

Spinal Cord Concussion Syndrome: Myth or Reality? Daniel Gaudin MD, PhD; Ahmed Alnemari; Tarek R Mansour; Mark Buehler MD The University of Toledo Medical Center



INTRODUCTION:

Spinal cord concussion (SCC) is still an area of conflict, possibly because it has not been as thoroughly studied as cerebral concussion has been or because of its infrequent incidence. The pathophysiology of SCC is unknown. The spinal cord injuries have historically been classified as concussions if they meet three criteria: 1) spinal trauma immediately precedes the onset of neurological deficits, 2) neurological deficits are consistent with spinal cord involvement at the level of injury, and 3) complete neurological recovery occurs within 72 hours after injury. Unfortunately, traditional radiological imaging techniques do not provide clear evidence of SCC and are often unremarkable. Diffusion tensor imaging (DTI) has emerged as a technique that allows for the evaluation of white matter integrity through the assessment of fractional anisotropy (FA) of tracts.

CASE PRESENTATION:

A young patient presents with decreased sensation and movement in his right arm along with cervical and lumbar back pain following a motor vehicle accident.

The brain MRI did not show any abnormalities but the DTI of the upper C-spine segment revealed significant changes in FA values of tracts on the right side as compared to the left side (Table A). These results are consistent with the patient's presentation of right-sided weakness post-trauma. When the FA values of tracts on the left and right sides were compared at lower segments of the C-spine, no significant differences were found; a finding that is also consistent with the absence of symptoms.

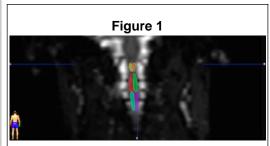
Table A				
	Left	Left (SD)	Right	Right (SD)
Upper Cervical (C1 – C2)	0.5902*	0.144	0.5552*	0.153
Mid Cervical (C3 – C4)	0.6279	0.125	0.6288	0.124
Lower Cervical (C5 – C6)	0.5917	0.139	0.6154	0.138

*Significant difference in FA values (P<0.05)

Summary of FA values of tracts at different locations of the C-spine.

DISCUSSION:

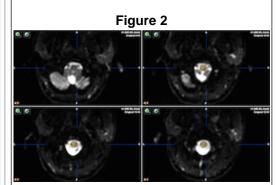
Spinal cord concussions (SCCs) are attributed to neurological disturbance as a result of trauma. According to some authors, SCC is a fully reversible spinal cord injury and it is usually characterized by short-lived motor weakness and sensory impairment that lasts for 24 to 72 hours without signs of physical variations (1). However, other authors have suggested that spinal cord concussion symptoms can last for longer than just a few days. Our results support the latter definition since the patient presented in this case still has ongoing symptoms related to the cervical spine injury incurred. Unlike other severe spinal cordrelated injuries, SCC is a primarily sport-related injury that occurs in a broad range of sports that allow contact such as gymnastics, hockey, diving, wrestling and pediatric athletes (2). Concussion injuries, especially those related to the spinal cord, have comparatively drawn the interest of clinical researchers in the recent past though the understanding of the topic remains relatively low due to lack of appropriate models for performing experiments (3). The cervical spine is the most prone part of adults participating in contact sports due to the loading forces exerted on the head alongside the neck when undertaking physical activities which leads to the compression of the spinal cord (4).



Brainlab image demonstrating a coronal view of the cervical segment of the spinal cord. Yellow = Right upper cervical; Orange = Left upper cervical; Red = Right middle cervical; Green = Left middle cervical; Blue = Right lower cervical; Violet = Left lower cervical.

EVALUATION OF CONCUSSIONS:

Concussions are considered common symptoms related to traumatic brain injury (TBI). However, the diagnosis has remained contentious since the appearance of the brain is relatively normal when assessed using traditional MRI imaging. In order to improve the imaging power, imaging modalities such as DTI have been developed.



Brainlab images demonstrating axial views of the cervical segment of the spinal cord. The images show that our areas of interest are chosen immediately below the cervicomedullary junction (top left image)

DIFFUSION TENSOR IMAGING (DTI):

DTI is an imaging technique that stems from MRI. This technique uses the principles of MRI to examine the molecular movement of water to study the microstructural white matter of the brain. The technique takes advantage of the high sensitivity of biological tissues to water molecules and allows the researcher to track the rate at which the molecules of water move in a randomized Brownian motion. With normal brain tissues, the molecules tend to diffuse uniformly in unrestricted motion due to the presence of natural barriers such as adjacent axons, cell membranes, and myelin . Such a uniform diffusion is referred to as being anisotropic. On the other hand, where the brain cells have been disrupted, the white matter loses its integrity, the molecular movement is restricted, and the tract is said to have lost anisotropy. The DTI images denoting variations in anisotropy help in detecting injury locations along the spine as reflected in variations in FA values.

CONCLUSION:

SCCs are poorly understood due to the low number of cases reported in the past. The application of MRI-DTI in the diagnosis has proven to be an effective technique in detecting injury locations along the spine. The knowledge derived from the MRI-DTI in the diagnosis of concussions using animal studies has been very crucial in improving the medical treatment of spinal cord concussions.

This report suggests a possible use of DTI in the diagnosis of SCC by comparing the differences in FA values in different sections of the spinal cord at various levels. Changes in FA values indicate a change in the integrity of the white matter tracts in question.

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