ZOOM Imaging of the Human Brain at 7T

C. J. Wargo[1], M. J. Avison[1], E. B. Welch[1,2], and J. C. Gore[1]
[1]Vanderbilt University Institute of Imaging Science, Nashville, TN, United States, [2]Philips Medical Systems, United States

Introduction

High field MR systems are of theoretical benefit due to the improvement in signal strength provided. This can be translated into an increase in achieved SNR for a given experiment or can be used to improve image resolution. High spatial resolution, however, comes at the cost of longer scan durations for large matrices. Longer scans are prone to loss in image quality due to patient motion, and result in lower achieved temporal resolution for functional scans. For a number of applications, the region of interest where high spatial resolution is desired is often restricted to a specific anatomical region. Such isolation of image acquisition, however, is not possible with a standard scan that requires the object be imaged in its entirety in the desired plane in order to prevent fold-over effects that would severely degrade image quality. A number of spectroscopic techniques have been developed that enable spectra to be obtained in a targeted manner using methods such as STEAM, PRESS, and OVS [1,2]. These techniques can be readily adapted to obtain images of the smaller excited regions using so called "reduced-FOV" or "ZOOM" approaches. In this abstract, we describe the application of a STEAM based "ZOOM" method with demonstrated application in acquiring reduced-FOV awake human subject brain images at 7T. The goal of this approach is to explore the potential for efficient resolution improvement for isolated brain regions across a variety of anatomical and functional studies.

Methods

STEAM Preparation - Reduced-FOV imaging was achieved using a basic STEAM preparation [1,2] executed prior to a gradient echo sequence on a 7T Philips Achieva system. Operator control for centering and FOV definition was used as inputs for establishing the STEAM parameters to excite a specified percentage of the selected area. This was accomplished using a pair of 90° RF pulses in the readout and phase-encode direction separated by TE/2, with slice selection within the gradient echo scan (figure 1). Spoiler gradients between all sets of RF pulses in the STEAM and GE sequence were used to dephase spins outside of the target FOV.

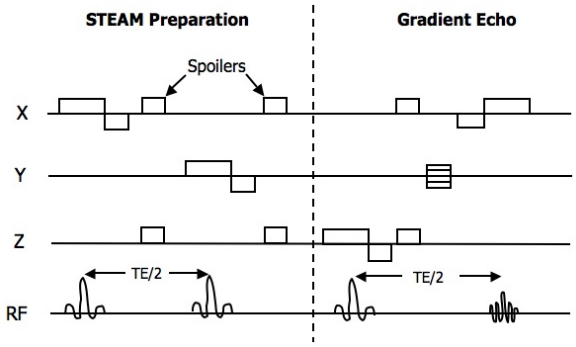

Figure 1 – STEAM preparation prior to a standard gradient echo sequence for reduced-FOV imaging.

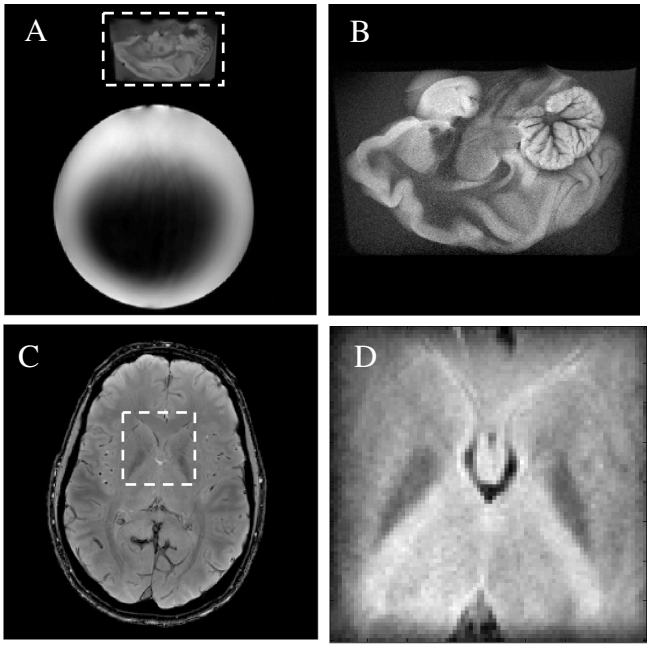

Figure 2 – A-B.) Targeted ZOOM of rhesus monkey brain, 156 µm, C-D.) Targeted ZOOM of human brain lentiform nucleus and internal capsule fibers, 855 µm.

Imaging Tests – Two imaging experiments were performed using a 16 channel SENSE coil and 7T Philips Achieva system, with full-FOV and reduced-FOV images acquired in both cases (parameters correspond to reduced case): 1.) Rhesus monkey brain in preserving solution on top of a $CuSO_4$ solution bottle - 156µm x 156µm x 3mm resolution, 40 x 64 mm FOV, TR/TE = 200/16ms, 4 acquisitions, 34 min 2.) awake healthy human subject - 855µm x 855µm x 3 mm resolution, 65 x 65 mm FOV, TR/TE = 500/16 ms, 4 acquisitions, 2 min 57sec scan.

Discussion

The reduced-FOV images (figure 2) demonstrate good suppression of the object outside the region of interest with high resolutions obtainable within practical scan durations. In some cases, slight residual fold-over of the brain edge was observed. Additional work will focus on optimizing achieved SNR and object suppression at higher resolutions through spoiling gradient improvement, customized shimming, and regional power calibration. Further applications will also be explored for a variety of human anatomical and functional brain studies.

References

[1] Frahm J, et al, J. Magn Reson, 64, 1985, 81-93.
[2] Frahm J, et al, MRM, 22, 1991, 133-142.