

## Diffusion Weighted Tractography of Nerve Pathology with Reduced Field of View EPI

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**Introduction:** Imaging methods that can visualize nerve fascicles in peripheral nerves are needed. Such techniques would be extremely useful in helping to distinguish axonometric nerve injuries which can recover through axonal regeneration from neurotmetic injuries which cannot either due to physical discontinuity in the nerve or intraneural fibrosis which impedes nerve fibers from regenerating. It would also be useful to visualize the spatial relationship of nerve fibers vis a vis tumors arising from nerves (nerve sheath tumors) to help determine the surgical resectability of such masses when clinically appropriate. Due to the geometric distortion that arises from the low phase encoding bandwidth in single-shot echo-planar imaging (ssEPI), local susceptibility gradients due to tissue interfaces often degrades image quality. In particular, achieving good image quality and spatial resolution with ssEPI diffusion in the spine has always been technically challenging since with conventional 1D slice selective excitation, a large field-of-view (~32-36 cm) has to be prescribed to avoid aliasing artifacts. Encoding such a large FOV with high resolution requires a very long echo-train length, which exacerbates off-resonance artifacts. 2D partially selective RF can be used to limit FOV in the phase-encoding direction and avoid aliasing [1,2]. We applied rFOV DTI to visualize nerve fibers in the clinical setting of traumatic nerve injuries and peripheral nerve tumors and correlated pre-operative findings with intra-operative electrophysiology.

**Methods:** DTI datasets were acquired on a 3T whole body MR750 scanner (GE Healthcare, Waukesha) utilizing the reduced field of view (rFOV) diffusion method which employs a 2D spatially selective RF excitation pulse in the ssEPI sequence with 10 direction-encoded images that uses a 2D echo-planar RF pulse to excite and read out a rectangular-shaped field of view. 14 patients were evaluated due to either traumatic nerve injury or suspected peripheral nerve sheath tumor. Slices were prescribed sagittally to cover the brachial-plexus. Imaging parameters common to all patients were: TR=3600ms, TE=52 ms, acquisition matrix=128x64, FOV=24x12 cm, slice thickness = 3 mm, 16 slices, b=500 s/mm<sup>2</sup>, 10 diffusion encoding directions, 10 averages, scan time = 9 minutes 30 seconds. Tractography analysis was performed on the DTI images using Brainwave software.

**Results:** rFOV DTI was used successfully to visualize the displacement and distortion of fascicles adjacent to nerve sheath tumors. In 4 cases, these findings were correlated with intraoperative visual inspection and electrophysiological testing. All such cases confirmed the location and relation of nerve fibers to tumor, confirming the utility of this technique in pre-operative planning. In 8 cases, findings of fascicular discontinuity (the presence and absence of nerve fibers in damaged peripheral nerve) were correlated with EMG findings of nerve injury. All such confirmed the location of injury.

Figure 1. 25 year old patient with neurofibromatosis I presented with a right axillary mass: a) Post contrast T1 weighted image demonstrates neurofibroma in the right axilla b) rFOV-EPI b=0s/mm; c) b=500s/mm; and d) & e) tractography images demonstrate preserved anisotropy in the dorsolateral aspects of the tumor. This finding correlated with electrophysiologic testing at the time of surgery demonstrating intact conducting axons in this region.

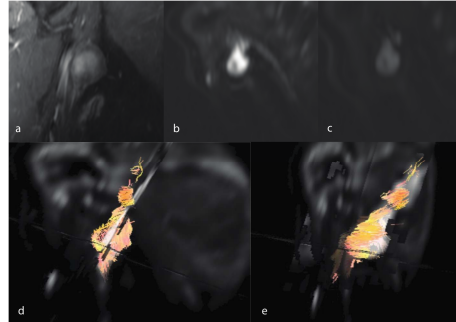
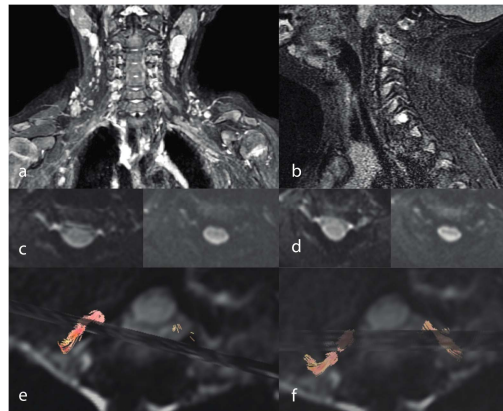


Figure 2. 6 month old patient with birth injury to the left brachial plexus: a) Coronal T2 fat saturated images MIP demonstrates thickening and increased signal within the C5-T1 nerve roots; b) Sagittal T2 fat saturated image demonstrates nerve root enlargement and T1 pseudomeningocele; rFOV-EPI b=0s/mm; b=500s/mm; and tractography images for C6 level (c & e) and C7 level (d & f) demonstrate loss of anisotropy at the left C6 root while C7 is preserved. This finding correlated with EMG and clinical symptoms of C6 loss of function.



**Conclusions:** Peripheral nerve tractography using MR DTI can be used to visualize the relationship of nerve fascicles to masses such as nerve sheath tumors which can be helpful in the planning of surgical resection. It also provides useful information following traumatic nerve injuries to help determine the extent of axonal disruption. References: [1] Kiefer C. ESMRMB 1999;302 [2] Saritas E. MRM 2008;60:468