Recurrence and Chronicity of Cervical Soft-Tissue Injury

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Steven B. Ross, D.C., F.A.S.B.E., D.A.A.P.M.

Chiropractic Physician • Independent Medical Examiner • Forensic Spine Biomechanics Expert

Professional Contact Information

drross@drstevenrosscom
858-544-1494
www.drstevenross.com
San Diego, CA 92127

This manuscript is intended for clinical reference, forensic evaluation, expert witness testimony, medico-legal documentation, IME, causation analysis, and evidentiary preparation.

Expert Disclosure & Legal Disclaimer

This manuscript is a scientific and forensic reference document. It reflects the author's biomechanical analysis, clinical interpretation, and application of accepted medico-legal methodologies. It is not a substitute for individualized medical evaluation or legal counsel.

Under Rule 702 and *Daubert v. Merrell Dow Pharmaceuticals*, expert opinions using this material must be based on:

- sufficient facts and data
- reliable principles and methods
- transparent application to case-specific facts

No statement in this work constitutes a universal causation claim or a conclusion regarding any specific patient or event. Use in litigation must include case-specific evaluation and correlation.

About the Author

Steven B. Ross, D.C., F.A.S.B.E., D.A.A.P.M.

Dr. Steven Ross is a Chiropractic Physician, Independent Medical Examiner, and Expert Witness specializing in spinal biomechanics, soft-tissue trauma, and medico-legal documentation. With more than four decades of clinical, diagnostic, and forensic experience, Dr. Ross has provided expert analysis in cases involving motor-vehicle trauma, acceleration–deceleration injuries, ligament failure, facet capsule injury, stroke/alleged manipulation injury, and disputed standards of care.

He is a Fellow of the American Academy of Applied Spinal Biomechanical Engineering and a Diplomate of the American Academy of Pain Management, with advanced training in pathobiomechanical syndromes, spinal stabilization biomechanics, and applied mechanical injury analysis.

Dr. Ross is recognized for his ability to translate complex biomechanical phenomena into clear, court-comprehensible explanations for legal professionals, insurers, and medical evaluators.

Abstract

Cervical soft-tissue trauma commonly leads to symptoms that recur or persist after the initial event. A reproducible subset of patients with whiplash-associated disorders progresses to chronic symptoms despite early conservative care. Objective evidence from clinical assessment, standard MRI, cohort imaging studies, and selected adjunctive tests supports peripheral soft-tissue micro-failure with altered segmental mechanics and secondary neuroplastic changes as plausible drivers of recurrence, findings that can be framed in a routine medico-legal opinion.

Mechanism of injury

Rear-end collisions produce rapid head and neck motion that overstretches and compresses cervical soft tissues. Even low-speed impacts can stretch facet joint capsules, annular fibers, and ligaments beyond their normal limits, producing microscopic tears, segmental laxity, and altered mechanics that can recur when stressed. Experimental models and cadaver studies demonstrate this pattern of tissue overload and segmental change, providing a mechanistic explanation for clinically observed instability and intermittent symptom recurrence.[1-3]

