

# **Active Range of Motion as an Indicator for Ligament and Membrane Lesions in the Upper Cervical Spine After a Whiplash Trauma**

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BERTEL KAALE, JOSTEIN KRAKENES, GRETHE ALBREKTSSEN, and KNUT WESTER

## FROM ABSTRACT

In the present study, we examined whether active range of neck motion (AROM) differed between persons with and without a diagnosis of whiplash-associated disorder type 2 (WAD2) and explored whether magnetic resonance (MR)–verified lesions of specific ligaments or membranes at the craniovertebral junction was associated with increased or decreased motion in any particular direction among the WAD2 patients.

A CROM goniometer was used for registration of flexion, extension, side bending (left and right) and rotation (left and right), respectively.

The neck structures considered were the alar and the transverse ligaments, and the tectorial and the posterior atlanto-occipital membranes.

Our study comprised 87 WAD2 patients and 29 control persons without any known neck injury.

WAD patients had on average a shorter range of active motion for all movements compared with the control group.

The difference was statistically significant for all measures considered, except side bending to the left.

Among the WAD patients, increasing severity of lesions to the alar ligaments was associated with a decrease in maximal flexion and rotation. A similar pattern was seen for lesions to the transverse ligament.

These findings indicate that soft tissue lesions may affect neck motion as reflected by AROM.

However, since lesions to different structures seem to affect the same movement, AROM alone is not a sufficient indicator for soft-tissue lesions to specific structure in the upper cervical spine.

## THESE AUTHORS ALSO NOTE:

“Whiplash Associated Disorder (WAD), caused by a motor vehicle collision, produce strain to neck muscles, ligaments and joints.”

“Accident related forces could damage soft tissue and joint structures and thereby alter the biomechanical conditions for active neck motion.”

Magnetic resonance (MR) studies can visualize anatomical injuries of specific ligaments and membranes in the upper cervical spine in chronic WAD2 patients.

“The alar ligaments play an important role in rotation, flexion and side bending in the upper cervical spine.”

The alar ligaments are “particularly vulnerable in a whiplash trauma.”

Injury to the alar ligaments may influence specific movements of the neck.

Studies have found that the AROM is reduced in all directions for patients with persistent WADs compared with asymptomatic volunteers.

The active range of motion in this study was measured with a CROM goniometer with two inclinometers.

Both WAD patients and the control persons were subjected to an MR examination using a 1.5-Tesla system. “A standard head coil was used, and proton density-weighted sequences with 2-mm-thick slices were obtained in three orthogonal planes with the head and neck in a neutral position.”

“The control persons showed no or only minor MR changes in the investigated ligaments and membranes, in contrast to the WAD patients.”

## RESULTS

“We found no hypermobility in the [whiplash] patients. On the contrary, WAD patients had on average a shorter range of motion for all movements compared with the control group. The difference was statistically significant for all measures considered, except side bending to the left.” **[Important: hypomobility was the universal finding in the whiplash patients v. the controls.]**

“For both the right and left alar ligaments, the maximal range of active flexion decreased significantly with increasing severity of MR-verified ligament lesions.”

“No significant association was found between lesions to the alar ligaments and maximal extension.”

Maximal range of active rotation decreased with increasing severity of alar ligament lesions.

## DISCUSSION

“The present study showed that WAD2 patients on average had lower range of neck motion compared to control persons without any known neck injury.”

“Among the WAD patients, we found that MR-verified lesions to the alar ligaments were associated with a reduction in flexion and rotation, whereas lesions to the posterior atlantooccipital membrane showed the strongest association with rotation.”

“The decrease in AROM with increasing severity of lesions to specific structures indicates a direct relationship.”

“However, since lesions to different structures seem to affect the same movements, additional MR examinations and clinical tests are needed for a more specific location of an injury.” **[Key Point]**

“With MR findings indicating lesions of cranio-cervical ligaments and membranes, we had expected to find a hyper- rather than hypo-mobility of the neck among the WAD patients. However, pain from the soft tissue lesion or biomechanical dysfunction, and also stiffer muscles around the injured area as a consequence of pain or cautiousness/anxiety, may explain the present finding of a general reduced active range of motion.”

Previous studies have observed a similar reduced active motion in whiplash patients compared to control persons.

This “study revealed that WAD patients with lesions to the alar ligaments had lower mean values of flexion and rotation, whereas those with lesions to the posterior atlanto-occipital membrane tended to have lower range of rotation.”

The MR examination, as well as testing of AROM, was performed on average 6 years after date of diagnosis of WAD and therefore represent chronic lesions.

“The severity of the MRI-verified lesions was also associated with accident-related factors, indicating that they were consequences of the whiplash trauma.”

“In summary, we have observed that MR-verified lesions to specific soft tissue structures in the upper cervical spine are associated with a reduced neck motion in specific directions.”

“A consistent trend in [reduced] rotation and flexion according to severity of lesion was seen for the alar ligaments.”

However, “since lesions to different structures seem to affect the same movement, and some patients present with lesions to multiple structures, more specific radiological and clinical assessment techniques are needed for a final detection and location of a potential injury. However, results from AROM testing may be utilized for performing more specific clinical testing, and has also a potential for being used as an effect measure in a rehabilitation situation.”

#### KEY POINTS FROM DAN MURPHY

1) Whiplash patients have on average a shorter range of active motion for all movements compared with controls.

- 2) In whiplash patients, increasing severity of lesions to the alar ligaments is associated with a decrease in maximal flexion and rotation. These findings indicate that soft tissue lesions may affect neck motion as measured by active range of motion.
- 3) Since lesions to different structures seem to affect the same movement, active range of motion alone is not a sufficient indicator for soft-tissue lesions to specific structure in the upper cervical spine, and adequate proton density MR is still required "for a more specific location of an injury."
- 4) Magnetic resonance (MR) studies can visualize anatomical injuries of specific ligaments and membranes in the upper cervical spine in chronic patients. Imaging requirements include using a 1.5-Tesla system with a standard head coil and proton density-weighted sequences with 2-mm-thick slices in three orthogonal planes with the head and neck in a neutral position.
- 5) The alar ligaments are "particularly vulnerable in a whiplash trauma."
- 6) The standard measurement of active range of motion is CROM goniometer with two inclinometers.
- 7) This study "found no hypermobility in the [whiplash] patients. On the contrary, WAD patients had on average a shorter range of motion for all movements compared with the control group." **[Important: hypomobility was the universal finding in the whiplash patients v. the controls.]**
- 8) "For both the right and left alar ligaments, the maximal range of active flexion decreased significantly with increasing severity of MR-verified ligament lesions."
- 9) "No significant association was found between lesions to the alar ligaments and maximal extension."
- 10) "Maximal range of active rotation decreased with increasing severity of alar ligament lesions."
- 11) "The present study showed that WAD2 patients on average had lower range of neck motion compared to control persons without any known neck injury."
- 12) "Among the WAD patients, we found that MR-verified lesions to the alar ligaments were associated with a reduction in flexion and rotation, whereas lesions to the posterior atlantooccipital membrane showed the strongest association with rotation."
- 13) "The severity of the MRI-verified lesions was also associated with accident-related factors, indicating that they were consequences of the whiplash trauma."
- 14) Active range of motion testing may be important in assessing the rehabilitation of the whiplash-injured patient.