CLINICAL EVALUATION OF REDUCED FIELD-OF-VIEW DIFFUSION IMAGING OF THE HUMAN SPINAL CORD

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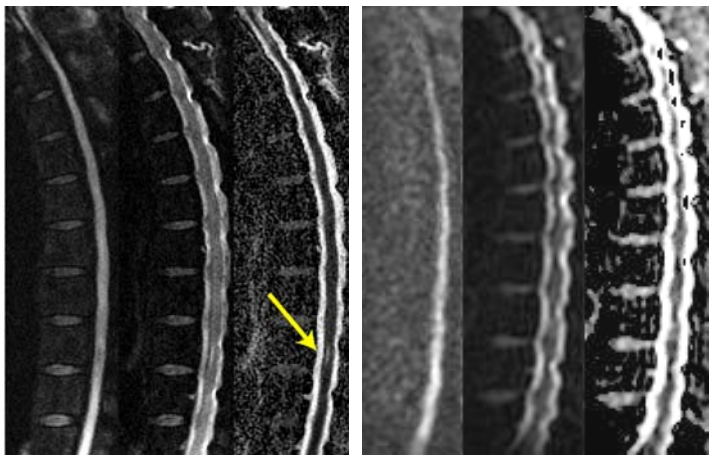
Introduction: Diffusion-weighted imaging (DWI) of the spinal cord is rarely performed clinically, given the difficulty of obtaining the required high spatial resolution of the moving spinal cord without excessive imaging artifacts using standard echo-planar imaging (EPI). To overcome this, we have applied a novel method based on acquiring a reduced field-of-view (rFOV) using a 2D echo-planar 90° RF pulse that improves standard EPI artifacts [1] and we have applied this to clinical patients.

Methods: rFOV diffusion imaging was performed in 41 clinical patients (36 cervical, 14 thoracic spine scans – some patients had both studies). Four sagittal slices were acquired with 4 mm thickness and 0.5 mm gap. The rFOV acquired was 18 x 4.5 cm^2 for cervical spine (192 x 48 imaging matrix, ±62.5 kHz BW), and 30 x 6 cm^2 for thoracic spine (320 x 64 imaging matrix, ±125 kHz BW), with in-plane resolution of 0.94 x 0.94 mm^2 for both cases. Partial k-space acquisition of 62.5% was used, to reduce readout time to 54 ms with TE of 63 ms (total scan time of 5 min). The b-value was 500 s/mm^2. Isotropic DWI, T2-weighted (b=0) images, and corresponding apparent diffusion coefficient (ADC) maps were automatically created and were available for immediate clinical review. Further details can be obtained from Reference 1.

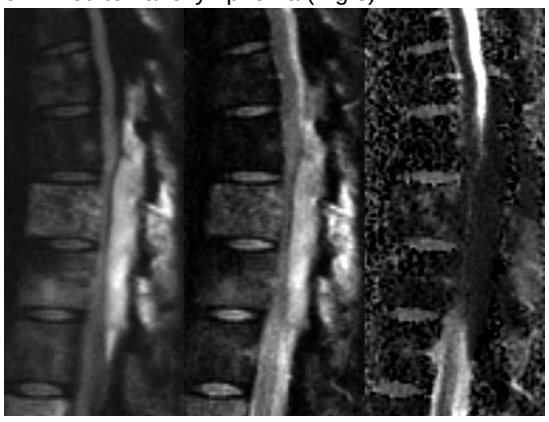
Inclusion criteria included an MRI study ordered for clinical purposes and signed informed consent for the study. Clinical indications were those typical for inpatients at our institution, primarily recent trauma, neck pain, suspicion of cord compression, infection, or infarction. In 6 patients, comparison studies using standard full-FOV EPI DWI were also acquired.



(a) (b)

Fig 1: Midline sagittal (a) rFOV and (b) full-FOV DWI of the thoracic spinal cord in a 49 year old man imaged to evaluate for possible nerve sheath tumors. From left to right are isotropic DWI (b=500 s/mm^2), T2-weighted, and ADC maps. Note the higher resolution and reduced distortion on the rFOV study, as well as the improved visualization of the vertebral bodies. The higher resolution allowed visualization of a tiny structure in the lower thoracic cord, likely a dilated central canal ("terminal ventricle"); the arrow demonstrates high ADC consistent with fluid.

Results: We observed improvements in imaging artifacts using rFOV DWI compared with our standard full-FOV DWI, particularly distortions in the PE direction (AP in our full-FOV EPI scans) (Fig 1). The improved resolution also resulted in a better estimation of cord diffusion characteristics without partial volume artifact. In two cases of spinal cord infarction, there was excellent depiction of the abnormal region (Fig 2). Additionally, reduced diffusion was observed in a dorsal epidural mass and bony structures in a patient later confirmed to have lymphoma (Fig 3).



(a) (b) (c)

Fig 3: 19 year old woman with back pain. rFOV (a) isotropic DWI, (b) T2-weighted, and (c) ADC map demonstrating a large dorsal epidural mass with reduced diffusion causing spinal cord compression. This was found to be lymphoma at surgical resection. Reduced diffusion is characteristic of small round blue cell tumors such as lymphoma, and narrowed the diagnostic possibilities in this case.

Discussion: rFOV DWI is a promising approach to image the spinal cord. The higher resolution and decreased imaging artifacts increased clinical confidence for both negative and positive results. In contradistinction to "outer volume" suppression techniques to reduce FOV [2], contiguous slices can be obtained, which is critical to image the entirety of the spinal cord, especially in the sagittal plane. The rFOV method is also compatible with parallel imaging approaches that might further reduce susceptibility artifacts, such as interleaved and readout-segmented EPI [3,4]. Such high-resolution approaches improve routine clinical imaging and are necessary to gain meaningful information from advanced techniques, including diffusion tensor imaging of the spinal cord.

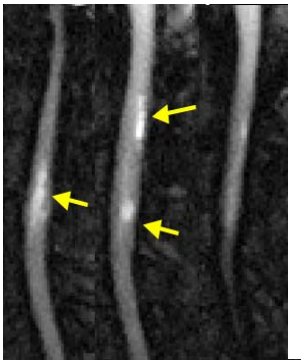


Fig 2: Contiguous sagittal diffusion images of the cervical spinal cord in a 72 year old man with acute onset of upper extremity numbness and weakness. Regions of reduced diffusion (arrows) are characteristic of acute spinal cord infarct.

References: 1. Saritas et al., *MRM* 2008; 60:468-473. 2. Wheeler-Kingshott et al., *Neuroimage* 2002; 16:93-102. 3. Bammer et al., *JMRI* 2002; 15:364-373. 4. Holdsworth et al., *Eur J Radiol* 2008; 65:36-46.