

**The Rapid and Progressive Degeneration of the Cervical Multifidus in
Whiplash:
A MRI study of Fatty Infiltration**

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BACKGROUND

The fat/water content of muscles, including the cervical spine multifidii muscles, can be accurately assessed using standard MRI imaging.

This study had 2 objectives:

- To study the temporal development of muscle fatty infiltrates (MFI) in the cervical multifidii following whiplash.
- To study the differences in multifidii MFI between those who recover or report milder pain vs. those who report moderate/severe symptoms at 3 months after whiplash injury.

This study used 36 whiplash-injured subjects (Quebec Task Force Classification category of WAD Grade II), assessed at < 1-week post-injury, 2-weeks post-injury, and 3-months post-injury.

Subject disability was measured with the *Neck Disability Index*, and classified as follows:

- 0–28% Recovered/Mild
- ≥ 30% Severe

KEY POINTS FROM THIS ARTICLE:

- 1) “Whiplash-Associated Disorders (WAD) from motor vehicle collisions (MVCs) afflict over 4-million Americans annually, reducing quality of life and accounting for an estimated \$30 billion in medical costs.”
- 2) “Half of all those exposed to a MVC will never fully recover.” **[Important]**
- 3) Of the 4 million annual whiplash-injured Americans, approximately 1 million (25%), are expected to present with a complex clinical picture that includes:
 - Severe-pain-related disability

- Muscle degeneration
- Sensory and motor disturbances
- Muscle weakness
- Psychological distress

4) “No structural cause of WAD has been found with available imaging technology.” **[Important]**

5) “A recent prospective investigation using conventional T1-weighted magnetic resonance imaging (MRI) uniquely identified neck muscle fatty infiltrates (MFI) between one- and three-months post injury in participants with more severe levels of WAD-related disability and symptoms of post-traumatic stress (PTSD).”

[Elliott J, Pedler A, Kenardy J, Galloway G, Jull G, Sterling M. The temporal development of Fatty infiltrates in the neck muscles following whiplash injury: an association with pain and posttraumatic stress. PLoS One. 2011; 6(6):e21194]

6) The temporal development of MFI on conventional MRI has been shown to be associated with the development of pain and psychological factors in whiplash-injured subjects.

7) Protocols used in this study include:

- All imaging data were collected with a 3.0T MRI scanner evaluating differences in fat and water for the neck multifidii muscles C3-C7, using slice thickness of 3mm.
- Pain and disability was measured using the *Neck Disability Index* (NDI), “which has been used extensively to quantify neck pain-related disability.”
- Symptoms of PTSD were measured using the *Posttraumatic Stress Diagnostic Scale* (PDS).

8) MFI values were essentially identical in both groups in the first week of assessment, However, “MFI values were significantly higher in the severe group when compared to the recovered/mild group at 2-weeks and 3-months.”

[Important]

“Comparing the recovered/mild to moderate/severe groups indicated no significant difference at 1 week with significant differences at 2 weeks and at 3 months.”

“While both groups entered the present study within one-week post-injury and had similar initial levels of MFI, the group with poor functional recovery uniquely demonstrated large muscle changes on water-fat MRI between 1- and 2-weeks post MVC.”

9) “MFI levels of 20.5% or above resulted in a sensitivity of 87.5% and a specificity of 92.9% for predicting outcome at 3 months.”

- 10) “Conclusions—Consistent with previous evidence, muscle degeneration occurs soon after injury but only in those patients with poor functional recovery.”
- 11) Multifidii MFI is predictive for risk factors of developing chronic whiplash syndrome, and “routine imaging protocols may need to be reconsidered in the vast majority of patients following whiplash.”
[Key Point: routine MRI of the cervical spine, looking for multifidii MFI, may be necessary to predict whiplash chronicity].
- 12) “Participants who recovered, or only had persistent mild symptoms, and those with chronic idiopathic neck pain did not develop MFI.” **[Important]**
- 13) “In the moderate/severe disability group, mean percent MFI significantly increased across all time points.”
- 14) “MFI levels of 20.5% or above resulted in a sensitivity of 87.5% (identification of 7/8 in the moderate severe group) and a specificity of 92.9%.”
- 15) “Having higher baseline pain-related disability was associated with having increased MFI at 2-weeks and 3 months post-injury.” **[Important]**
- 16) “MFI levels at 2 weeks may be used to predict severity based on NDI at 3 months.” **[Important]**
- 17) MFI can result as a consequence of “inflammation, denervation, disuse, altered activation of the sympathetic nervous system (SNS), and stress system dysregulation.” **[Key]**
- 18) “Injury to a number of anatomical structures (facet joints, discs, ligaments, vascular tissues, and dorsal root ganglia) could produce an inflammatory response, which, similar to other chronic pain disorders, could affect the functioning of the peripheral and central nervous systems as well as the structure and strength of skeletal muscle.” **[Key]**
- 19) Higher levels of TNF- α may impair the recovery of muscle function.
[TNF- α is an inflammatory cytokine. TNF- α levels can be reduced using omega-3s, vitamin D, low-level laser therapy, etc.]
- 20) Decreased activity after a MVC increases the risk of chronic WAD. “The effect of depriving healthy individuals from their normal daily activity (as may be expected to occur if an individual reduces normal activity after a whiplash injury) can lead to fatigue, mood swings, reductions in muscle volume and intramuscular fatty infiltration.”
- 21) Altered sympathetic nervous system (SNS) activation exerts a number of actions on the muscle cell. “In a state of prolonged stress, as might be expected in some cases of whiplash, excessive sympathetic outflow could result in hypoxia and

toxaemia under which, intramyocellular oxidative stresses may affect the contractility of skeletal muscle, and possibly the MFI observed in this and another study.” **[CHIROPRACTIC KEY]**

22) “These findings may have implications for whiplash where the early assessment and management of modifiable factors (e.g. symptoms of PTSD, pain intensity, muscle degeneration) may attenuate some physical aspects of the chronic condition.”

23) “Water-fat MRI may have implications for early assessment, characterization, and management of WAD.”

COMMENTS FROM DAN MURPHY

Often, whiplash controversies center around organic injury vs. psychosocial models. This study suggests that post-traumatic whiplash stress may cause increased sustained sympathetic tone, altering muscle contractibility, accelerating multifidii muscle atrophy, documented with MRI confirmed fatty infiltration. Hence, a biosocial phenomenon causes an organic injury, increasing the risk of chronic pain.

Similarly, fear avoidance (another psychosocial phenomenon), may reduce movement, also resulting in muscle atrophy, fatty infiltration, and chronicity.

Physiological injury to the soft tissues of the spinal column also cause reflex alterations in muscle tone and movement parameters, enhancing muscle atrophy, fatty infiltration, and chronicity.

Spinal soft tissue injury with subsequent articular “fibrosis of repair” will impair joint movement, also resulting in enhancing muscle atrophy, fatty infiltration, and chronicity. Additionally, evidence suggests that reduced articular movement results in increased and sustained sympathetic tone, again altering muscle contractibility, accelerating multifidii muscle atrophy, documented with MRI confirmed fatty infiltration. **[the classic chiropractic subluxation complex]**

This suggests that management of whiplash injury should:

- Begin early, within a week of being injured.
- Include varieties of stress management.
- Encourage early and persistent movement.
- Employ early and persistent therapeutic movement, including exercise, passive articular movements, and chiropractic joint adjusting.

Additionally, anti-inflammatory protocols seem logical, including low-level laser therapy, omega-3s, vitamin D, etc.