Online Table: Table of participant characteristics

Subject ID	Age	Gender type	ASIA Impairment Scale	Hospital Admittance to Scan Time (hrs)	SCI Etiology	Lesion Length (cm)	Hemorrhage Length (cm)	%Δ fADC	%Δ AD
1	72	Male	A	2.25	Fall/Jump	4.79	1.59	-89.02	-18.86
2	56	Female	B	4.5	Bicycle Accident	4.54	NA	-35.64	-27.98
3	44	Male	B	3.3	Motor Vehicle Collision	9.63	NA	-10.71	-2.56
4	69	Male	Not Completed	2.75	Motor Vehicle Collision	4.34	NA	-67.34	0.98
5	48	Male	A	2.5	Fall/Jump	4.2	1.17	-15.6	-21.84
6	29	Male	Not Completed	12	Motor Cycle Accident	8.06	NA	-13.48	-9.59
7	47	Male	Not Completed	3.75	Fall/Jump	2.15	NA	-47.65	-38.36
8	52	Male	C	6.25	Motor Vehicle Collision	3.02	NA	-15.5	-23.22
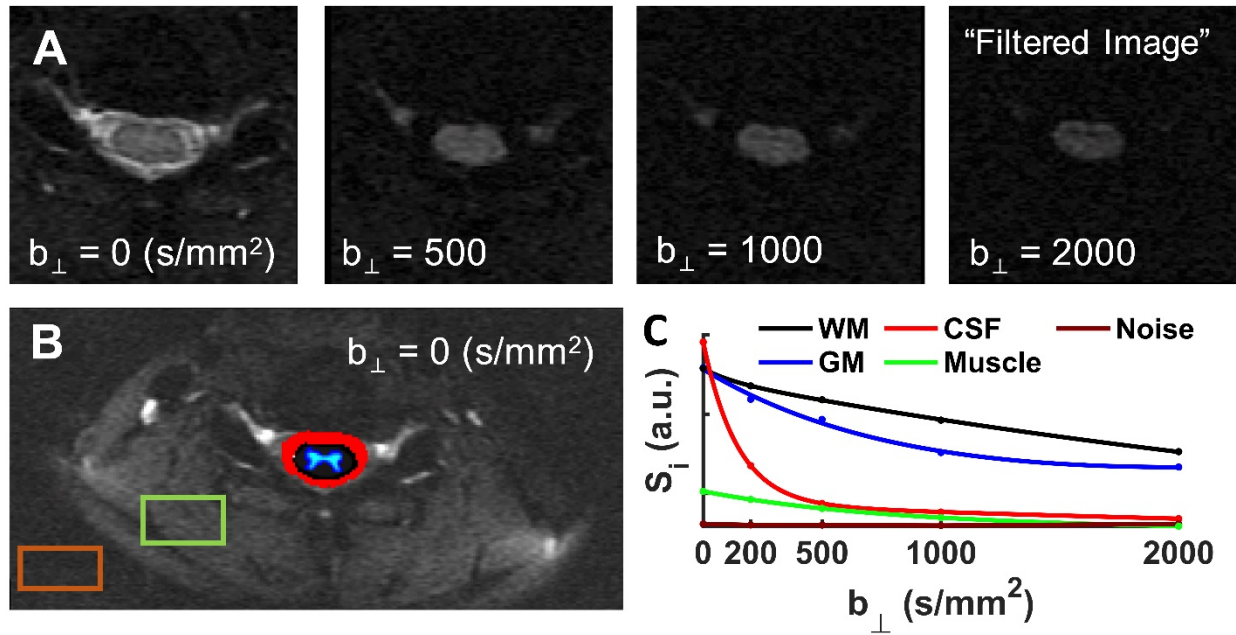
Online Figure 1. Signal Characteristics of Single-Axis PGSE Perpendicular to the Human Spinal Cord. Signal decay in a standard PGSE sequence was acquired with gradients directed perpendicular to the spinal cord in healthy individuals. Regions of interest (B) from the white matter (WM-black), gray matter (GM-blue), cerebrospinal fluid (CSF-red), muscle (green), and noise (brown) demonstrate the signal behavior from a perpendicular diffusion weighting, $b_\perp$ (C). As demonstrated in the images (A) and verified by modeling the signal intensity at each region of interest as a biexponential decay (C) for increasing $b_\perp$-values (0 to 2000 s/mm^2), perpendicular diffusion gradients attenuate the GM signal, and nearly completely suppress CSF and muscle signal, with less attenuation to the WM signal.