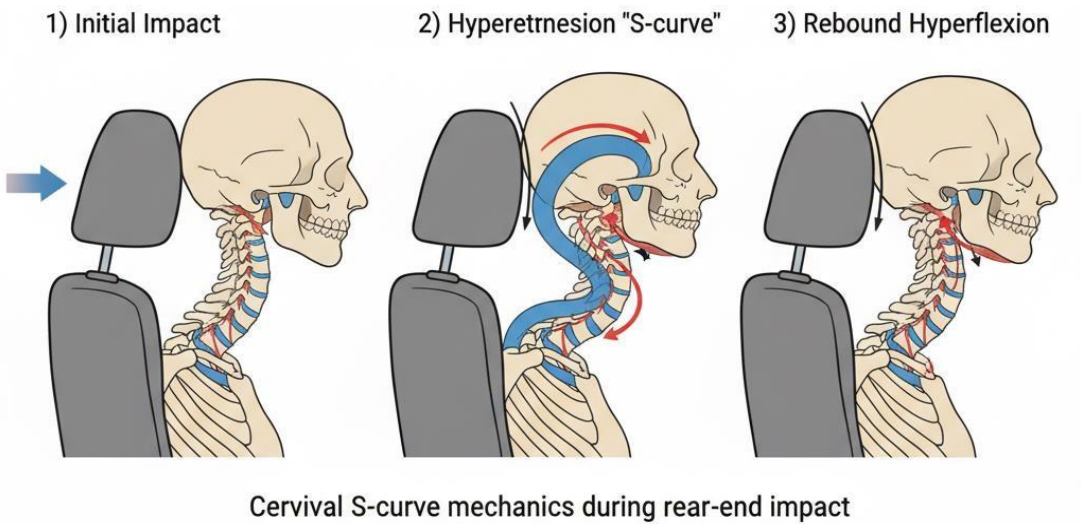

Figure 1: (1) initial impact → (2) hyperextension "S-curve" → (3) Rebound Hyperflexion

Table 1: Simplified biomechanical correlates (Structure Injured | Mechanism | Clinical Effect | Key References)

Structure Injured	Mechanism	Clinical Effect	Key References
Facet joint capsule	Overstretch of capsular fibers during rapid extension/compression	Localized neck pain, focal tenderness, episodic mechanical catching and reduced segmental control	Siegmund2001[2] Pearson 2004 [5]
Disc annulus	Shear and compression causing annular micro-tears or bulging	Referred pain patterns, stiffness, intermittent radicular- type symptoms with movement	Ito 2004 [6] Ivancic 2014 [4]
Anterior longitudinal ligament and other cervical ligaments	Rapid tensile loading with micro-failure of collagen fibers	Segmental laxity, altered range of motion, susceptibility to recurrent symptoms with load	Ivancic 2014 [4]
Paraspinal muscle	Reflexive overload and strain with altered recruitment	Persistent muscular pain, fatigability, reduced endurance on clinical testing	Persad 2021 [7]

Clinical course and recurrence

High-quality cohort and registry data show consistent long-term morbidity following WAD. While reported prevalence of persistent symptoms varies by methodology and case definition, multiple large cohorts and systematic reviews report that roughly 30–50% of patients will continue to experience recurrent or ongoing neck pain at 3–5 years post-collision; a smaller but clinically significant subset report severe disability.

Variation across studies is explained by differences in baseline risk, psychosocial context, compensation systems, and outcome measures, but the signal that a non-trivial minority develop chronicity is robust. Where available, long-term pain correlates with microstructural abnormalities on advanced imaging and with objective kinematic and neurophysiologic findings.[1]

Diagnostic correlates

MRI (standard 1.5 T or 3 T sequences) should be treated as the primary routine imaging tool for clinical and forensic assessment because it detects soft-tissue and disc pathology most applicable in ordinary practice.

Advanced modalities such as DTI, QST, and sEMG are best described as adjunctive or research-level tools that can add supportive information but are not standalone diagnostic thresholds.

