Trunk Sway Measures of Postural Stability During Clinical Balance Tests in Patients With Chronic Whiplash Injury Symptoms

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FROM ABSTRACT:

Study Design.
Trunk sway occurring during clinical stance and gait tasks was compared between a group of subjects with a chronic whiplash injury, resulting from an automobile collision, and a normal collective.

Objectives.
To examine if population specific trunk sway patterns for stance and gait could be identified for chronic whiplash injury patients.

Methods.
25 subjects with history of whiplash injury and 170 healthy age-matched control subjects participated in the study.

Trunk sway angular displacements in chronic whiplash patients were assessed for a number of stance and gait tasks similar to those of the Tinetti and Clinical Test of Sensory Interaction and Balance (CTSIB) protocols.

We used a lightweight, easy-to-attach, body-worn apparatus to measure trunk angular displacements and velocities in the roll (lateral) and the pitch (forward-backward) planes.

Results.
Data analysis revealed several significant differences between the two groups.

A pattern could be identified, showing greater trunk sway for stance tasks and for complex gait tasks that required task-specific gaze control such as walking up and down stairs.

Conclusions.
Subjects who have a chronic whiplash injury show a characteristic pattern of trunk sway that is different from that of other patient groups with balance disorders.

Balance was most unstable during gait involving task-specific head movements which possibly enhance a pathologic vestibulo-cervical interaction.
THESE AUTHORS ALSO NOTE:

Approximately 18% to 40% of patients injured in a rear-end automobile collision will develop chronic neck pain.

“Patients with chronic symptoms of pain, restricted upper body movement, and balance disorders after a whiplash injury often need years of therapy and rehabilitation to recover from their infirmity.”

During whiplash, “severe tissue injury to the cervical spine probably occurs in the first 100 milliseconds due to upward movement of the torso and secondary straightening of the cervical spine.”

“It has been postulated that the whiplash motion may cause vestibular receptor damage.”

Suspected injured structures during a whiplash injury including:

- Muscles
- Ligaments
- Fascia
- Intervertebral discs
- Nerves
- Facet joints
- Articular cartilage
- Joint capsules

Some whiplash injuries produce prolonged symptoms consisting of neck and back pain, headaches, dizziness, blurred vision, paraesthesias, and cognitive difficulties.

These symptoms may persist for months or years after whiplash injuries.

Many chronic symptoms from whiplash are associated with deficient balance control.

Human balance is controlled by

1) Vestibular receptors located in the inner ears
2) Visual sensory systems
3) Proprioceptive afferent systems from the muscles and joints

“Postural instability in the form of a falling tendency can result from inappropriate interaction among these three sensory inputs that provide orientation information to the central neural circuits controlling posture.”
“Accompanying the trauma due to a whiplash injury may be injury to the sensory receptors innervating or surrounding the cervical structures.”  

“The receptors for proprioception in the neck include joint receptors, Golgi tendon organs, as well as muscle spindles that are present in high density in the intervertebral muscles and dorsal muscles.”

“Afferents from these muscles have a profound effect on postural reflexes.”

“A deficit in this afferent input could well cause a pathologic interaction within the vestibulospinal system leading to an inappropriate control of balance or eye movements.”

“Unsteadiness or vertigo associated with the interaction of vestibular and neck afferent input could also be due to a direct damage to the brain, the brain stem, the cranial nerves, or the inner ear labyrinthine structures.”

“All these different structures could be affected in the whiplash injury.”

Whiplash trauma can cause an otolith crystal dislocation that then leads to short episode of vertigo due to a benign paroxysmal positional nystagmus (BPPN).

“A direct concussion of the brain stem can lead to a central vestibular dysfunction.”

“Proprioceptive deficiency within neck muscles may influence vestibular nuclei responses in a way that could lead to vertigo.”

Complaints of vertigo or dizziness following whiplash range between 20.8% and 85%.

The whiplash injured patients in this study showed genuine whiplash-associated disorders, including:
reduced neck movement, cervico-cephalic symptom complex (i.e., neck pain, neck muscle stiffness, headache, shoulder pain), paraesthesias, vegetative dysregulation (i.e., sweating attacks at night or day, nausea, vomiting), vertigo, tinnitus, muscular dysbalance (i.e., muscle stiffness in the lower and upper back).

8 of the patients were Quebec Task Force on Whiplash class II disorder and the other 17 patients were class III.

The time between injury and entry into the clinic was 2.2 years on average.

The mean initial pain score on a 1 to 10 visual analog scale (VAS) was 5.1.
Trunk sway was measured with two angular velocity transducers.