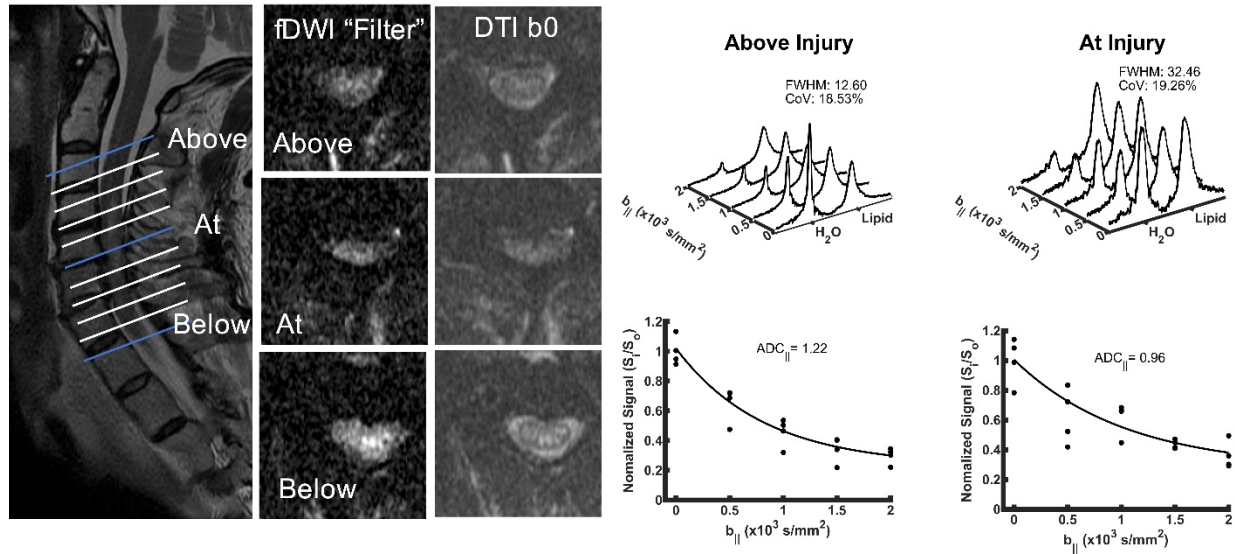
Online Figure 2. Low image quality but acceptable spectral quality for an individual with acute spinal cord injury. Water peaks are shown within the spectral data, and a bi-exponential fitted to the normalized data provides the $ADC_{\parallel}$ at the injury site despite low image quality on a 1.5T MR.
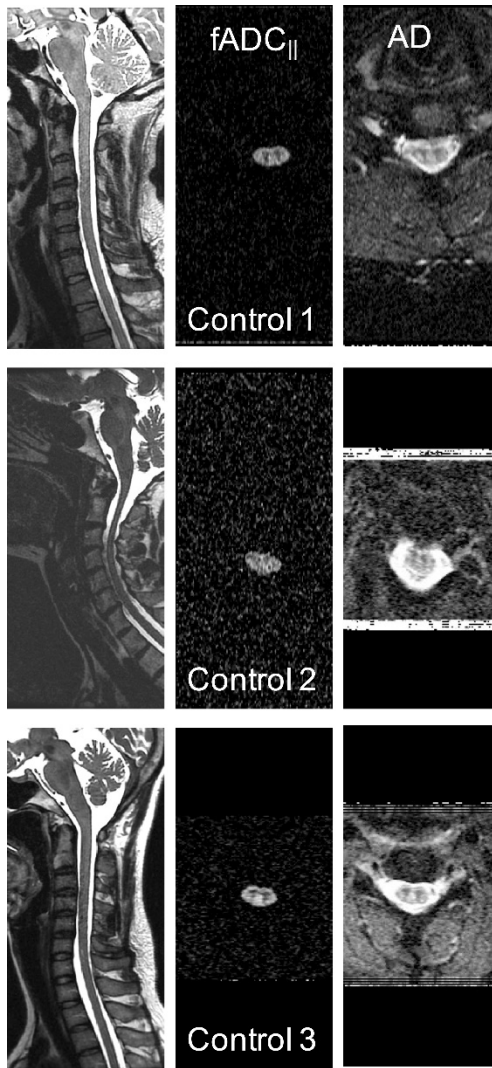
Online Figure 3. Sagittal T2w and axial diffusivity maps for each healthy control.

