MAGNETIC RESONANCE ELECTRICAL IMPEDANCE TOMOGRAPHY AT 11 AND 17 T

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Introduction

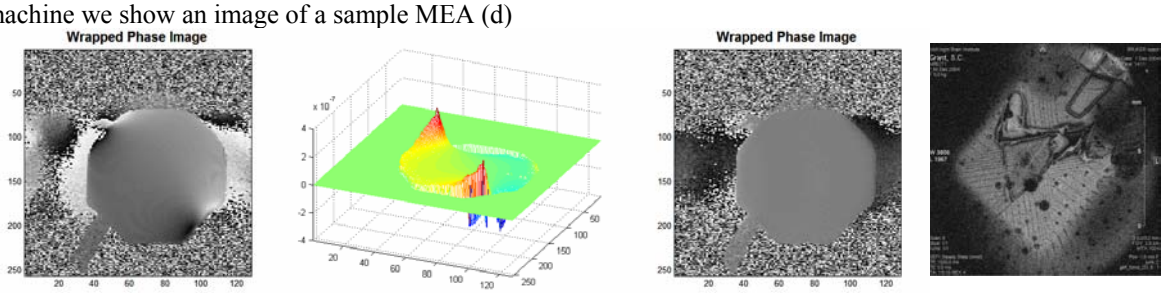
We are developing an MRI-based conductivity imaging technique known as Magnetic Resonance Electrical Impedance Tomography (MREIT) in which magnetic flux density maps subject to multiple injection currents are measured and used to reconstruct conductivity and current density slice images. We have developed this technique to the stage of obtaining electrical conductivity images of biological tissues and phantoms[1,2]. Our immediate aim is to develop methods for obtaining cross-sectional images of anisotropic/isotropic conductivity and current density distributions in animal brains. Further, since neural activity induces conductivity changes, we intend to monitor neural function by imaging changes in conductivity and current density, thus establishing functional MREIT (fMREIT) techniques. MREIT may also be usable for direct mapping of neural activity by imaging weak fluctuations of internal magnetic flux density signals, therefore suggesting direct functional MRI (DfMRI). We will initially develop these techniques using high field (14 and 11T) MRI scanners to determine performance limits and then devise ways to practically implement them with a whole body 3T MRI scanner in anticipation of the application of these methods in human brain imaging.

Experimental

This work is at an early stage, and we have recently (Dec 2004) started feasibility testing using the 4.7, 11.1 and 17.6 T instruments at the McKnight Brain institute. We have detected 20 mA currents flowing between electrodes in phase images gathered from both 11.1 and 4.7 T magnets. From the 17.6 T magnet, we have determined that the nature and quantities of materials used in constructing multielectrode arrays (MEAs) (which we will use in order to compare records of activity in neural preparations with MREIT scans) are such that they do not produce large artifacts in scans.

Results and Discussion

Imaging results using a saline/$CuSO_4$ filled phantom with gradient echo image collection at 11.1 T are shown (a), (b), for 20 mA synchronous pulsed current injection from top left to bottom right of image and (c) for no current injection. From 17.6 T machine we show an image of a sample MEA (d)



(a) (b) (c) (d)

Conclusions

We believe we have proved the feasibility of this method. More work is required to establish the size of gradient-related artifacts in voltage measurements collected from MEAs in high fields, and to form good magnitude images at 11.1 T.

Acknowledgements

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References

[1] Seo J K *et al*. *IEEE Trans. Biomed. Eng.* **50** 1121-1124 (2003).
[2] Oh S H et al. *Magn. Reson. Med.* **51** 1292-1296 (2004).