Measurement Tasks performed on these patients included:
Standing on 2 legs for 20 seconds with eyes open and then eyes closed, on both a solid surface and then on a foam surface.

The same tasks were performed with a 1-legged stance.

Then, walking approximately five steps with the eyes closed, or while horizontally rotating the head in rhythm with stepping or while vertically pitching the head in rhythm with stepping was performed.

Also, walking up a set of stairs with no handrails was performed.

Dizziness Handicap Inventory

“To provide a subjective assessment of the patients balance problems, we asked them to answer translated questions from the Dizziness Handicap Inventory (DHI).”

The DHI was developed as a self-assessment tool to quantify the impact of dizziness on the patient's everyday life.


RESULTS

“The balance of whiplash-associated disorder (WAD) patients, as measured by the deviations of the trunk in the pitch and roll directions, could be characterized by a pattern of sway highly dependent on the type of task. That is, trunk sway for stance tasks, simple gait tasks with head movements, and for more complex gait tasks such as walking up and down stairs, differed in a characteristic way from that of normal subjects in a manner unlike patterns we have noted for either the elderly or vestibular-loss subjects.” [IMPORTANT]

In chronic whiplash patients, one-legged stance tasks showed a significant reduction in duration both for eyes open and closed on a normal support surface.

“ Asking subjects to perform head rotations while walking directly tests the ability of subjects to walk normally while cervical and vestibular systems are being additionally stimulated.”

“The typical whiplash injury patient rotates the head and the trunk less.”

Measuring sway as noted above accurately classified 64% of the whiplash patients and 99.4% for the normal controls. [IMPORTANT]

Dizziness Handicap Inventory
“The score of the DHI gives an idea of the frequency of subjective dizziness occurrences in the subjects.”

A patient suffering from occasional attacks of dizziness (<12 times/yr) had a DHI mean score of 24.8.

“If the patient was suffering from reoccurring but not continuous vestibular problems (>12 times/yr), the mean score was 34.2.”

“For continuous dizziness, the score was 49.1.

“In our group of whiplash patients, the mean score was 65.5.” [WOW!]

“Two thirds of the subjects had a score greater than 49.1, indicating a considerable self-perceived handicap; 87.5% had a score higher than 24.8, a level indicating at least a slight handicap caused by the vertigo.”

DISCUSSION

“Our tests with patients who had a chronic WAD revealed a characteristic pattern of trunk sway not seen in previous groups of patients we have tested.”

“The roll angle instability walking up stairs proved to be the most significant marker distinguishing WAD patients from normal controls.”

Whiplash “patients have difficulty combining visual, vestibular, and neck proprioceptive signals to generate balance control commands.”

“Both vestibular and cervical [proprioceptive] effects are generally counteracting.” [IMPORTANT]

Consequently the reduced [proprioceptive] cervical input as a result of neck trauma might lead to a relative increased in vestibular activity.

KEY POINTS FROM AUTHORS

1) Subjects who have a chronic whiplash injury show patterns of trunk sway for stance and gait tasks that are different from that of controls and other patient groups with balance disorders (like the elderly).

2) Balance was unstable standing eyes open but was most unstable during gait with task-specific gaze control, which possibly enhances a pathological vestibulo-cervical interaction.

3) Measuring trunk sway is a simple way to quantify a balance control problem.
KEY POINTS FROM DAN MURPHY

1) 18% to 40% of patients injured in a rear-end automobile collision will develop chronic neck pain.

2) Subjects who have a chronic whiplash injury have a pattern of trunk sway that is different from that of normal controls or other patient groups with balance disorders like the elderly.

3) Patients with chronic whiplash symptoms often need years of therapy and rehabilitation to recover from their infirmity.

4) During whiplash, the injury to the cervical spine probably occurs in the first 100 milliseconds.

5) Chronic whiplash injuries include neck and back pain, headaches, dizziness, blurred vision, paraesthesias, and cognitive difficulties.

6) The cervical spine proprioceptive afferent systems can be injured and become dysfunctional following whiplash injury, resulting in vertigo, dizziness, and balance problems.

7) Post-whiplash abnormal afferent input could cause a pathologic interaction within the vestibulo-spinal system leading to an inappropriate control of balance or eye movements.

8) Cervical proprioceptive afferents inhibit the vestibular nucleus.

9) Reduced cervical proprioceptive input (chiropractic subluxation complex) as a result of neck trauma would increases vestibular activity (dizziness and balance problems).

COMMENT:

This article provides more support for the model that whiplash injures cervical spine soft tissues that contain mechanoreceptors, resulting in abnormal sensory input into the central neural axis, including the vestibular nucleus. Chiropractors refer to the abnormal mechanical afferent input as nerve interference.