High Resolution 3D MR Imaging Using 3x Acceleration Wideband MRI Technique

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INTRODUCTION

3D MR imaging, which obtains higher SNR and higher spatial resolution is not widely used yet in the clinical study mainly due to its relatively long scan time. In this study, we proposed a novel accelerate technique, Wideband MRI, to either speed up the scan time or increase image resolution by acquiring images of multiple locations simultaneously [1]. It is regarded as a new dimension for MR imaging acceleration with the good compatibility to existing MRI sequences.

In this study, we implemented 3x acceleration (Wideband factor W=3) Wideband technique on various applications by acquiring images of three slabs at distinct locations of the subject simultaneously to obtain not only a high resolution 3D imaging, but also a high contrast imaging of different tissues using different sequence in three applications: a) *rat brain* b) *human brain* and c) *human knee*. All images were acquired without other accelerating methods such as parallel imaging or partial k-space method.

METHOD

The experiment settings are listed below. The animal study was taken on a 7T Bruker Biospec 70/30 system using a 4 channel phase array coil. The human brain and knee was taken on a 3T Bruker MRI/MRS MedSpect system with quadrature head/knee coils.

a) 0.15mm^3 isotropic T2 weighted rat brain imaging was acquired with a fast spin echo sequence, total coverage = 1.6 x 1.2 x 3.6 cm^3, matrix size 107 x 80 x 240, TR/TE = 1500/43ms, rare factor 16 with a total scan time of *13m20s*.

b)0.75 mm^3 isotropic human brain imaging was acquired with a Modified Driven Equilibrium Fourier Transform (MDEFT) sequence, total coverage= 16.65 x 18.75 x 16.65 cm^3, matrix size 222 x 250 x 222, TR/TE= 32.9/6.5ms, flip angle = 22 degree with a total scan time of *11m50s*.

c) 0.5 mm^3 isotropic human knee imaging was acquired with a GEFI sequence, the total coverage was 12.8 x 12.8 x 19.6 cm^3, matrix size 256 X 256 x 384, TR/TE= 30/7.7ms, flip angle = 25 degree with a total scan time of *16m38s*.

RESULTS

The figure 1 showed the results of high contrast and high resolution 3D structural imaging by acquiring 3 different slabs simultaneously. The T2 weighted rat brain imaging demonstrated the detail information in olfactory bulb, cortex and vessel by using fast spin echo (Fig 1b). In Fig 1c, the human brain shows good contrast not only in the gray matter and white matter but also in the cerebellum region. In Fig 1d, GEFI provided good contrast in bones and soft tissues (fat, muscle and cartilage) of this high resolution knee imaging. All these images are acquired, from 11-16 min, in 1/3 of the original 3D imaging acquisition time by using this wideband MR technique. Due to these human studies were performed in an aged human Bruker MedSpect system with slow gradients, modern clinical scanner can do much faster than these acquisition time.

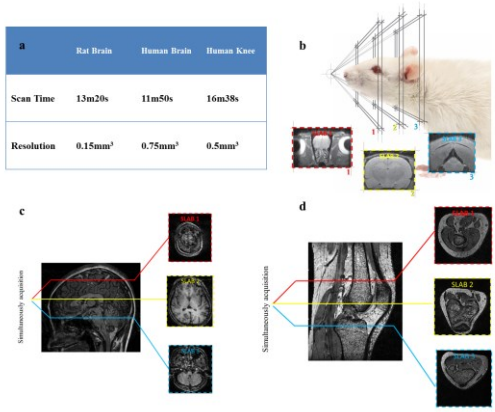

Figure 1. a) The total scan time and the resolution of the 3D high resolution rat brain, human brain and human knee image. Due to human studies were performed in an aged human Bruker MedSpect system with slow gradients, modern clinical scanner can do faster than these values b) The high resolution 3D rat brain image by using simultaneously acquisition of 3 different slabs (W=3). The detail information in olfactory bulb, cortex and vessel was clear. c) The high resolution 3D human brain image brain with good contrast in gray matter and white matter by using W=3 Wideband MRI. d) The high resolution 3D human knee image brain with good contrast in fat, muscle and cartilage by using W=3 Wideband MRI.

CONCLUSIONS

Wideband MRI technique demonstrates high contrast and isotropic high resolution 3D structural imaging in all three applications. Moreover, Wideband MRI technique reduced the scan time from an hour to a quarter of an hour, providing a powerful solution to obtain high contrast and high resolution imaging in clinical applications. In a current spine MR imging study, we are able to do 10X acceleration to obtain good quality image for diagnosis. Combined with other technologies such as compression sensing, wideband MRI will become an important tool for modern medical imaging societies.

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REFERENCES

[1] Wideband MRI: A New Dimension of MR Image Acceleration, Edzer L. Wu et al. Proc. Intl. Soc. Mag. Reson. Med. 17 (2009)