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2X accelerated whole brain isotropic MRA using Wideband MRI

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Introduction

MRI has been the optimal tool for intracranial studies for its ability to detect brain tissues and even blood flow. Time-of-flight MR angiography takes advantage of the contrast between fresh inflow blood and stationary tissues [1]. Angiographs with isotropic sub-millimeter resolution can clearly show the condition of blood flow of vessels deep inside the brain noninvasively, the isotropic resolution allows a full three dimensional reconstruction that can be viewed from any angle. However, such sub-millimeter imaging requires long acquisition time which makes this imaging sequence less appealing. One method, MOTSA MRA, is to acquire multiple thin slabs [2], by reducing the slab thickness the acquisition time can be shortened.

On the other hand, Wideband MRI (WB MRI) is a technique that acquires multiple slice/slab images simultaneously by increasing the excitation/acquisition bandwidth; it can be used to either increase the imaging speed or the image resolution [3]. Wideband MRI is ideal for studies that require a large coverage along the subject such as whole brain or whole body imaging, and by applying multi-slab Wideband MRI technique on MOTSA should be able to further reduce the scan time.

Materials and Methods

Angiograph of the whole brain was taken; the total coverage is 200x19x200 cm^3, matrix size: 200x190x200, making the resolution 1mm isotropic. Other imaging parameters (Wideband/MOTSA) are as followed: TE=4ms, TR=30/60ms, flip angle=45 degree, NEX=1. In the MOTSA experiment, 4 thin slabs of 10% overlap were excited with a interlaced order to avoid crosstalk. In Wideband MRI, the acceleration is determined by a "W factor", e.g. the number of slice/slab images acquired simultaneously. Shown in Fig. 1 is the geometrical setting of W=2 Wideband MRA, the whole brain was excited by an RF pulse with 2ms duration, covering the same FOV as standard 3D whole brain MRA. The RF pulse used in Wideband MRI was modulated *Sinc*, the out-of-slab ripples and transient band could induce unwanted signal in the accelerated images. All images were acquired with a Bruker 3T Biospec human system, without using additional accelerating methods such as parallel imaging or partial Fourier acquisition.

Results

Shown in figure 2 are the maximum intensity projection (MIP) images on to the coronal plane of (b) standard MRA, (c) MOTSA and (d) W=2 standard Wideband MRA (e) improved Wideband MRA. In both images the internal carotid artery and the carotid siphon were clear and continuous but broken in the dark band between slabs

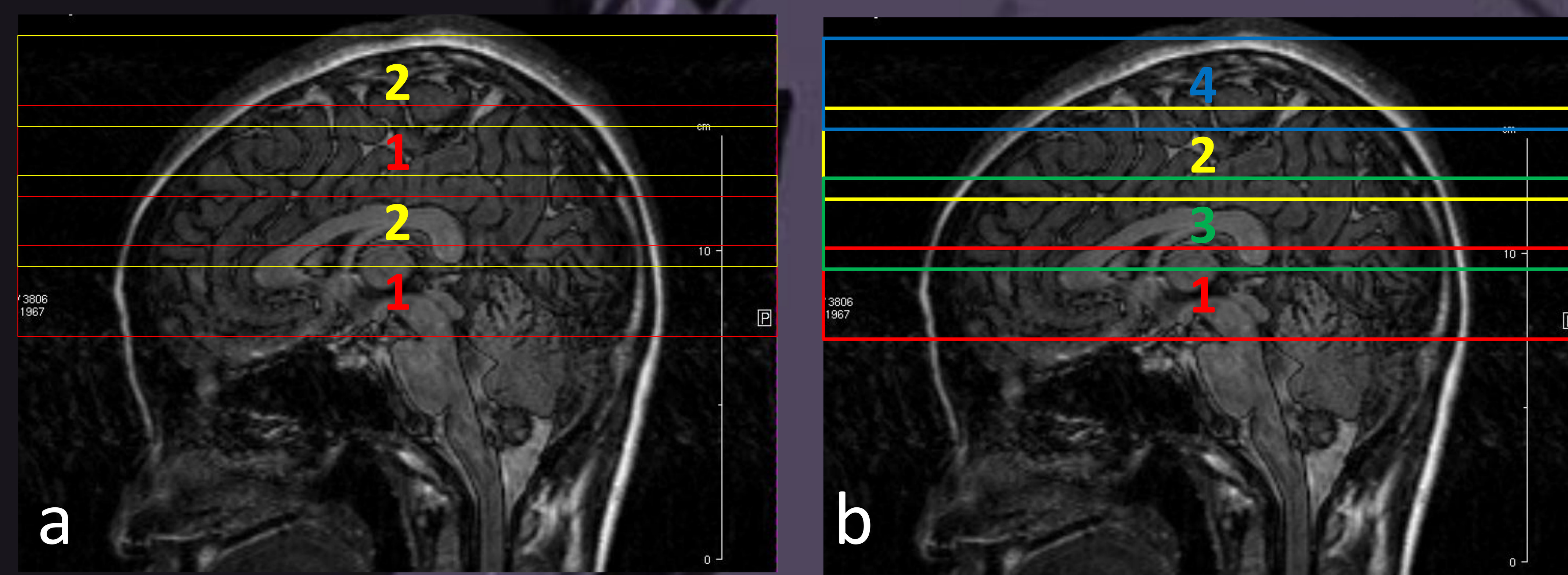

Fig.1. a) Geometry setting of the WideBand W=2 MRA. The separated two slabs were both excited and acquired at the same time. B) The MOTSA MRA was acquired in the interlace order.

