SPINAL CORD DIFFUSION TENSOR IMAGING (DTI) AND ITS APPLICATION

Essay
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Dedication:

I dedicate this work to ***Soul of my Father.***

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*First of all and above all great thanks to **Allah**.*

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Abstract

In future, fiber tracking and DTI indices may help the surgeon to determine their surgical approach. Correlation between quantitative diffusion measures, such as FA and ADC, and acute or chronic injuries of the spinal cord may be useful to predict outcome and monitor the response to treatment. Spinal cord injury results in functional disabilities in patients. it is important to develop a noninvasive imaging technique for early evaluation of spinal cord integrity after injury, X-ray and better CT are useful in delineating bony details and are important in preoperative planning , Magnetic resonant imaging (MRI) is the method of choice for detection and diagnosis of many disorders in the spine because of its inherent sensitivity to subtle soft tissue changes and its capability to displaying long segment of vertebral column in one examination. In the context of trauma MRI can detect ligamentous injury and internal derangement of the spinal cord.Diffusion weighted MRI promises to add to the diagnostic specificity of MRI in the spine. Based on its ability to depict the microscopic motion of water protons, DWI can be used to sensitize image contrast to microstructural changes and thus can provide important information complimentary to regular MRI sequences DWI provides important biological information about the composition of tissues, their physical properties, their microstructure, and their architectural organization.

Keyword: SCI-DWI- DTI-ADV

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LIST OF ABBREVIATIONS

SCI	Spinal cord injury
CT	Computed tomography
MRI	Magnetic resonance imaging
DWI	Diffusion Weighted imaging
CNS	Central Nervous System
CSF	Cerebrospinal fluid
FSE	Fast spin echo
PDWI	Proton density weighted images
ADC	Apparent diffusion coefficient
RF	Radiofrequency pulse
DTI	Diffusion tensor imaging
FA	Fractional anisotropy
EPI	Echo Planar Imaging
ADCSI	Apparent diffusion coefficient superior-inferior
ADCAP	Apparent diffusion coefficient anterior-posterior
RARE	Rapid imaging with relaxation enhancement
FACT	Fiber Assignment by Continuous Tracking
SNR	Signal-To-Noise Ratio
3D	Three dimension
NEX	Number of excitations
FoV	Field of view
AcqRes	Acquired resolution
ReconRes	Reconstructed resolution
ROI	Regions Of Interest
ECG	Electrocardiography

PTMM	Progressive post-traumatic myelomalacic myelopathy
MT	magnetization transfer
MTCSF	Magnetization transfer signal intensity relative to cerebrospinal fluid
GM	Gray matter
WM	White matter
tADC	Transverse apparent diffusion coefficient
DTT	Diffusion tensor tractography
FT	Fiber tractography

Introduction

Diffusion tensor imaging (DTI) of the spinal cord is recently shown to be feasible and could be of diagnostic value in diseases affecting the spinal cord ***(Izbudak1et al, 2011)***.

DTI is becoming a valuable surrogate measurement of the microscopic anatomy of the central nervous system. It measures both the magnitude and direction of the diffusion of water molecules by applying gradients in multiple planes. DTI can characterize white matter tracts within the brain and spinal cord by measuring alterations to the anisotropy of tissue ***(T.H. Kim et al, 2010).***

DTI is a modification of the MRI technique that is sensitive to the Brownian motion of water molecules in biological tissues. Within cerebral white matter, water molecules diffuse more freely along the direction of axonal fascicles than across them. Arising from the restriction of free water diffusion by axonal membrane , axonal microtubules and the axonal myelin sheath. Such directional dependence of diffusivity is termed anisotropy. By combining anisotropy data with the directionality it is possible to obtain estimates of fiber orientation. This has led to fiber tractography (FT) in which 3D pathways of white matter tracts are reconstructed form continuous trajectories ***(S. Rajasekaran et al, 2012).***

Although conventional MRI shows the detailed anatomy of the structures imaged, the functional status of these tissues cannot be determined: for example, in cervical myelopathy, even though the affected segment of the spinal cord shows changes in signal intensity, the physiological state and functional integrity of the nerve fiber tracts of the spinal cord are not shown. However, pathological conditions affect the diffusion of water in the tissues, and it is this phenomenon that is used by DTI to assess the affected tissues ***(K. Majcher1 et al,2012).***

DTI has been applied to the spinal cord and has been demonstrated to be a similarly valuable tool for assessing the extent of white matter damage in numerous spinal cord-related conditions including multiple sclerosis , amyotrophic lateral sclerosis , myelitis , and spinal cord injury (SCI) ***(Rachael L et al, 2012).***

DTI provides a definition of the extent of axonal and gray matter changes enabling localization of the injury site ***(Rachael L et al, 2012).***

Patients who have had prior spinal cord injuries may benefit from DTI and FT. Preliminary results after peripheral nerve grafting seem promising .Our early experience shows that FT may be used to assure the anatomic presence of intact fibers, a factor needed for successful grafting. Fibers destroyed by the initial injury or secondarily to Wallerian degeneration do not respond to grafting ***(Denis Ducreux et al, 2007).***

DTI allows for the in vivo examination of the extent of damage to white matter microstructure which may enable the detection and diagnosis of subtle injuries and may provide a means of monitoring the effects of a therapeutic intervention ***(Huda1 et al,2008).***

DTI and FT may help to characterize some tumors and to delineate their margins ***(Huda1 et al,2008).***.