

Dynamic kine magnetic resonance imaging in whiplash patients

Pain Research and Management
2009 Nov-Dec 2009;Vol. 14, No. 6; pp. 427-32

Lindgren KA, Kettunen JA, Paatelma M, Mikkonen RH.

FROM ABSTRACT:

The multitude of symptoms following a whiplash injury has given rise to much discussion because of the lack of objective radiological findings.

The ligaments that stabilize the upper cervical spine can be injured. Dynamic kine magnetic resonance imaging (dMRI) may reveal the pathological motion patterns caused by injury to these ligaments.

To compare the findings and motion patterns in the upper cervical spine, 25 whiplash trauma patients with longstanding pain, limb symptoms and loss of balance indicating a problem at the level of C0-C2, as well as matched healthy controls were imaged using dMRI. A physiotherapist performed the bending and rotation of the upper cervical spine for the subjects to ensure that the movements were limited to the C0-C2 level. An oblique coronal T2- and proton density-weighted sequence and a balanced fast field echo axial sequence were used.

The movements between C0-C2 and the signal from the alar ligaments were analyzed. Contact of the transverse ligament and the medulla in rotation was seen in two patients. The signal from the alar ligaments was abnormal in 92% of the patients and in 24% of the control subjects. Abnormal movements at the level of C1-C2 were more common in patients than in controls (56% versus 20%).

Whiplash patients with longstanding symptoms had both more abnormal signals from the alar ligaments and more abnormal movements on dMRI at the C0-C2 level than controls.

THESE AUTHORS ALSO NOTE:

On average, 30% (range 11% to 42%) of people with acute whiplash develop chronic whiplash symptoms.

“Injury to the alar ligaments associated with neck sprain could be a cause of pain and disability among these [chronic whiplash] patients.”

Whiplash injury to the upper cervical spine can cause balance disturbance, dizziness, visual problems and jaw problems.

The stability of the cranial-cervical junction is primarily provided by the alar and transverse ligaments.

“The alar ligaments restrain rotation of the upper cervical spine.”

“The alar ligaments may be irreversibly overstretched or even ruptured in unexpected rear-end collisions.”

Alar ligament integrity can be assessed using high-resolution proton density-weighted MRI.

In this study, the authors investigated the integrity of the upper cervical spine ligaments in 30 chronic whiplash patients and in 30 matched control subjects using dynamic (functional) MRI (dMRI). Specifically, a trained physiotherapist laterally bent (for one scan) and rotated (for another scan) the upper cervical spine of the patients and subjects while the dMRI scan was performed.

The chronic whiplash patients had symptoms that could be explained by problems between O-C1-C2, including:

Neck pain

Headache

Upper limb symptoms

Lower limb symptoms

Loss of balance

Some tongue numbness

The chronic whiplash patient’s duration of symptoms was 7.8 ± 7.5 years.

	Normal Controls	Chronic Whiplash Patients
Abnormal Alar Ligament	24%	92%
Abnormality of Dens Movement	20%	56%
Unstable Occiput-C1 Joint	3%	23%
Transverse Ligament/Medulla Contact	Zero	7%

The alar ligament signal was abnormal in 92% of the chronic whiplash patients and in 24% of the control subjects.

56% of the chronic whiplash patients and 20% of the control subjects had an abnormality of movement of the dens, and 95% of these were “no movement of the dens.”

Occiput-C1 joint instability was assessed by noting widening in the joint during side bending. Occiput-C1 instability was found in 23% of chronic whiplash patients and in 3% of the control subjects.

During rotation, contact between the transverse ligament and the medulla was found in 7% of chronic whiplash patients and in none of the control subjects.

DISCUSSION

"Because of the lack of a disc and the horizontal nature of the facet joints, the stability of the atlanto-axial complex depends mainly on the ligaments and muscles."

"The most important function of the alar ligaments is to limit axial rotation of the head."

55% of the rotation of the cervical spine occurs at the C1-C2 joint

5% of the rotation of the cervical spine occurs at the Occiput-C1 joint.

