3D PROPELLER-Based Diffusion Weighted Imaging

E. Aboussouan[1], and J. Pipe[1]
[1]Barrow Neurological Institute, Phoenix, Arizona, United States

Introduction

PROPELLER [1] and Turboprop DWI [2] have shown advantages over traditional EPI DWI which include higher resolution, relative insensitivity to motion and robustness to off-resonance. In this work, we propose a new sequence dubbed TURBINE (TURBoprop IN Elevation), which adapts the TurboProp scheme to 3D DWI imaging. The potential benefits of this approach over EPI and turboprop include higher SNR efficiency, lower SAR and MTS, reduced off-resonance artifacts and 3D phase correction. The method also offers the potential for 3D zero padding and 3D motion correction although these were not part of this study.

Methods

The TURBINE trajectory is based on the turboprop sequence where the gradient echoes are placed in the slice encoding direction (Fig 1a). The kz encoding positions are spaced by (1/slab thickness) instead of (1/FOV), greatly increasing the speed of the kz trajectory, thus minimizing warping by factors of ~20.

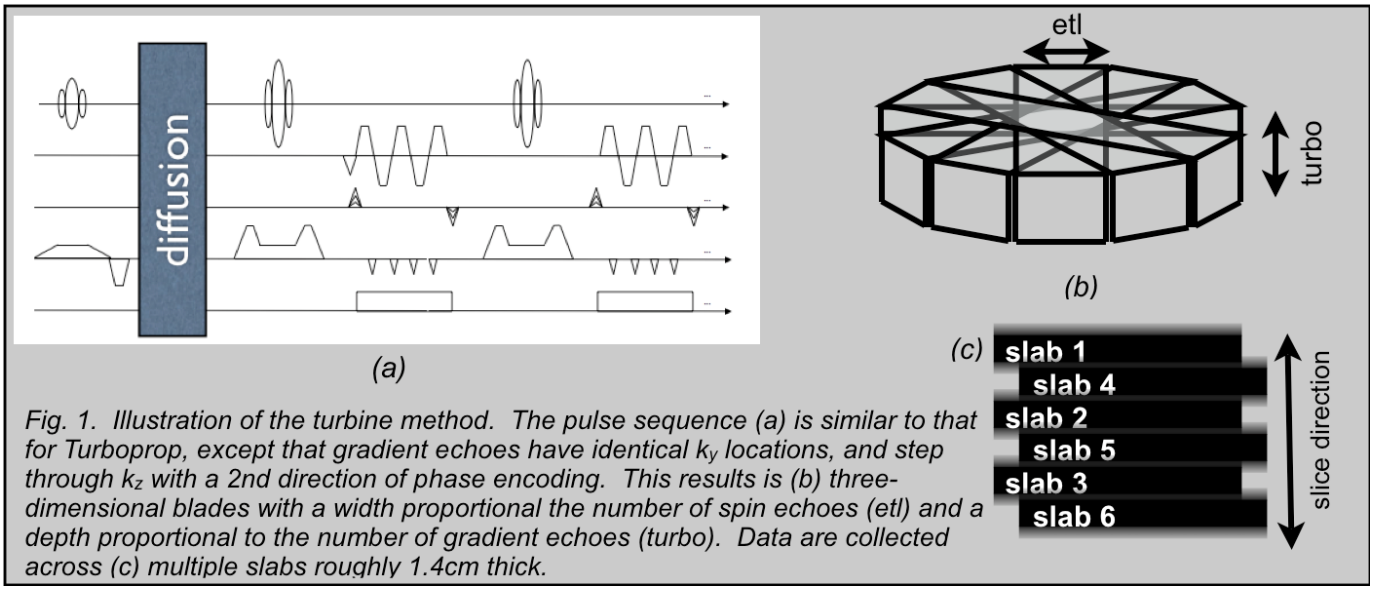

Fig. 1. Illustration of the turbine method. The pulse sequence (a) is similar to that for Turboprop, except that gradient echoes have identical k_y locations, and step through k_z with a 2nd direction of phase encoding. This results is (b) three-dimensional blades with a width proportional the number of spin echoes (etl) and a depth proportional to the number of gradient echoes (turbo). Data are collected across (c) multiple slabs roughly 1.4cm thick.

Experiments and Results

T2W and DW images of a healthy brain were acquired on a GE SIGNA 3T scanner with an 8-channel brain coil (Fig.2)

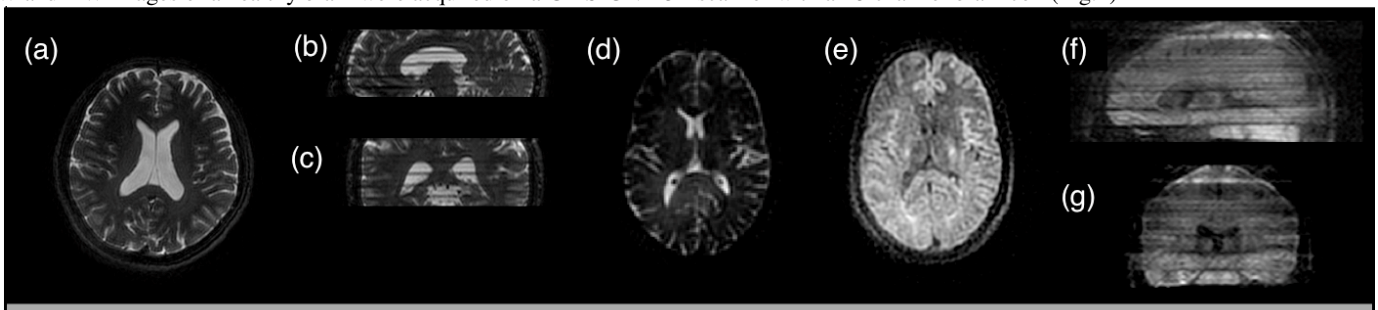

Fig. 2. T2 weighted volume (a,b,c), B0 (d) and diffusion weighted volume (e,f,g). The T2W volume was acquired in 2:32 with a 240x240x60mm^3 FOV and a 4s TR. The DWI volume was acquired in 7:18 and covers a 240x240x98mm^3 FOV with a 2mm isotropic resolution.

Discussion

The proposed method suggests a way to obtain 3D DWI, an application of high clinical relevance. However, several issues need to be resolved. Appropriate RF phase cycling [3] could mitigate the signal variation/attenuation in the DW (non-CPMG) sequence. This effect is thought to be responsible for the shading in the center of the brain and the low SNR in (Fig.2e-g). Different methods are also being investigated to correct the inconsistent shading between slices.

References:

[1] Pipe JG, et al, MRM (47), 42-53, 2002.
[2] Pipe JG, et al, MRM (55), 380-385, 2006.
[3] Le Roux, P. JMR. v155, p278-292, 2002.

Acknowledgements

This work was supported in part by GE Healthcare.