The authors are from the Department of Psychiatry, University Hospital of Northern Sweden. They investigated cervicocephalic kinesthetic sensibility, active range of cervical motion, and oculomotor function in 27 patients, 2-years after whiplash injury, and compared them to healthy control subjects without a history of whiplash injury. Correlations between oculomotor test, cervical range of active motion, and cervical kinesthetic sensibility in patients with whiplash were studied.

To be included in the study, patients incurred whiplash injury grades II and III, according to the Quebec Task Force Classification on whiplash-associated disorders (WAD).

“Grade II includes neck complaints and musculoskeletal signs; grade III includes additional signs (decreased or absent deep tendon reflexes, weakness, and sensory deficits). Patients with a head injury, unconsciousness, fracture or dislocation of the cervical spine, or a previous history of neck injury or neck pain, were excluded.”

At follow-up 2 years after the trauma, only 7 subjects (26%) were symptom free.

The authors note:

In a whiplash injury the head is thrown backward, forward, or laterally without being hit externally.

Whiplash injuries result in long-term disability with 6% of patients not returning to work after 1 year.

“The symptoms and complaints following whiplash trauma include neck pain, headache, vertigo, nausea, blurring of vision, dysacusis, fullness of the ear, and various emotional and cognitive disturbances.”

In some patients with moderate whiplash trauma oculomotor dysfunction may be explained by involvement of the cervical proprioceptive system. [Important]

Pronounced oculomotor dysfunction in some whiplash cases is possibly caused by medullary lesions.

In whiplash injuries it is likely that proprioception is primarily involved, either by lesioning or functional impairment of muscular and articular receptors, or by alteration in afferent integration and tuning. [Important]
“It is probable that cervicocephalic kinesthesia is linked to information coming from the extensive muscular and articular proprioceptive system. Head orientation in space and with respect to the trunk makes use of visual, vestibular, and cervical proprioceptive cues. The neck muscle proprioceptive system can influence the oculomotor and vestibular system.”

Kinesthetic Sensibility Test

All subjects had their vision occluded by goggles. They wore a helmet firmly tied to the head with light beam (laser pointer) affixed to the top of the helmet. After a few seconds of concentration on a target position, the subject performed a maximal rotation of the head to the left for approximately 21 seconds, then tried to locate the initial reference position. The subject’s relocation accuracy was measured in centimeters from the point on which the light beam stopped to the center of the target. Ten trials were undertaken with head rotation to the left, followed by 10 trials to the right. The same experimental procedure was used to study the repositioning of the head from a maximal extension for 10 trials and from maximal flexion for 10 trials.

Thirty-nine healthy subjects (24 women, 15 men) volunteered as controls, and all were free of cervical pain or had no history of whiplash injury.

Oculomotor Test

Computer controlled horizontal eye movement oculomotor tests were recorded by bitemporally placed surface electrodes and were performed for all subjects 2 years after whiplash injury. They were compared with 25 healthy controls without a history of a soft tissue injury of the neck or a head injury.

Active cervical range-of-motion was measured with the CROM instrument.

RESULTS

Active head repositioning was significantly less precise in the whiplash subjects than in the control group.

Compared with healthy subjects, whiplash subjects showed significant repositioning errors in all directions.

Whiplash subjects with complaints of dizziness showed a higher repositioning error compared to whiplash subjects without dizziness.

Whiplash subjects who claimed radiculopathy symptoms (pain radiation, weakness, sensoric disturbances) showed greater failure in horizontal repositioning (overshooting) compared to whiplash subjects without radiculopathy claims.
"A significantly lower range of active motion in the sagittal plane (flexion/extension) occurred for the group with repositioning dysfunction, compared to the group with normal repositioning."

Oculomotor Test

Sixteen whiplash patients (62%) showed pathologic failures in oculomotor function. There was a significant association between oculomotor dysfunction and repositioning dysfunction. Patients with oculomotor dysfunction were less accurate in head repositioning than were persons with normal oculomotor performances.

“Oculomotor test results showed significantly more aberrations for women than for men 2 years after trauma.”

DISCUSSION

“Our study was concerned with the capacity of patients with whiplash injury to relocate the head in space after an active displacement by moving the head away from a reference position. Repositioning dysfunction was present in 62% of subjects with whiplash trauma 2 years after the trauma. Patients with whiplash injury return the head to the reference position with significantly less accuracy than healthy subjects. Some arguments suggest that the neck kinesthetic sensibility is mainly involved in this inaccuracy. The whiplash subjects showed less accuracy in vertical plane repositioning movements, which might be explained by the hyperextension/hyperflexion trauma mechanism. Overshooting could indicate a lack of proprioceptive information and a search for additional proprioceptive information coming from stretched antagonist muscles, constituting a type of overshooting by 'confirmation'."

“Experimental, clinical, and histologic examinations have verified lesions of the brain stem after whiplash injury. Oculomotor dysfunction similar to that observed in patients with brain stem lesions has been described in acute injuries as well as in chronic whiplash patients.”

“These results suggest that restriction of cervical movement and changes in the quality of proprioceptive information from the cervical spine region affect voluntary eye movement.” [Important]

Other studies illustrate the presence of mechanoreceptive and nociceptive nerve endings in cervical facet capsules proving that these tissues are monitored by the central nervous system and implying that neural input from the facets is important to proprioception and pain sensation in the cervical spine. In our study significant correlations occurred between active range of cervical motion and oculomotor performances as well as kinesthetic sensibility, which could indicate that the zygapophysial joints' dysfunction mediates this proprioceptive dysfunction.
“For whiplash subjects age and sex seem to correlate with cervical kinesthetic performances and with oculomotor functions. This fact could indicate that elderly people and women are more vulnerable to injuries affecting the proprioceptive systems.”

Increased muscle spindle sensitivity may be mediated by the sympathetic nervous system acting on the intrafusal fibers of the muscle spindles. The increased sensitivity of the muscle spindles may give rise to erroneous proprioceptive signaling, especially if spindles in different neck muscles or on different sides of the neck are unequally sensitized. [Important: increased sustained sympathetic tone.]

Erroneous cervical proprioceptive information converges in the central nervous system with vestibular and visual signals, with a consequent feeling of dizziness or unsteadiness caused by a distorted mental representation of body orientation and by a misinterpreted relation to surroundings. In our study, whiplash subjects with complaints of dizziness showed greater repositioning error than subjects without dizziness.

CONCLUSION

“Proprioceptive dysfunction might be one of the most important factors for understanding the morbidity after a noncontact whiplash trauma to the neck.” [Key Point]

“Some of the patients who claimed no symptoms after trauma showed oculomotor dysfunction and repositioning dysfunction. Neck pain measured with VAS did not correlate significantly with oculomotor performance and kinesthetic sensibility in this study. These results point to a multifactorial background of the chronic morbidity after whiplash trauma.”

The results suggest that restricted cervical movements and changes in the quality of proprioceptive information from the cervical spine region affect voluntary eye movements. A flexion/extension injury to the neck may result in dysfunction of the proprioceptive system. Oculomotor dysfunction after neck trauma might be related to cervical afferent input disturbances. [Very Important]

COMMENTS FROM DAN MURPHY

[This is a good article that uses the same neurological model that we use:

* trauma to the cervical spine
* reduced cervical range of motion
* abnormal cervical joint proprioception
* altered input into the vestibular nucleus
* resulting in abnormal oculomotor function with blurred vision, and related
* pain, headache, vertigo, nausea, emotional and cognitive disturbances]