HUMAN HEAD IMAGING AT 11 TESLA

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Introduction

With the ever-increasing push to higher magnetic fields for human systems, the future of proton MR imaging in the clinical realm is still a matter of debate. One of the biggest concerns with high field human MRI is the creation of standing wave patterns resulting from the dielectric properties of tissues at high frequencies (1). Recent work has focused on the quantification and simulation of these artifacts at high field using tissue equivalent phantoms and excised tissue samples (2). In continuation of these efforts, this study capitalized on a unique opportunity to acquire the first images of a human head at 11 T.

Experimental

A freshly excised human head was obtained from ScienceCare Anatomical, Inc. (Phoenix, AZ). Vessels in the head were ligated to prevent fluid loss. To verify the anatomical regularity of the excised head, images were collected on a 3-T Siemens Allegra system; these data demonstrated normal looking, homogeneous images. All other experiments were performed on an 11-T, 40-cm Magnex magnet with a Bruker Biospec console. A ReCav coil (3, 4) with a diameter of 20.5 cm operating at 470.74 MHz was used for all volume coil experiments. Sample loading resulted in relatively poor matching, but the power was adequate to provide ample RF penetration for low flip angle acquisitions of gradient-echo images.

In the absence of array coil or parallel imaging technology on this magnet, a single 12.5-cm square surface coil was placed on the outer wall of a 20.5-cm diameter tube and rotated to eight equidistantly-spaced locations about the head. Gradient echo images acquired from all eight locations were later combined through simple image addition to yield a single image with relatively little apparent RF nonuniformity.

Results and Discussion

Results demonstrate the first MR images of an intact, human head at 11 T. As expected, the volume coil displays significant wave behavior similar to that observed in the fixed human brain (2). This wave behavior causes distortions apparent in the regional signal amplitude of the image. As demonstrated by surface coil experiments, pulsing different coils during different TRs may be an effective way to minimize RF interference.

Conclusions

Even with crude image addition, the image quality of a composite image acquired with individualized sampling is outstanding compared to a volume field coil. Although experiments at such a high field strength in a human head in vivo will likely not be possible for years, these images indicate the continued potential of proton MRI above current clinical field strengths despite the known problems of RF wave behavior.

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References