Diffusion weighted imaging of the Prostate Gland in the Face of Magnetic Susceptibility Differences – Parallel EPI and PROPELLER FSE approaches

T. P. Roberts[1], M. Haider[1]
[1]Medical Imaging, University of Toronto, Toronto, ON, Canada

Introduction

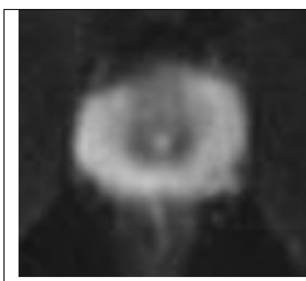
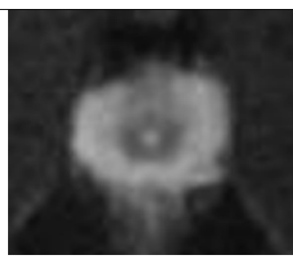
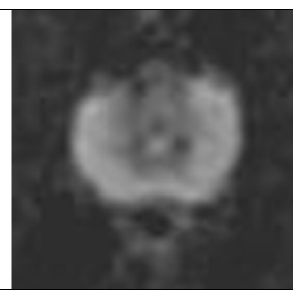
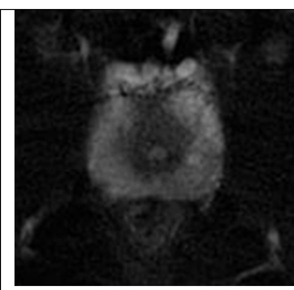
Characterization of prostate cancer non-invasively may require an estimate of cell density, derived from diffusion-weighted imaging. However, the anatomic location of the prostate makes it extremely sensitive to internal lower abdominal and pelvic motion. Consequently single shot EPI techniques might be preferred. These, however, suffer from an intrinsic sensitivity to magnetic field inhomogeneities (e.g. magnetic susceptibility differences) which may be pronounced around the prostate gland. The purpose of this study was to investigate the use of parallel imaging (with ASSET) to reduce the echo time, TE, of DW-EPI as well as to employ the recently developed multishot fast spin echo “PROPELLER” approach. PROPELLER imaging acquires blades of k-space with each blade passing through the center of k-space, which is thus oversampled.

Materials and Methods

Five healthy male subjects (mean age 38yrs ± 5yrs) underwent diffusion weighted imaging at 1.5T using a 4-element TORSO phased array RF coil. Single shot DW-EPI (128x128) and DW-EPI with ASSETx2 were acquired with a 24cm FOV and 9mm slices. Subsequently similar spatial resolution PROPELLER DWI were acquired, followed by ultra high resolution (512x512) PROPELLER DWI scans.

Results

With conventional DW-EPI using a 128x128 matrix, the minimum echo time for a b-value of 600s/mm2 was 81.5ms, leading to considerable magnetic susceptibility artifact. Further, the long echo train length (ETL) incurred considerable k-space amplitude modulation, leading to blur in the reconstructed image (Figure a). Using ASSET reduces the ETL to 64 and thus reduces blur (Figure b) as well as reducing TE to 63.3ms, considerably reducing the impact of magnetic field inhomogeneities. PROPELLER scanning (Figure c) shows almost no sensitivity to magnetic field inhomogeneities although contrasts the single shot EPI approaches in requiring several minutes of scan time. High resolution (512x512) PROPELLER (Figure d) produces sharply delineated images with exquisite spatial resolution and contrast but at the expense of extremely long scan times.

			
a) DW-EPI. Single shot DW-EPI provides a motion-resistant image, but is sensitive to blur and magnetic susceptibility artifact	b) DW-EPI with ASSETx2 reduces the ETL from 128 to 64 and thus reduces image blur, as well as TE	c) PROPELLER DWI shows little or no sensitivity to magnetic susceptibility differences	d) High-resolution PROPELLER DWI (512x512). Spatial resolution, in-plane < 470um

Conclusion

In areas of the body affected by magnetic susceptibility differences (air:tissue, bone:tissue interfaces) single shot EPI methods for diffusion weighted imaging can be considerably augmented by the use of ASSET to reduce ETL and shorten TE. Alternatively, if motion is not limiting, PROPELLER multishot diffusion-weighted FSE provides a compelling imaging strategy largely immune from magnetic susceptibility artifact and compatible with high and ultra-high spatial resolution.