Table 2: Practical diagnostic comparison for post-traumatic cervical assessment

Modality	Routine Clinical Use	Adjunctive/Research Role	Key Caveats / Representative References
MRI (standard T1/T2/PD)	Primary imaging for clinical assessment of soft-tissue and disc changes	N/A	Operator and sequence dependent; useful for ruling in structural correlates when present. Anderson SE 2012.[8]
Clinical history and physical examination	Core assessment for mechanism, temporal pattern, and functional deficits	N/A	Essential first-line evidence; reproducibility improved with standardized protocols.
Functional tests (range-of-motion, segmental provocation, strength/endurance tests)	Routine bedside/clinic measures to demonstrate mechanical findings	N/A	Technique-sensitive; increases clinical plausibility when consistent with imaging.
DTI / advanced 3D MRI	Not routine; used as adjunct when standard MRI is inconclusive	Research/adjunct to demonstrate tract-level or ligamentous signal changes	Normative databases immature; interpret with caution. Jang 2018. [9]
Surface EMG (sEMG)	Not routine; may be used in specialized clinics with strict protocol	Adjunct for muscle recruitment pattern analysis	High technique sensitivity and variable classifier results; protocol crucial. DeVocht 2005. [10]
Quantitative Sensory Testing (QST)	Not routine; used as adjunctive phenotype/prognostic tool	Adjunct for detecting sensitization and small-fiber dysfunction	Test panel dependent; useful for mechanism/phenotype rather than binary diagnosis. van Driel 2024. [11]

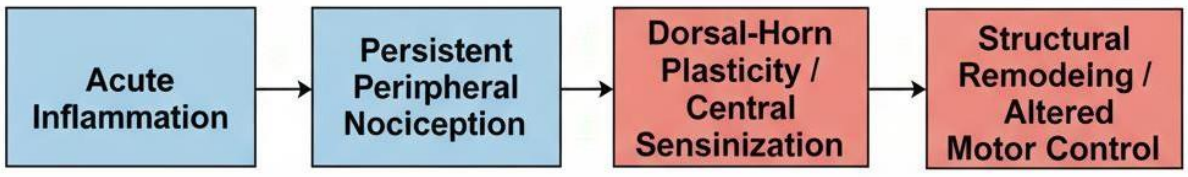

Figure 2: Flow diagram: The progression from acute inflammation to altered motor control

DTI and advanced 3D MRI sequences have demonstrated tract-level and ligamentous signal abnormalities in selected WAD cohorts; however, normative DTI spinal databases remain immature, which limits the interpretive certainty for single-patient extremes. Surface EMG and QST provide reliable adjunctive functional data but are technique-sensitive and must be interpreted with established protocols to minimize false positivity.[3]

Discussion

The corpus supporting recurrence contains strong, reproducible elements and important limitations:

- **Strengths.** Reproducible mechanical thresholds in cadaveric and model systems; convergent imaging and kinematic evidence in cohorts with persistent symptoms; clear mechanistic plausibility linking peripheral micro-failure to central sensitization.[2]
- **Limitations.** Heterogeneous case definitions; selection and compensation bias in some datasets; evolving imaging standards (DTI parameter heterogeneity) that limit cross-study comparability; and absence of large, randomized trials isolating the effect of early interventions on long-term recurrence. Importantly, diagnostic metrics vary with timing post-injury and operator technique, which is a critical caveat for forensic interpretation (Bohman et al., 2012).

Clinical application, therefore, depends on a simple triangulation: history and exam findings that match a plausible mechanical mechanism, routine MRI corroboration when present, and cautious use of adjunctive tests to support a clinical phenotype. When objective signs are absent on routine assessment, experts should state the probabilistic limits of inference rather than asserting categorical causation.

Clinical Application

Clinical interpretation should rest on a structured triangulation of evidence:

(1) a documented history and examination consistent with a biomechanically plausible mechanism of injury.
(2) corroborative findings on standard MRI when available; and
(3) selective use of validated adjunctive tests that reinforce the clinical phenotype.

In the absence of objective corroboration, expert reports should delineate the probabilistic boundaries of inference and avoid categorical claims of causation.

Legal and Forensic Implications

For admissibility and evidentiary weight in medicolegal contexts, documentation should include:

(4) a biomechanical mechanism aligned with event parameters and validated thresholds summarized in Table 1;

(5) a temporal pattern and symptom recurrence consistent with known injury models;

(6) diagnostic findings interpreted in light of modality-specific accuracy and known error rates outlined in Table 2; and

(7) a differential assessment addressing degenerative, pre-existing, or non-traumatic contributors.

