On Cervical Zygapophysial Joint Pain After Whiplash

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Nikolai Bogduk, MD, PhD

FROM ABSTRACT
Objective
To summarize the evidence that implicates the cervical zygapophysial joints as the leading source of chronic neck pain after whiplash.

Summary of Background Data
Reputedly a patho-anatomic basis for neck pain after whiplash has been elusive. However, studies conducted in a variety of disparate disciplines indicate that this is not necessarily the case.

There is convergent validity from (1) whiplash postmortem studies, (2) whiplash biomechanics studies, and (3) whiplash clinical studies indicating that the primary source of chronic whiplash pain is injuries to the cervical zygapophysial joints.

Results
1) Postmortem studies show that a spectrum of injuries can befall the zygapophysial joints in motor vehicle accidents.

2) Biomechanics studies of normal volunteers and of cadavers reveal the mechanisms by which the zygapophysial joints can sustain injury during whiplash.

3) Whiplash studies in cadavers and laboratory animals have produced zygapophysial joints injuries.

4) Clinical studies have shown that zygapophysial joint pain is very common among patients with chronic neck pain after whiplash, and that this pain can be successfully eliminated by radiofrequency neurotomy.

Conclusion
The fact that multiple lines of evidence, using independent techniques, consistently implicate the cervical zygapophysial joints as a site of injury and source of pain, strongly implicates injury to these joints as a common basis for chronic neck pain after whiplash.

DR. BOGDUK ALSO NOTES:

1) “Convergent validity arises when multiple, independent approaches point to the same conclusion,” which allows for greater confidence in the conclusion.
2) In whiplash, four convergent lines of evidence "implicate the cervical zygapophysial joints as the leading source of pain in patients with chronic whiplash-associated disorder."

3) To prepare this paper, Dr. Bogduk used only original data on the topic from his personal library and by searching PubMed with the terms whiplash, neck pain, zygapophysial joint, and injury:

The **postmortem studies** identified a variety of nonlethal injuries:

A) Nerve-root lesions
B) Rim-lesions to the intervertebral discs (the disc is traumatically separated from the cartilaginous end-plate of the vertebral body)
C) Intraarticular hemorrhages
D) Fractures of the facet articular cartilage
E) Fractures of the facet subchondral bone
F) Fractures of the entire facet articular processes

Virtually none of these lesions were seen on postmortem radiography. **[Important]**

"Medical imaging in vivo may fail to identify lesions that are definitely present at postmortem. Consequently, in the context of whiplash injury, normal radiographs, or even normal magnetic resonance imaging, do not mean that the patient has no lesion."

The **human biomechanics studies** identified these injurious mechanisms:

A) The cervical spine undergoes a "highly abnormal" "S" shaped deformation with extension of the lower cervical spine and flexion of the upper cervical spine.

B) During the extension of the lower cervical spine, the anterior margins of the vertebral bodies are widely separated, resulting in an avulsion of the annulus fibrosus from the vertebral endplate (a rim lesion).

C) Also during the extension of the lower cervical spine the inferior facet articular process chisels into the superior facet articular surface of the vertebra below, allowing for the spectrum of lesions to the facet joints.

- The intraarticular meniscoids could be contused or ruptured
- Impaction fractures of the articular processes could occur
- Cadavers studies during whiplash show that the facet joints undergo compression that exceeds physiological limits and the capsules undergo strains beyond normal limits.
- Strains in the annulus fibrosus can exceed normal limits.
Proven Non-lethal Pain Producing Injuries Caused By Whiplash Trauma

From Nikolai Bogduk, MD, PhD

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- Intra-articular Hemorrhage [causes organization, adhesions, fibrosis]
- Facet Capsular Tear
- Meniscoid Contusion [can result in joint motion block, spasm, torticollis]
- Articular Subchondral Fracture [acceleration of cartilage arthritis]
- Fracture of the Articular Pillar
- Disc Tear or Torn From the Vertebral Rim [acceleration of disc degenerative disease, these injuries do not heal (reattach)]
One whiplash study using 21 cadavers found:

- Intervertebral disc injuries 90%
- Tears of the anterior longitudinal ligament 80%
- Tears of the zygapophyial joint capsules 40%

"Collectively, these various biomechanics studies, in normal volunteers and in cadavers, predict or produce the same spectrum of lesions as that identified in postmortem studies. In particular, they indicate that the zygapophyial joints can be injured."

The animal studies also identified facet capsule injury as well as downstream neurophysiological changes that are markers of pain activity.

4) "These studies demonstrate the physiological processes that link biomechanical injury to pain from an injured zygapophyial joint."

5) Cervical medial branch blocks [of the posterior primary rami] are a diagnostic test for pain stemming from a cervical facet joint.

6) The prevalence of neck pain stemming from a facet joint is about 50%, indicating the facet joint is a very common source for neck pain. Dr. Bodguk cites 7 studies showing a prevalence of cervical facet joint pain between 36-67%.

