



Injury Briefing

A review of the latest studies from Dr. Michael D. Berry.

Objective Evidence of Whiplash: State of Our Knowledge

A recent literature review from the journal *Spine* examines current whiplash injury models to explore the various ways tissue damage can occur. The authors analyzed existing evidence of tissue damage of the facet joints and capsules, intervertebral discs, dorsal root ganglions, vertebral artery, and muscles.

The biomechanical context for tissue injury

During a rear-end collision, the cervical spine undergoes a horizontal shear force. Although the movement of the neck and head remains largely within physiologic limits, the spine itself experiences abnormal motion, as shown in studies of cadavers and human volunteers. The magnitude of these strains can vary with timing, vehicle, and the person; additionally, some tissues may tolerate injury better than others.

Facet joint injury

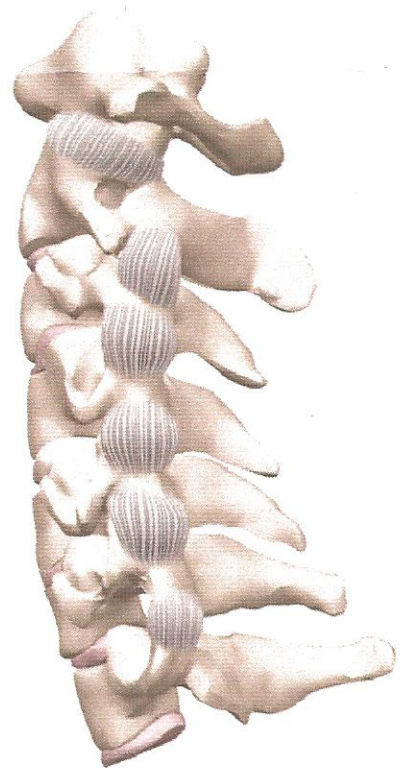
Currently, the strongest evidence for tissue damage can be found in research on facet joint injury. Multiple studies of human cadavers, human volunteers, and animal models have confirmed that injury occurs to the facet capsule. Excessive loading of the facet joints is associated with axonal swelling, collagen fiber disorganization, altered morphology of the ligament, as well as permanent damage to neuronal signaling in the spinal cord. Most importantly, this damage occurs without observable signs of tissue rupture or tearing using conventional medical imaging.

Spinal ligament and disc damage

As the spine is thrust into abnormal motions during whiplash, tearing or damage of the anterior disc and ligament can occur. This process has been observed in cadaver studies but has not been explored in other settings. The researchers suggested further research in this area.

Damage to nerve and dorsal root ganglion

Other than direct nerve impingement, nerve roots and the dorsal root ganglion in the neck are at risk for injury during whiplash. As the neck and head moves rapidly, resistance to blood flow could create pressure gradients in and outside of the spinal canal. These pressure gradients have been shown "to induce plasma membrane breakdown of spinal ganglia nerve cells." The authors concluded this hypothesis, "offers a potential mechanism by which neck, upper limb and/or shoulder girdle pain can result from nerve root injuries and trauma in the neck."



The ligaments of the cervical spine are the likely source of most chronic whiplash pain.

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Vertebral artery damage

A recent study revealed that patients with whiplash are significantly more likely to experience cervical arterial dissections when compared to the general population (1.5% vs. 0.0041%). Yet symptoms of vertebral artery injury may not occur until 4-12 months after an auto collision. Scientists hypothesize that vertebral artery injury can occur during whiplash with cervical spine extension and axial rotation beyond the physiologic limit. This may cause pinching of the vessel or tearing of the intimal layer of the artery during overstretching.

Researchers noted that although vertebral artery injury has been found in cadaver studies, since there has been no further investigation of this process in live human volunteers or animals, more research is needed to validate these findings.

Does muscle injury occur with whiplash?

Muscle pain is commonly reported with whiplash, but it's difficult to image muscle injuries. Research shows that within the first 24 hours after whiplash injury, one study showed that patients had elevated levels serum creatine kinase, a marker of muscle injury. These elevated levels dropped after 48 hours but patients' pain lingered for more than three months. Other research shows that patients with chronic pain show signs of fatty infiltrates in the muscle tissue, indicating dysfunctional neural inputs into the muscle tissue.

Clinical context

This literature review confirms that tissue damage occurs during whiplash despite it being difficult to detect using conventional imaging and radiography. Although small fractures can be detected by CT scans, CT did not reliably detect ligament and tissue damage in one cadaver study.

As researchers continue to grapple with the challenge of proving whiplash injuries, millions of patients continue to suffer from persistent neck pain and whiplash symptoms. Fortunately, most researchers and practitioners "are well past the era when the pain and suffering of whiplash patients was discounted and dismissed." The authors concluded that though "the suffering is real...the search for the cause must continue."

1. *Curatolo M, Bogduk N, Ivancic P, McLean S, Siegmund G, Winkelstein B. The role of tissue damage in whiplash-associated disorders. Spine 2011;36(255):S309-S315.*
2. *Elliott JM, O'Leary S, Sterling M, Hendrix J, Pedler A, Jull G. Magnetic resonance imaging findings of fatty infiltrate in the cervical flexors in chronic whiplash. Spine 2010;35(9):948-954.*