40% of the rotation of the cervical spine occurs C2-C7.

Alar ligaments can be visualized using proton density weighted MRI with slice distances not exceeding 2mm.

Chronic whiplash patients have more abnormal signals from the alar ligaments and more movement disturbances at Occiput-C1-C2 in dMRI than control subjects.

Studies that use 4mm slice distances often miss alar ligament abnormalities. Slice distances must be no more than 2mm.

"Contact between the transverse ligament and the medulla can only be seen during rotation using [dMRI]." Contact between the transverse ligaments and the medulla during rotation "is abnormal."

"Symptoms and complaints among WAD patients can be linked with structural abnormalities of the ligaments and membranes of the upper cervical spine, particularly the alar ligaments."

Abnormal findings on [dMRI] are verified on nearly all surgically treated patients.

"We found that many whiplash patients with persisting disabilities had alar ligament abnormalities, and disturbed function Occiput-C1-C2 complex."

"Abnormalities in proprioception and in the upper neural coordination centers produce symptoms similar to those seen in our whiplash patients." Upper cervical spine ligaments could contribute to these symptoms.

KEY POINTS FROM DAN MURPHY

- 1) On average, 30% (range 11% to 42%) of people with acute whiplash develop chronic whiplash symptoms.
- 2) "Injury to the alar ligaments associated with neck sprain could be a cause of pain and disability among these [chronic whiplash] patients."
- 3) Whiplash injury to the upper cervical spine can cause balance disturbance, dizziness, visual problems and jaw problems.
- 4) The stability of the cranial-cervical junction is primarily provided by the alar and transverse ligaments.
- 5) "The alar ligaments restrain rotation of the upper cervical spine."
- 6) "The alar ligaments may be irreversibly overstretched or even ruptured in unexpected rear-end collisions."
- 7) Alar ligament integrity can be assessed using high-resolution proton density-weighted dynamic MRI.
- 8) Chronic whiplash patient symptoms attributable to Occiput -C1-C2, include:
 - Neck pain
 - Headache
 - Upper limb symptoms
 - Lower limb symptoms
 - Loss of balance
 - Some tongue numbness
- 9) This study found:

	Normal Controls	Chronic Whiplash Patients
Abnormal Alar Ligament	24%	92%
Abnormality of Dens Movement	20%	56%
Unstable Occiput-C1 Joint	3%	23%
Transverse Ligament/Medulla Contact	Zero	7%

- 10) 95% of dens movement abnormalities found were "no movement of the dens." **[Significant chiropractic applications]**

- 11) "Because of the lack of a disc and the horizontal nature of the facet joints, the stability of the atlanto-axial complex depends mainly on the ligaments and muscles."
- 12) "The most important function of the alar ligaments is to limit axial rotation of the head."
- 13) 55% of the rotation of the cervical spine occurs at the C1-C2 joint
- 14) 5% of the rotation of the cervical spine occurs at the Occiput-C1 joint.
- 15) 40% of the rotation of the cervical spine occurs at C2-C7.
- 16) Alar ligaments can be visualized using proton density weighted MRI with slice distances not exceeding 2mm.
- 17) Chronic whiplash patients have more abnormal signals from the alar ligaments and more movement disturbances at Occiput-C1-C2 in dMRI than control subjects.
- 18) Studies that use 4mm slice distances often miss alar ligament abnormalities. Slice distances must be no more than 2mm.
- 19) "Contact between the transverse ligament and the medulla can only be seen during rotation using [dMRI]." Contact between the transverse ligaments and the medulla during rotation "is abnormal."
- 20) "Symptoms and complaints among WAD patients can be linked with structural abnormalities of the ligaments and membranes of the upper cervical spine, particularly the alar ligaments."
- 21) "We found that many whiplash patients with persisting disabilities had alar ligament abnormalities, and disturbed function Occiput-C1-C2 complex."
- 22) "Abnormalities in proprioception and in the upper neural coordination centers produce symptoms similar to those seen in our whiplash patients." Upper cervical spine ligaments could contribute to these symptoms.