

## Translating State-of-the-Art Spinal Cord MRI Techniques to Clinical Use: a Systematic Review of Clinical Studies Utilizing DTI, MT, MWF, MRS, and fMRI

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### Introduction

A recent meeting of international imaging experts identified 5 state-of-the-art MRI techniques that can elucidate aspects of spinal cord microstructure and function: diffusion tensor imaging (DTI), magnetization transfer (MT), myelin water fraction (MWF), MR spectroscopy (MRS), and functional MRI (fMRI). This study aimed to summarize technical methods and challenges employing these techniques, and determine their progress toward clinical translation.

### Methods

MEDLINE, Embase, and Pubmed databases were searched for studies investigating diagnosis, correlation with disability, and prediction of outcomes using these techniques in all spinal cord pathologies. Study design, subjects, technical methods, clinical measures, and analysis techniques were extracted to identify trends. Studies were assessed for risk of bias and quality of evidence using GRADE.

### Results

6597 unique citations were identified, and full-text review of 274 articles yielded 104 included studies. 69 DTI and 25 MT studies were identified, with both recently showing sharp increases, in addition to 1 MWF, 11 MRS, and 8 fMRI studies. Most studies were exploratory, showing high (73%) or moderately high (21%) risk of bias related to acquisitions, manual analysis, and study design. Acquisition techniques varied widely across studies. The DTI metric fractional anisotropy (FA) showed moderate evidence of correlating with disability in several pathologies including degenerative cervical myelopathy and spinal cord injury, low evidence of group differences vs. controls, and insufficient evidence for diagnosis or prognosis. Numerous other metrics showed very low evidence to demonstrate group differences, and insufficient evidence as diagnostic tests, biomarkers, or prognostic tools.

### Conclusions

Powerful MRI techniques are emerging that could provide improved diagnostics, monitoring of disease progression and recovery, and prediction of outcomes. Current evidence is limited, with only FA demonstrating consistent correlation with disability. Standardized acquisitions, automated analysis, and higher quality studies that limit potential bias are needed to provide the evidentiary basis necessary to facilitate clinical translation.

### Learning Objectives

By the conclusion of this session, participants should be able to 1) understand the 5 MRI techniques identified as state-of-the-art by a recent expert panel, 2) appreciate the technical methods and challenges of each technique, and 3) be informed of the current evidence toward clinical translation for these methods.

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