2X accelerated whole brain isotropic MRA using Wideband MRI

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Abstract

By implementing Wideband MRI technique to whole brain intracranial MR angiography, we have shortened the time needed for sub-millimeter isotropic 3D MRA to only half of the original imaging time while maintaining useful information for diagnosis.

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. The downside of this method is that the RF pulse profile of each thin slab has loss at the edges, overlapping between slabs may solve this issue but costs up to 20% of the obtained images to be redundant.

Wideband MRI is a technique that acquires multiple images simultaneously by increasing the 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, the exact reason why we chose MRA.

Materials and Methods

Angiograph of the whole brain was taken; the total coverage is 25.6x19.2x25.6 cm^3, matrix size: 256x192x256, making the resolution 1mm isotropic. Other imaging parameters are as followed: TE=5ms, TR=37ms, flip angle=30 degree, NEX=1, fat saturated. In Wideband MRI, the acceleration is determined by a "W factor", e.g. the number of images acquired simultaneously. We use W=2 acceleration in our experiment, making the actual number of encodings along Z direction to be 128, 1/2 the original value and halving the total scan time. Shown in Fig. 1 is the geometrical setting of W=2 Wideband MRA, the whole brain was excited by an RF pulse with 2.5ms duration, covering the same FOV as standard 3D whole brain MRA. 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 standard MRA (left) and W=2 accelerated Wideband MRA (right). In both images the internal carotid artery and the carotid siphon were clear and continuous. As for smaller vessels such as vertebral arteries were somewhat unclear in the Wideband accelerated image. Contrast to noise ratio of the blood vessels of the two images are 86.6 and 82.8 respectively, a 4.3% difference.

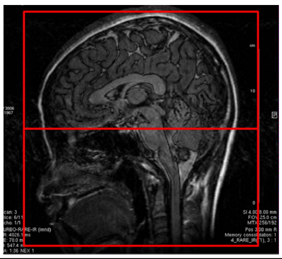

Fig.1. Geometry setting of the W=2 MRA. Images from the two slabs that cover the whole brain were both excited and acquired at the same time.

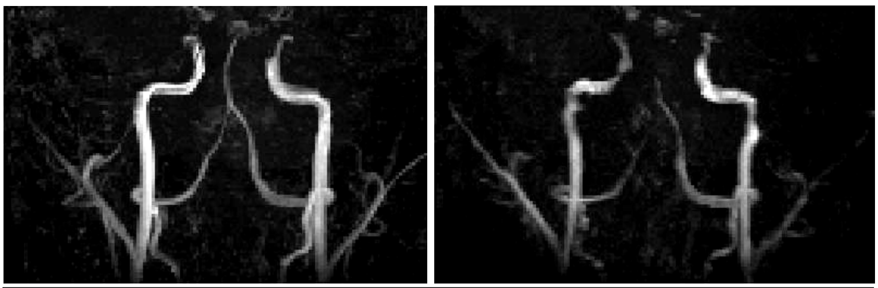

Fig.2. MIP images of standard MRA (left) and Wideband MRA (right). The CNR of blood vessels are approximately the same after 2X acceleration.

Discussion & Conclusion

Although there is some loss of information in the accelerated images the main arteries for diagnosis were intact, it may be recovered with improved Wideband MRI sequence and post processing. In Wideband MRI the RF excitation profile is better compared to multiple thin slab excitations, it is uniform across the slab thickness avoiding dark bands caused by transient bands between thin slabs, a total 10% image loss as a result. That is to say the image efficiency of Wideband MRA is better than MOTSA MRA. Also mentionable is W=2 Wideband MRI does not require additional RF excitation power and it could combine with other accelerating methods further reducing the total scan time to under 5 mins.

To sum up, with the help of Wideband MRI technique we were able to shorten the time for 3D 1mm isotropic whole brain MRA by a factor of W= 2. We believe the Wideband technique is a potential tool for MRA especially whole body MRA.

References

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