Is recovery from whiplash influenced by macromolecular changes in spinal cord white matter?

Mark A Hoggarth PT, DPTa,b\* mark.hoggarth@northwestern.edu

James M Elliott PT, PhDb,c jim.elliott@sydney.edu.au

Mary J Kwasny ScDd m-kwasny@northwestern.edu

Marie Wasielewski RTb marie-wasielewski@northwestern.edu

Kenneth A Weber II DC, PhDe kenweber@stanford.edu

Todd B Parrish PhDa,f toddp@northwestern.edu

1. Department of Biomedical Engineering, McCormick School of Engineering, Northwestern University, Evanston, IL, USA
2. Department of Physical Therapy and Human Movement Sciences, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA
3. Northern Sydney Local Health District, The Kolling Research Institute and The Faculty of Health Sciences, The University of Sydney, St. Leonards, NSW, Australia
4. Department of Preventive Medicine, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA
5. Systems Neuroscience and Pain Lab, Department of Anesthesiology, Perioperative and Pain Medicine, Stanford University, Palo Alto, CA, USA
6. Department of Radiology, Northwestern University, Chicago, IL, USA

\*Corresponding Author:

Dr. Mark A. Hoggarth

645 North Michigan Avenue

Suite 1100

Chicago, Illinois, 60611

Abstract

Introduction

Whiplash injuries from non-fatal motor vehicle collisions (MVC) affect nearly four million people in the United States each year. Treatment for whiplash-associated-disorders (WAD) is limited, with little evidence of structural lesions with conventional imaging. Magnetization transfer (MT) imaging is a tool to quantify macromolecular content in white matter, and was utilized in this study to investigate white matter damage in the cervical spinal cord of participants with whiplash injuries.

Methods

78 participants with WAD were studied. MT images were collected parallel to each of the cervical intervertebral disks. MT ratios (MTR) were measured in the bilateral corticospinal tracts, spinothalamic and spinoreticular tracts, and cuneate and gracile fasciculi. Measures of the homogeneity of the MTR (MTR*h*) were generated from the eight white matter tracts at each level. Groups by clinical outcome, based on Neck Disability Index, were compared using a generalized linear model.

Results

With regard to MTRh, there was a significant interaction between recovery status and sex (p=0.015). Least square mean MTRh for female and male recovered groups were: 0.094 and 0.111; mild: 0.087 and 0.112; severe: 0.140 and 0.067. Least square mean MTR*h* for females with severe clinical outcome were significantly different from recovered and mild females (p=0.023 and p=0.005), and males with severe outcome (0.010).

Conclusions

MTRh imaging of the spinal cord can identify tract specific and regional changes in white matter integrity following whiplash injuries. Significant MTRh differences between sexes were observed, supporting many large-scale clinical studies detailing poorer recovery in females when compared to males.