

# **Fatty Infiltration in the Cervical Extensor Muscles in Persistent Whiplash-Associated Disorders: A Magnetic Resonance Imaging Analysis**

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FROM ABSTRACT:

**Study Design.**

Cross-sectional investigation of muscle changes in patients suffering from persistent whiplash-associated disorders (WAD).

**Objectives.**

To quantitatively compare the presence of fatty infiltrate in the cervical extensor musculature in a cohort of chronic whiplash patients (WAD II) and healthy control subjects across muscle and cervical segmental levels.

**Summary of Background Data.**

Magnetic resonance imaging (MRI) can be regarded as the gold standard for muscle imaging; however, there is little knowledge about *in vivo* features of neck extensor muscles in patients suffering from persistent WAD and how fat content alters across the factors of muscle, vertebral segments, age, self-reported pain and disability, compensation status, body mass index, and duration of symptoms.

**Methods.**

A reliable MRI measure for fatty infiltrate was performed of the cervical extensor muscles bilaterally in 113 female subjects (79 WAD, 34 healthy control; 18-45 years, 3 months to 3 years post injury).

The measure was performed on all subjects for the rectus capitis posterior minor and major, multifidus, semispinalis cervicis and capitis, splenius capitis, and upper trapezius.

**Results.**

The WAD subjects had significantly larger amounts of fatty infiltrate for all of the cervical extensor muscles compared with healthy control subjects.

In addition, the amount of fatty infiltrate varied by both cervical level and muscle, with the rectus capitis minor/major and multifidi at C3 having the largest amount of fatty infiltrate.

## Conclusion.

There is significantly greater fatty infiltration in the neck extensor muscles, especially in the deeper muscles of the upper cervical spine, in subjects with persistent WAD when compared with healthy controls.

## THESE AUTHORS ALSO NOTE:

“Studies indicate that up to 40% of people who have had a whiplash injury will continue to have pain for 6 months and between 10% and 30% of patients will continue to report symptoms for 2 years or longer.” **[Important]**

“It is clear that if symptoms persist for 6 months following injury, the status of a whiplash patient is unlikely to change significantly.”

“The value of diagnostic magnetic resonance imaging (MRI) for acute whiplash-associated disorders (WAD) from a pathoanatomic perspective is reported to be poor with MRI usually failing to identify any structural lesion(s) related to symptoms. However, these studies have focused on changes in the intervertebral disc, facets, and ligaments with little focus on muscular tissue.”

MRI is widely used as a diagnostic modality in the evaluation of fatty infiltrates in the deep extensor musculature in patients with lumbar spine syndromes.

“Studies have observed atrophy and fatty infiltrate in the suboccipital muscles of patients with chronic neck pain.”

## RESULTS:

“The multifidus muscle in the WAD group had a higher index of fat within the muscle at all cervical levels but particularly at C3.”

There was higher muscle fat in the whiplash group compared with the control group in the rectus capitis posterior minor and rectus capitis posterior major muscles.

## DISCUSSION

“Muscle fatty infiltrates were identified throughout the entire cervical extensor muscles in both normal and WAD subjects, although significantly larger amounts of fatty infiltrate occurred throughout the extensor muscles in the WAD group.”

“The largest amounts of intramuscular fat were found in the rectus capitis posterior minor, major, and deep cervical multifidi muscles in the WAD group.”

“The higher levels of fatty infiltrate in the suboccipital (rectus capitis posterior minor and major) and multifidus muscles, particularly at the C3 segment in the WAD group, could lead to the contention that there was a greater injury with consequent change in the muscles at these segments.”

“Although it is known that a whiplash injury can damage any number of structures at any segment in the cervical spine, it is possible that those with upper cervical injuries may be more prone to chronicity.” **[Key Point]**

“Certainly headache and the symptoms of lightheadedness and unsteadiness, which are consistent with impairments in the upper cervical structures, are common in those with chronic WAD.” **[Very Important]**

Aging is an unlikely cause of the fatty infiltration because there was “no association between age and fatty infiltrate.”

“The fact that fatty infiltrate was widespread and not isolated to one level in this whiplash group suggests that the degeneration may be a consequence of generalized disuse.”

“Alternatively, a greater presence of fatty infiltration in the deep cervical WAD muscles may be the consequence of either a minor nerve injury or irritation and subsequently demyelinated nerve tissue resulting from an acute inflammatory process with the other variable disuse adding to the changes over time.”

Studies have shown that damage to the zygapophysial joint and intervertebral discs can cause inflammation and thus irritate the adjacent mechano-sensitive nerve tissue.