The images compare the fADC$_{||}$ and AD maps for each individual SCI participant,

illustrating the removal of extra-axonal signals with the fDWI scheme on a 3T magnet

and no SCI.
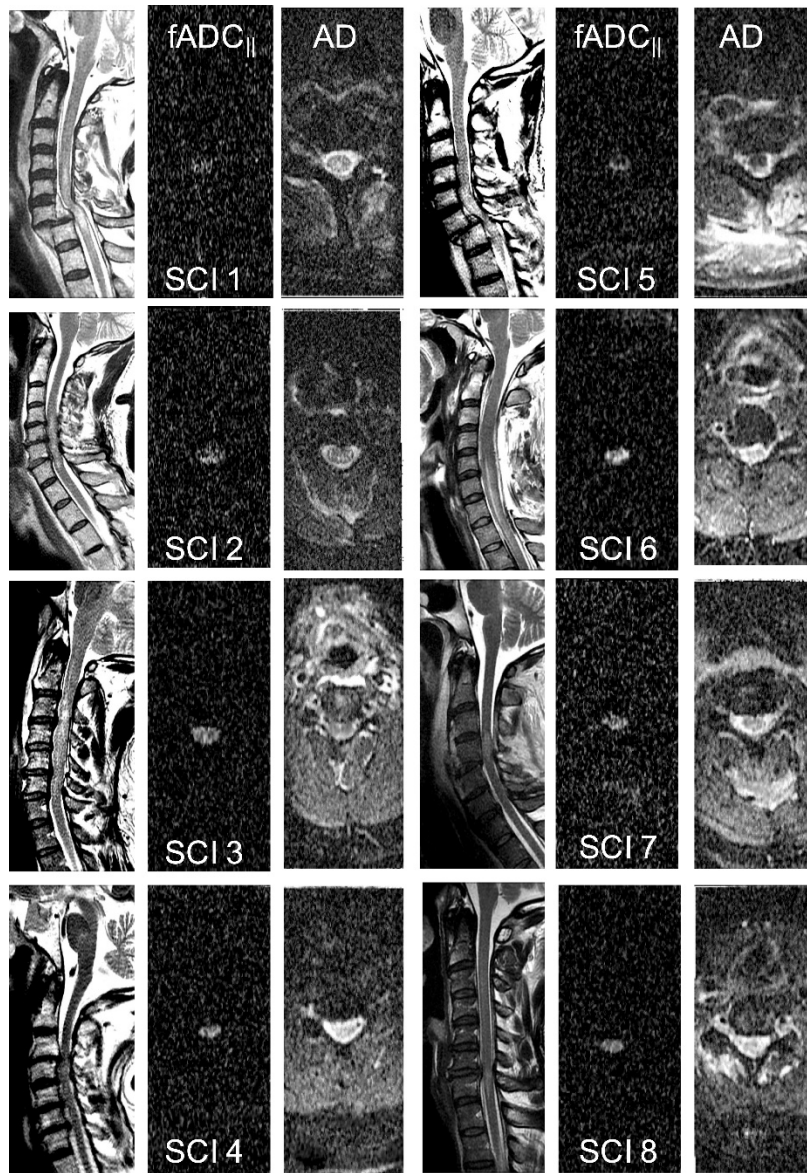
Online Figure 4. Sagittal T2w and axial diffusivity maps for each SCI patient. The images compare the $fADC_{||}$ and AD maps for each individual SCI participant, illustrating the removal of extra-axonal signals with the fDWI scheme on 1.5T magnet and a spinal cord injury.