

The Role of the Cervical Spine in Post-concussion Syndrome

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Cameron M. Marshall, Howard Vernon, John J. Leddy, Bradley A. Baldwin

Canadian Memorial Chiropractic College.
State University of New York at Buffalo.

This study has 116 references.

This paper reviews the existing literature surrounding the numerous proposed theories of PCS (post-concussive syndrome) and introduces another potential, and very treatable, cause of this chronic condition; cervical spine dysfunction due to concomitant whiplash-type injury.

The authors discuss the cases of 5 patients with diagnosed PCS, who experienced very favorable outcomes following various treatment and rehabilitative techniques aimed at restoring cervical spine function; treatment included spinal manipulation.

These authors propose that a cervical injury, suffered concurrently at the time of the concussion, acts as a "major symptomatic culprit in many PCS patients."

KEY POINTS FROM THIS ARTICLE:

- 1) "Concussion injuries, or mild traumatic brain injury (mTBI), have an estimated prevalence of 3.8 million per year in the United States."
- 2) Concussions are one of the least understood injuries facing sports medicine and neuroscience today.
- 3) The post-concussion syndrome (PCS) is the chronic phase of concussion. The patient is considered to be chronic when symptoms persist longer than 4-12 weeks. This occurs in about 10–15% of concussed patients.
- 4) "In the majority of cases, concussion symptoms resolve within 7–10 days; however, approximately 10–15% of these patients develop persistent symptomatology lasting weeks, months or even years after injury."
- 5) "Any significant blunt impact and/or acceleration/deceleration of the head will also result in some degree of inertial loading of the neck potentially resulting in strain injuries to the soft tissues and joints of the cervical spine."
- 6) "Acceleration/deceleration of the head–neck complex of sufficient magnitude to cause mTBI is also likely to cause concurrent injury to the joints and soft tissues of the cervical spine."

- 7) A proposed mechanism for persisting symptomatology following concussion (the post-concussive syndrome) is “concomitant low-grade sprain–strain injury of the cervical spine occurring concurrently with significant head trauma.”
- 8) The range of linear impact accelerations causing concussion injury is between 60–160 G, with the peak occurring at 96.1 G. Whiplash injuries can occur at accelerations of 4.5 g. Thus it is highly likely that individuals who experience the G forces to sustain a concussion will also experience cervical spine injury.
- 9) It has been known since 2006 that brain-injured athletes concurrently injure their cervical spines.
- 10) “Injury or dysfunction of the cervical spine has been shown to cause headaches, dizziness and loss of balance, nausea, visual and auditory disturbances, reduced cognitive function, and many other signs and symptoms considered synonymous with concussion.”
- 11) There is considerable overlap of the signs and symptoms of mild traumatic brain injury and of whiplash injury:

Signs and Symptoms of Concussion	Signs and Symptoms of Whiplash Associated Disorders
Headache Pressure in Head	Headache
Neck pain	Neck/shoulder pain Reduced/painful neck movements
Nausea/vomiting	Nausea/vomiting
Dizziness Balance problems	Dizziness Unsteadiness
Blurred Vision Sensitivity to Light	Vision problems
Difficulty remembering Confusion Feeling Like “In a Fog” Difficulty Concentrating	Memory problems Problems Concentrating
Sensitivity to Noise	Ringing in Ears
Feeling Slowed Down “Don’t Feel Right” Nervous / Anxious / Irritable Sadness / More Emotional Fatigue / Low Energy /Drowsiness Trouble Falling Asleep	Reduced/painful Jaw Movements Numbness, Tingling or Pain in Arm or Hand Numbness, Tingling or Pain in Leg or Foot Difficulty Swallowing Lower back pain

12) It is “well established that injury and/or dysfunction of the cervical spine can result in numerous signs and symptoms synonymous with concussion, including headaches, dizziness, as well as cognitive and visual dysfunction; making diagnosis difficult.”

13) During concussive injury to the brain, neurons undergo stretch and shear forces that cause mechanical disruption of the cell structure, “leading to glutamate release and subsequent mitochondrial calcium (Ca²⁺) overload resulting in impaired oxidative metabolism and reduced ATP production.”