Expert testimony is most valuable when uncertainty is explicitly quantified through confidence ranges and stated diagnostic limitations rather than categorical conclusions.

Table 3: Reliability Considerations for Forensic Opinions on Symptom Recurrence

Criterion	Meaning	Application
Clinical Testability	The method can be examined and replicated in a clinical setting.	Use established physical exam and imaging findings that can be verified by other clinicians.
Known Variability	The inherent limitations and error rates of diagnostic methods are acknowledged.	Cite the known strengths and weaknesses of clinical tests and imaging used in the case.
Relevance to Facts	The opinion directly links the injury mechanism to the patient's specific symptoms and findings.	Ensure the clinical picture aligns with the described event and subsequent symptom pattern.

Summary

A convergent body of clinical, imaging, and biomechanical evidence supports recurrent and chronic symptom states following cervical soft-tissue trauma. These phenomena are mechanistically plausible, observable in clinical practice, and diagnosable with established modalities when applied rigorously. For clinical and forensic purposes, the most defensible opinions integrate the injury event, clinical timeline, objective findings with known limitations, and consideration of alternative causes.

Bibliography

[1]. De Zoete RMJ, Coppieters I, Farrell SF. Editorial: Whiplash-associated disorder—advances in pathophysiology, patient assessment and clinical management. *Front Pain Res.* 2022;3:1071810. doi:10.3389/fpain.2022.1071810

[2]. Siegmund GP, Myers BS, Davis MB, Bohnet HF, Winkelstein BA. Mechanical evidence of cervical facet capsule injury during whiplash. *Spine.* 2001;26(19):2095-2101. doi:10.1097/00007632- 200110010-00010

[3]. Budzik J, Balbi V, Verclytte S, Pansini V, Thuc VL, Cotten A. Diffusion tensor imaging in musculoskeletal disorders. *Radiographics.* 2014;34(3):E56-E72. doi:10.1148/rg.343125062

[4]. Ivancic PC. Cervical spine instability following axial compression injury: a biomechanical study.

Orthop Traumatol Surg Res. 2014;100(1):127-133. doi:10.1016/j.otsr.2013.10.015.

[5]. Pearson AM, Ivancic PC, Ito S, Panjabi MM. Facet joint kinematics and injury mechanisms during simulated whiplash. Spine. 2004;29(4):390-397. doi:10.1097/01.BRS.0000090836.50508.F7.

[6]. Ito S, Ivancic PC, Panjabi MM, et al. Cervical intervertebral disc injury during simulated frontal impact. Spine. 2004;29(??): (see paper for full table data). Available at: PMC article.

[7]. Persad LS, Wang Z, Pino PA, et al. Specific tension of human muscle in vivo: a systematic review. J Appl Physiol. 2024;137(4):945-962. (provides pooled estimate ≈26.8 N/cm² and range)

[8]. Anderson SE, Boesch C, Zimmermann H, Busato A, Hodler J, Sturzenegger M. Are there cervical spine findings at MR imaging that are specific to acute symptomatic whiplash injury? A prospective controlled study with four experienced blinded readers. *Radiology.* 2012;262(2):567–575. doi:10.1148/radiol.11102115.

[9]. Jang SH. A review of traumatic axonal injury following whiplash injury: evidence from diffusion tensor imaging and diffusion tensor tractography. *Front Neurol.* 2018;9:57. doi:10.3389/fneur.2018.00057.

[10]. DeVocht JW, Pickar JG, Wilder DG. Spinal manipulation alters electromyographic activity of paraspinal muscles: a descriptive study. *J Manipulative Physiol Ther.* 2005;28(7):465–471. doi:10.1016/j.jmpt.2005.07.002. (Representative methodological anchor for sEMG use and reliability

[11]. van Driel MEC, et al. Quantitative sensory testing: a practical guide and clinical application. [Review / guideline] 2024. (See systematic reviews and practical guides summarizing test-specific diagnostic performance, and cohort QST studies in whiplash.)