Patients suffering from persistent WAD have “various functional impairments.”

“From a proprioceptive standpoint, it is the smaller, non-torque-producing muscles that possess large spindle densities and are largely required for fine motor control.”

Afferents [mechanoreceptive] from upper cervical muscles project to the “inferior olivary nucleus and cerebellum.” **[Very Important]**

High fat infiltration in the deep suboccipital and multifidi muscles, which possess high spindle [mechanoreceptive] density, [would reduce appropriate central mechanoreceptive input and reduce fine motor control of the joints served by those muscles].

## CONCLUSIONS:

“This is the first study to demonstrate that female patients (18-45 years) with persistent WAD (II) show quantifiable MRI changes in the fat content of the cervical

extensor musculature, and these changes are not present in subjects with no history of neck pain.”

This study demonstrates increased fatty infiltration in the deep extensor musculature at higher cervical segments.

The authors give 4 viable explanations for this fatty infiltration:

- 1) They are the result of muscle structural damage.
- 2) They are the result of adjacent structural damage, such as the facet or disc, with subsequent inflammation.
- 3) They are the result of a nerve injury and subsequent nerve inflammation in the upper cervical region.
- 4) They are the result of a generalized disuse phenomenon.

#### KEY POINTS FROM AUTHORS:

- 1) MRI can document muscular fatty infiltration in the suboccipital and segmental extensor muscles in the cervical spine.
- 2) “Subjects with WAD had significantly more fatty infiltrate in all of the suboccipital and segmental extensor muscles compared with the healthy control group. Fatty infiltration occurred to a larger extent in the rectus capitis posterior minor and major muscles and the multifidi at the C3 segmental level in those subjects suffering from persistent WAD.”

#### KEY POINTS FROM DAN MURPHY

- 1) Magnetic resonance imaging (MRI) is the gold standard for muscle imaging, and is capable of documenting fatty infiltration of the small deep muscles of the upper cervical spine, including the suboccipitals and multifidi.
- 2) Chronic whiplash subjects have significantly larger amounts of fatty infiltrate for all of the cervical extensor muscles compared with healthy control subjects especially in the deeper muscles in the upper cervical spine.
- 3) The cervical muscles with the largest amount of fatty infiltrate are the rectus capitis minor/major and multifidi at C3.
- 4) “Up to 40% of people who have had a whiplash injury will continue to have pain for 6 months and between 10% and 30% of patients will continue to report symptoms for 2 years or longer.” **[Important]**

- 5) "Studies have observed atrophy and fatty infiltrate in the suboccipital muscles of patients with chronic neck pain."
- 6) "The value of diagnostic magnetic resonance imaging (MRI) for acute whiplash-associated disorders (WAD) from a pathoanatomic perspective is reported to be poor with MRI usually failing to identify any structural lesion(s) related to symptoms. However, these studies have focused on changes in the intervertebral disc, facets, and ligaments with little focus on muscular tissue."
- 7) "The higher levels of fatty infiltrate in the suboccipital (rectus capitis posterior minor and major) and multifidus muscles, particularly at the C3 segment in the WAD group, could lead to the contention that there was a greater injury with consequent change in the muscles at these segments."
- 8) Whiplash injuries to the upper cervical spine are more likely to cause chronicity than injuries at other areas. **[Key Point]**
- 9) "Certainly headache and the symptoms of lightheadedness and unsteadiness, which are consistent with impairments in the upper cervical structures, are common in those with chronic WAD." **[Very Important]**
- 10) Patients with chronic whiplash symptoms have "quantifiable MRI changes in the fat content of the cervical extensor musculature, and these changes are not present in subjects with no history of neck pain."

#### CHIROPRACTIC IMPORTANT CONCEPTS ASSOCIATED WITH THIS ARTICLE:

- 1) The suboccipital and multifidi muscles are "smaller, non-torque-producing muscles that possess large spindle densities [very important from a proprioceptive standpoint] and are largely required for fine motor control."
- 2) Whiplash trauma injures structures of the upper cervical spine, with consequent direct or indirect fatty infiltration of the suboccipital and multifidi muscles.
- 3) Fatty infiltration of these muscles reduces appropriate central mechanoreceptive input and reduces fine motor control of the joints served by those muscles.
- 4) Afferents [mechanoreceptive] from upper cervical muscles project to the "inferior olivary nucleus and cerebellum." **[Very Important]**
- 5) I (Dan Murphy, DC) believe that the reduced mechanical driven plasticity of the cerebellum may be the most damaging component of chronic whiplash pathophysiology.