Comparison of Single-shot and Readout-segmented, Multi-shot (RESOLVE) Diffusion Tensor Imaging in the Cervical Spinal Cord

Michael Bredtoft Geneser[1,2], Mette Hjelm Hansen[1], Lillian Sønderby Nielsen[1], Dora Grauballe Zeidler[1,2]
[1]*Dept. of Neuroradiology, Aarhus University Hospital, Aarhus, Denmark;* [2]*Center of Functionally Integrative Neuroscience, Aarhus University, Aarhus, Denmark*

Background:
Diffusion Tensor Imaging (DTI) provides useful information on the viability of tissue in a variety of neurological disorders. DTI of the spinal cord is a clinically attractive technique, as myelopathy, infarction, tumors etc. are accompanied by diffusion restriction, tract distortion, or interruption [1]. However, spinal cord DTI can be challenging, as susceptibility gradients and low spatial resolution compromise the diagnostic image quality. Recently, a new technique has been introduced applying readout-segmented, multi-shot echoplanar imaging (EPI) permitting very short echo spacing [2]. Combined with 2D phase-correction this method reduces susceptibility based image distortion and motion-induced phase error considerably resulting in high-resolution DTI images (*syngo* RESOLVE, Siemens®, Erlangen, Germany). Here we present preliminary results comparing image quality in cervical cord DTI using a standard single-shot (ss) EPI sequence compared to the RESOLVE technique.

Methods:
RESOLVE has recently been installed on our clinical 1.5T MAGNETOM® Avanto MRI system (Siemens®, Erlangen, Germany). In the course of subsequent protocol optimization using a spine (24 elements) and neck (12 elements) matrix coil we compared our by then standard ssEPI DTI with a RESLOVE multi-shot EPI DTI in two healthy subjects. This study will be completed in the near future by further six healthy subjects and twelve patients suspected for myelopathy due to degenerative spine disease. The imaging parameters are specified in Tab.1. We then compared the degree of distortion by measuring the area (mm^2) of the spinal canal from the intervertebral disc C2/C3 to C7/T1 on T2, $B0_{RESOLVE}$ and $B0_{ssEPI}$, where T2 served as the standard sequence closest to anatomy (Fig. 1). Moreover, fusion images of $T2/TRACE_{ssEPI}$ and $T2/TRACE_{RESOLVE}$ were created, and distortion was quantified by measuring max. deviation between the two components (Fig. 2). Image analysis was done with OsiriX Imaging Software (Advanced Open-Source DICOM Viewer, version 5.5.2).

	ssEPI	RESOLVE
b values	800/0	800/0
TR/TE	2900/88 ms	2900/72 ms
resolution	1.5x1.5x3mm	1.5x1.5x3mm
averages	16	3
slices	15	15
imaging time	5min., 34s	5min., 52s

Tab.1: Imaging parameters for the single-shot EPI and RESOLVE sequence, respectively.

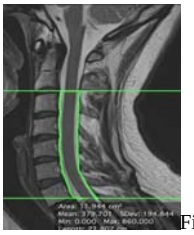
Fig. 1: Area measurement on T2


Fig. 2: Measurement of deviation between T2 and single-shot EPI

Results:
Subjective image quality of RESOLVE was generally superior to ssEPI (B0, ADC, and TRACE). Examples for B0 are shown in Fig. 3. The area of the spinal canal was increased due to distortion on both DTI sequences compared to T2 with the overestimation more distinctive on ssEPI in both subjects (8.54/1.25% on RESOLVE and 11.91/5.62% area increase on ssEPI compared to T2). The same was true for the deviation on $T2/TRACE_{ssEPI}$ and $T2/TRACE_{RESOLVE}$ fusion images, where the max. deviation at C7/T1 was 8.2/10.7mm on ssEPI and only 2.2/4.8mm on RESOLVE, respectively.

Conclusion:
Our preliminary results indicate more robust image quality of the RESOLVE sequence in cervical spinal cord DTI. Images are less degraded by distortion compared to a standard ssEPI sequence at approximately the same imaging time in our protocol. These results will be substantiated by the acquisition of more data in both healthy subjects and patients with degenerative spine disease.

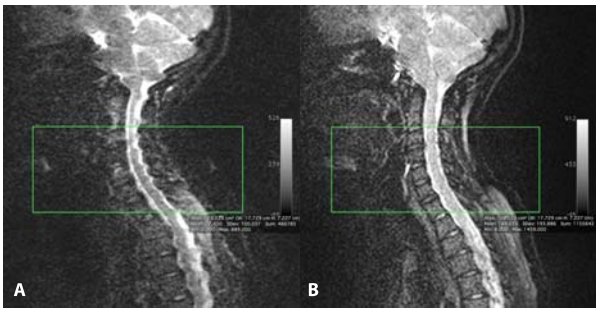

Fig. 3: Comparison of image quality of $B0_{ssEPI}$ (A) and $B0_{RESOLVE}$ (B).

References:
1. Song, T., et al., *Diffusion tensor imaging in the cervical spinal cord.* Eur Spine J, 2011. **20**(3): p. 422-8.
2. Porter, D.A. and R.M. Heidemann, *High resolution diffusion-weighted imaging using readout-segmented echo-planar imaging, parallel imaging and a two-dimensional navigator-based reacquisition.* Magn Reson Med, 2009. **62**(2): p. 468-75.