<table>
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<th>Year</th>
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<tr>
<td>1995</td>
<td>Spine</td>
<td>54%</td>
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<tr>
<td>1996</td>
<td>Spine</td>
<td>60%</td>
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<td>2001</td>
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<td>2002</td>
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<td>46%</td>
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<tr>
<td>2008</td>
<td>Pain Physician</td>
<td>39%</td>
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</tbody>
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7) "The zygapophyial joints are the single, most common source of pain in patients with chronic neck pain after whiplash."

8) Dr. Bogduk notes that chronic cervical facet joint pain can be treated with radiofrequency neurotomy (the ablation of the nerves that transmit pain from the injured facet joints). However, he also qualifies the statement with:

- A) Radiofrequency Neurotomy only treats cervical facet pain, which affects about 50% of those suffering from chronic whiplash pain. The other 50% of chronic whiplash pain sufferers are not amenable to the Radiofrequency Neurotomy procedure.

- B) Inclusion criteria for the Radiofrequency Neurotomy procedure requires successful pain relief with diagnostic blocks of the medial branch of the posterior primary rami performed on two separate occasions.
Whiplash injures the *facet* joint. The *facet* joint has nociceptors “R” which are connected to the brain through the medial branches of the posterior primary rami. If diagnostic anesthetic blocking of the medial branch of the posterior primary rami eliminates pain, it indicates the *facet* is the source of the pain. Radiofrequency neurotomy of the *facet* joint capsules coagulates the neurofilament proteins, giving 70% of the patients longer relief of their whiplash pain.
•C) Successful Radiofrequency Neurotomy on appropriately selected patients is about 70%, and the pain relief lasts for a medium of about 400 days. This would mean that the procedure works on about 35% of chronic whiplash patients \([50\% \times 0.7 = 35\%]\) for about 400 days on average. Dr. Bogduk notes that if/when the pain returns, the procedure can be repeated.

•D) “Medial branch blocks and radiofrequency neurotomy cannot be performed other than by specially trained, medical practitioners,” and there are very few medical practitioners who are properly trained and qualified to do these procedures. “Few practitioners around the world are skilled in these procedures; and among those who purport to be skilled, there is no guarantee that they perform the procedures properly.” “The available evidence indicates that good outcomes can only be expected if those guidelines are followed.”

•E) Some medical practitioners that claim to do these procedures do not follow the proper guidelines, performing it “irresponsibly if not fraudulently.”

•F) Radiofrequency neurotomy outcomes in patients pursuing litigation are about the same in patients not involved in litigation.

•G) Appropriately selected and performed radiofrequency neurotomy has also been successful in treating chronic facet derived cervicogenic headache.

9) There is an extensive amount of evidence indicating that post-whiplash pain syndrome is attributed to injury to the cervical facet joints; no other explanation for whiplash pain has more evidence.

KEY POINTS FROM DR. BOGDUK:

1) Biomechanical studies implicate injury to the facet joints in whiplash.

2) Animal studies show that facet joints produce pain.

3) Clinical studies show that facet joint pain is common.
COMMENTS FROM DAN MURPHY:

This study reiterates:
Many involved in a whiplash injury develop chronic neck pain. This chronic whiplash-generated neck pain does not seem to be associated with litigation status. The primary injury and source of pain in the chronic whiplash patient is the facet joint. It is highly unlikely that the pain producing facet joint injury, including fractures, are discernable with either radiography or MR imaging. For facet joint pain to be definitely ruled-in or ruled-out, the patient must undergo, on two separate occasions, medial branch blocks of the posterior primary rami.

Although Dr. Bogduk is advocating radiofrequency neurotomy ablation of the facet joint nerves as the best treatment option in the management of chronic whiplash pain, it should be understood that:
1) only about 50% of chronic whiplash patients are appropriate for this procedure
2) it only works on about 70% of those judged to be appropriate candidates for the technique, and
3) the effective pain relief is for about 400 days

Chiropractic adjusting affects many tissues but primarily the facet joints.

There are several studies indicating that chiropractic spinal adjusting is more effective that radiofrequency neurotomy ablation in the treatment of the chronic whiplash patient:
1) The Woodward study was 93% effective (Article Review #40-07) [Chiropractic treatment of chronic ‘whiplash’ injuries; Injury; Volume 27, Issue 9, November 1996, Pages 643-645]
2) The Khan study was 74% effective (Article Review #45-99) [A symptomatic classification of whiplash injury and the implications for treatment; The Journal of Orthopaedic Medicine; Volume 21(l), 1999, pp. 22-25]

Consequently, I believe that chiropractic spinal adjusting should be performed on all chronic whiplash patients prior to having the patient undergo medial branch blocks of the posterior primary rami and radiofrequency neurotomy ablation of the facet joints.

OTHER CONCERNS

Radiofrequency ablation of the facet joints not only stops nociception but also stops mechanoreception. Many chiropractors, including myself, and other providers, are concerned that ablation of the mechanoreceptors may adversely affect local neuromuscular reflexes controlling stability and therefore the incidence of future joint degeneration, as well as adversely affecting central summation and central neurological function.