14) “To restore proper ion balance within the cell, the ATP pump is activated to a greater capacity requiring large amounts of ATP. The imbalance between increased ATP requirements, decreased ATP production and reduced cerebral blood flow quickly leads to an energy crisis within the brain known as spreading depression.”
[thus, the importance of chiropractic adjusting and low-level laser therapy]

15) The symptoms of concussion are due to neuronal dysfunction and not due to structural damage of the involved neurons, which is “why conventional structural imaging techniques such as CT and MRI are typically unremarkable.”

16) These authors review 5 proposed theories to account for the PCS:

Theory 1: Continued metabolic dysfunction.
 Continued reductions in ATP production.

Symptom recovery from a single concussion may take 3–8 days, but return to pre-concussion ATP production may take 30 days (the metabolically depressed state).

Suffering a second concussion during this metabolically depressed state significantly increases symptom durations to 24–59 days, and normalization of ATP production is from 60–120 days.

This highlights the importance of achieving full recovery before returning to sporting activity.

Theory 2: Continued axonal dysfunction

Diffusion tensor imaging (DTI) is an advanced imaging technique that assesses the integrity of white matter tracts.

“The neuronal shearing that occurs with impact as well as the subsequent ion imbalance and Ca²⁺ overload, can alter the cellular environment and brain function due to suggested myelin loss, microscopic lesions and axonal degeneration.”

Theory 3: Psychological factors

Preexisting psychological disturbances such as depression and anxiety increase the risk of developing PCS.

Theory 4: Altered cerebral blood flow [**important for chiropractors, Ogura study**]

Continued reductions in cerebral blood flow and oxygenation secondary to autonomic nervous system dysfunction; known as cerebral hypoperfusion.

Single positron emission computed tomography (SPECT) is used to examine cerebral blood flow using radioactive tracers.

Theory 5: A cervicogenic component to concussion injuries:

- “The symptoms of headache and dizziness, so prevalent in concussion-type injuries, may actually be the result of cervicogenic mechanisms due to a concomitant whiplash injury suffered at the same time.”
- The cervicogenic mechanisms of concussion-type symptoms involve both nociception and proprioception.
- Numerous brain stem structures receive mono-synaptic inputs from the C2 dorsal root ganglion afferents, including:

Lateral cervical nucleus

Central cervical nucleus

Caudal projections to C5 level

Cuneate nucleus, lateral cuneate nucleus

Nucleus tractus solitarius

Intercalatus nucleus

Nucleus X of the vestibular system

Trigemino-cervical nucleus (for headache nociception)

- ‘Cervicogenic Vertigo’ is “both [a] monosynaptic and polysynaptic reflex pathways from the upper cervical spine afferents (associated with a rich innervation from joint and muscle proprioceptors in the cervical spine) to the brainstem structures associated with balance.”
- Cervical ocular and vestibular reflexes can “initiate balance disturbances and symptoms associated with this [post-concussive] problem.
- Cervicogenic headache has been recognized for decades.
- Three prior studies have also concluded that injuries of the cervical spine are responsible for post-concussion syndrome, and have shown excellent clinical outcomes as a consequence of treatment to the cervical spine.

17) These authors present 5 case studies of patients diagnosed with post-concussive syndrome who were treated successfully in a chiropractic clinic. Their improvement was rapid and documented using standard measurement outcomes, and the results were long-lasting. Treatment included:

- Active Release Therapy (ART)
- Localized vibration therapy over the affected muscles
- Spinal manipulative therapy (SMT) of the restricted joints
- Low-velocity mobilizations (on 1 patient)

18) "Management of persistent PCS symptoms through ongoing brain rest is outdated and demonstrates limited evidence of effectiveness in these patients." Instead, there is evidence that "skilled, manual therapy-related assessment and rehabilitation of cervical spine dysfunction should be considered for chronic symptoms following concussion injuries."

COMMENTS FROM DAN MURPHY

This study is timely, but disturbing. It highlights the lack of understanding by athletes, the public, and healthcare providers that it is essentially impossible to sustain a traumatic brain injury without also injuring the soft tissues of the cervical spine. It is anatomically/biologically *probable* that these cervical spine injuries cause many, if not most, of the symptoms of the post-concussion syndrome.

It is also gratifying to see a published study showing that traditional chiropractic management of post-concussive syndrome patients resulted in rapid and sustained improvement in post-concussive signs and symptoms, allowing the athlete to return to full completion.

All patients suffering from the post-concussive syndrome should be referred to a chiropractor for cervical spine evaluation and treatment.