AbstractID: 11020 Title: Advantages of Multi-Shot, Variable-Density Spiral, Diffusion-Weighted MR Imaging for Radiation Treatment Planning

Purpose:
The prerequisite for intensity-modulated radiation therapy (IMRT) is accurate target and critical structure definition. Diffusion-weighted MRI provides information that may improve target delineation and, therefore, radiation treatment outcome. However, geometric distortion artifacts have hampered the use of diffusion-weighted MRI in radiation treatment planning. We demonstrate here a multi-shot (i.e. interleaved), variable-density spiral method that not only diminishes geometric distortion artifacts, but also permits acquisition of higher resolution diffusion-weighted images for use in radiation treatment planning.

Method and Materials:
A custom, multi-shot, spin-echo, variable-density spiral sequence with bipolar diffusion gradients was implemented on a 3.0T GE scanner. High-resolution, multi-shot, diffusion-weighted images were acquired on three healthy volunteers (FOV: 240mm^2, matrix: 256^2, interleaves: 32, TE: 50 msec, TR: 3000 msec, scan time: 3.2 minutes). To demonstrate the inherent self-navigating capabilities of variable-density spiral, diffusion-weighted images were reconstructed without and with self-navigated phase correction. For comparison to the current state-of-the-art method, diffusion-weighted images were also collected using a clinical, single-shot, spin-echo echo-planar imaging (EPI) sequence with ramp sampling, partial k-space, and parallel imaging (FOV: 240mm^2, matrix: 128^2, TE: 64.7 msec, SENSE, R=2, scan time: ~1 minute).

Results:
The inherent self-navigating capability of variable-density spiral was effective at diminishing motion-induced phase errors, encoded by the diffusion gradients, that varied from shot-to-shot. The multi-shot diffusion-weighted images exhibited good signal-to-noise ratio despite the 47% reduction in voxel volume compared to the diffusion-weighted EPI images. Off-resonance effects resulted in geometric distortions in ventral and rostral brain regions on diffusion-weighted images collected with EPI, but did not compromise the geometric integrity of diffusion-weighted images acquired with multi-shot spiral.

Conclusions:
Multi-shot, variable-density spiral permits acquisition of high-resolution, diffusion-weighted images that do not suffer from geometric distortions that have previously prohibited their use in radiation treatment planning.

Conflict of Interest:
None