Detection of beaded nerve fibers using d-PFG MRI

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Nerve axons in the peripheral nervous system exhibit a beaded morphology when they are subjected to variety of insults (mechanical, chemical, or metabolic)[1]. This study asseses whether double pulsed-field gradient (dPFG) NMR[3-4] can detect the change from a cylindrical to a beaded appearance in rat sciatic nerves following a controlled axonal beading induced injury model.

Rat sciatic nerves were excised and subjected to axial tension sufficient to induce beading or minimal tension to straighten their macroscopic undulation (control). The nerves were immediately immersed in fixative and rehydrated in phosphate buffered saline (PBS) prior to acquiring NMR data[2]. The nerves were placed in a 7T vertical-bore Bruker AVANCE III MRI scanner and oriented along B_0 (Z axis). Diffusion tensor MRI (DTI) was performed prior to d-PFG NMR to verify the nerve fiber orientation. dPFG NMR parameters were: δ=3.15ms, Δ=30ms, G = 0-177 mTm^{-1} The angle ϕ between the two consecutive PFG blocks was varied between 0 and 2π in the ZY plane. DTI parameters were: TR/TE = 3000/7 ms, resolution = 468 x 468 x 5000 μm^3. The d-PFG experiment was also performed with glass cappilary (GCA) array MRI phantom[4] consisting of many 5μm ID water-filled tubes.

Figures 1a) and b) show confocal microscope images of the beaded and unbeaded (control) nerves; the corresponding angular d-PFG NMR signal dependence is shown in Figures 1c) and d), respectively. The angular dependance of the signal in Figure 1d) is consistent with what one expects for unform cylinders, which was varified with the GCA phantom. The angular dependence in Figure 1c) is consistent with an array of parallel prolate ellipsoids.

In this pilot study, d-PFG NMR showed significant changes between normal and beaded sciatic nerve axons. Future studies will focus on developing and fitting mathematical models to our experimental data, and assessing the viability of performing such measurements *in vivo*.

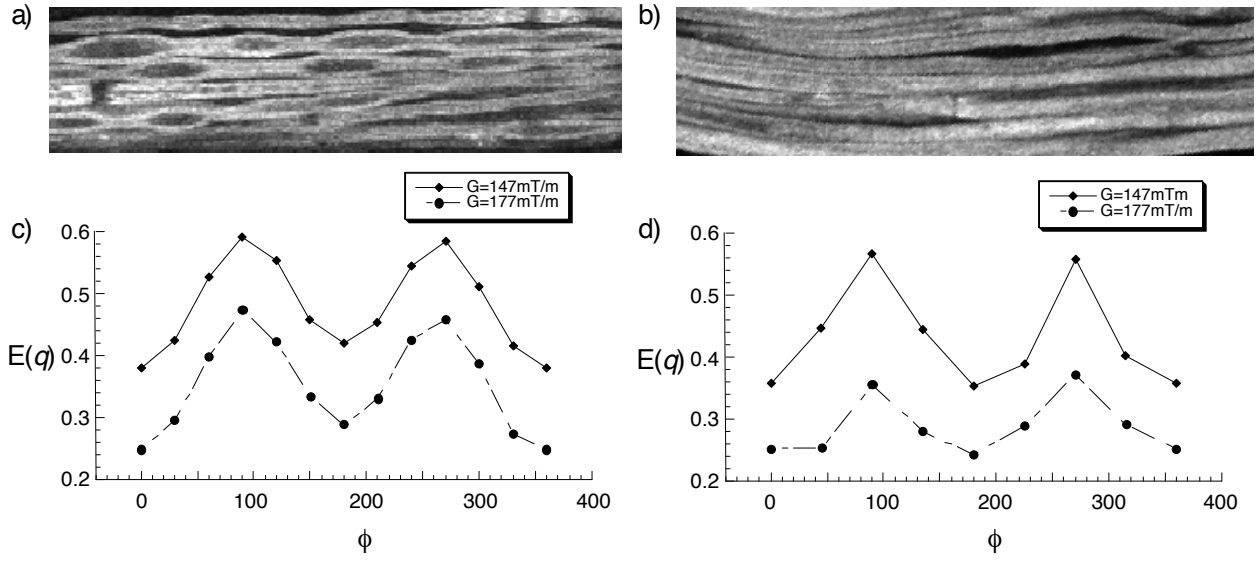

Figure 1: a) and b) show confocal microscope images of beaded and control rat sciatic nerves respectively, while c) and d) show the the corresponding angular dependance of the d-PFG signal

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