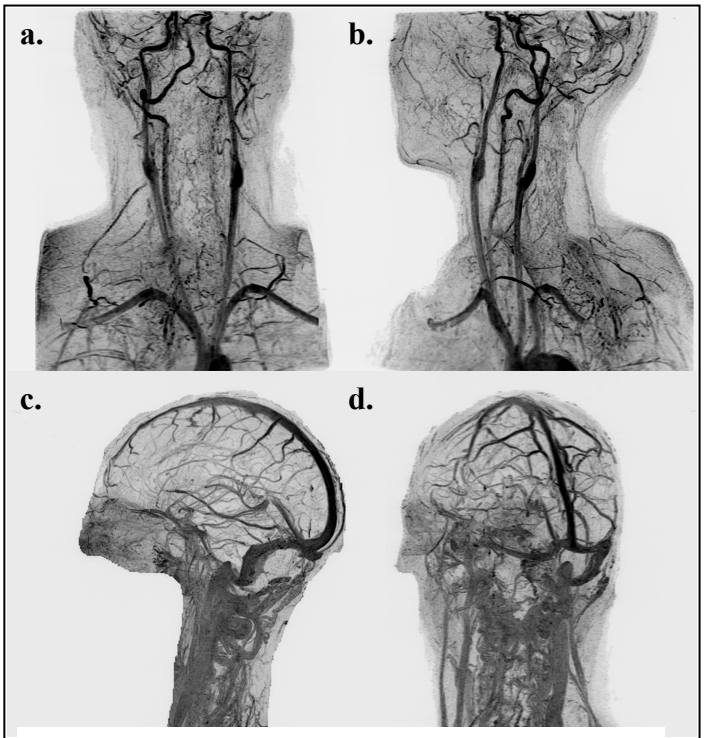

Fig 2. Dynamic FOV acquisition capturing the (a,b) carotid arteries and (c,d) intracranial vasculature in a single scan.

References: [1] Nael K, Radiol 242:600(2007). [2] Laub G, MRA Club 1.3(2009) [3] Haider CR, MRM 60:749(2008).