Fig.2. MIP images of (a) Whole Brain 3D MRA; the internal carotid artery and the carotid siphon using (b) 3D MRA (c) MOTSA MRA (d) standard Wideband MRA (e) Improved WB MRA. The green block display the dark band effect in the MOTSA MRA and Standard Wideband MRA. A improved Wideband MRA was able to overcome the dark band issue and remain the same accelerate rate.

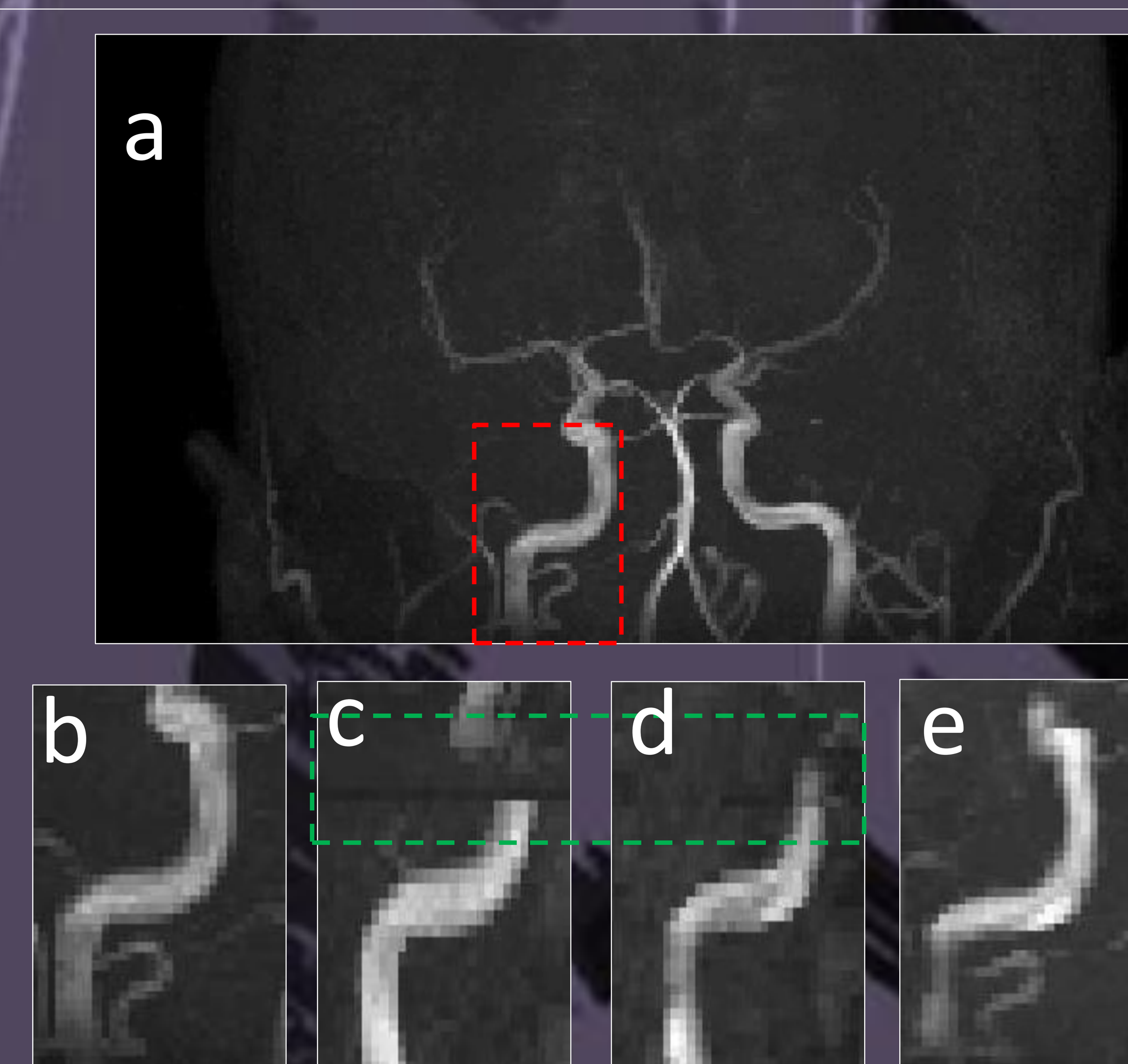

Table 1	3D MRA	MOTSA MRA	Standard WB MRA	Improved WB MRA
Dark band	No	Yes	Yes	No
Scan Time	2x	2x	1x	1x

Discussion & Conclusion

The total scan time of W=2 multi-slab Wideband MRI is 5min20sec, compared to 9min30sec of MOTSA, about a 2-fold time reduction without using parallel imaging. Both image (b) & (c) suffers from dark bands caused by imperfect RF pulse shapes. However, in a recently improved Wideband method (fig.2(d)) we were able to overcome the RF profile issue and acquire uniform MRA images while maintaining the same imaging speed (table. 1).
As a preliminary result, we have demonstrated that Wideband technique has the capability to accelerate MOTSA for intracranial isotropic MR angiograph.

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