Management of Whiplash Associated Disorders

International Chiropractors Association of California

The participants in the guidelines development process undertaken by the ICAC are:

Charles G. Davis, DC – Editor
Joe Betz, DC
Art Croft, DC, MS, MPH, FACO
Ed Cremata, DC
Deed Harrison, DC
Hugh Lubkin, DC
John Maltby. DC
Dan Murphy, DC, DABCO
James Musick, DC
Bryan Gatterman, DC, DACBR
Shad Groves, DC, DACNB

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ICA of California
9700 Business Park Drive #305
Sacramento, CA 95827
800-275-3515

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Introduction

Injuries from whiplash may give rise to an array of symptoms and complaints. This document is a combination of research and clinical experience for the primary practitioner in a whiplash case.

This document provides a structure for the assessment and treatment of people with WAD during the first 12 weeks following injury and additional care in chronic cases. This document offers a summary of how to apply the recommendations.

As an individual patient can be considered a case study, all levels of evidence were considered, not just randomized control trials.

The Institute of Medicine defines clinical practice guidelines as "Systematically developed statements to assist practitioners' and patient decisions about appropriate health care for specific clinical circumstances". Guidelines are also known as "parameters, practice protocols, practice standards, review criteria and preferred practice patterns"

Field M and Lohr K. Clinical practice guidelines: Directions for a new program. Institute of Medicine. Washington, D.C. National Academy Press; 1990.

Medicare utilization review (UR) protocols, which were statutorily required to be based upon "Professionally developed norms of care, diagnosis, and treatment based upon typical patterns of practice." *(Public Law 92-603, Section 249f, 42 United States Code, Section 1301).*

> *In this document the maxima guidelines are that considered in a complicated case.*
>
> *Most injuries should not require the maxing out of these guidelines.*

Guidelines are designed to support the decision-making processes in patient care. The content of a guideline is based on a systematic review of clinical evidence - the main source for evidence-based care.

Purposes of guidelines

- To describe appropriate care based on the best available scientific evidence and broad consensus;
- To reduce inappropriate variation in practice;
- To provide a more rational basis for referral;
- To provide a focus for continuing education;
- To promote efficient use of resources;
- To Act as focus for quality control, including audit.

It is a guide only and there will always be individual variations.

"Randomized trial information is rarely available to answer questions of etiology, diagnosis, and prognosis, and that only a portion of the clinical issues is appropriate information available."

Sniderman AD. Clinical trials, consensus conferences, and clinical practice. Lancet. 1999 Jul 24;354(9175):327-30.

You must answer 5 questions to successfully apply information to your individual patient.

1. *Are the patients in these trials sufficiently similar to mine?*
2. *Do the outcomes make clinical sense to me?*
3. *Is the magnitude of benefit likely to be worthwhile for my patient?*
4. *What are the adverse effects?*
5. *Does the treatment fit in with my patient's values and beliefs?*

Williams HC. Applying trial evidence back to the patient. Arch Dermatol. 2003 Sep;139(9):1195-200.

I. Introduction

Each patient is an N of 1 clinical trial. An N of 1 is a clinical trial in which a single patient is the entire trial, a single case study.

We found little evidence that estimates of treatment effects in observational studies reported after 1984 are either consistently larger than or qualitatively different from those obtained in randomized, controlled trials.
Benson K, Hartz AJ. A comparison of observational studies and randomized, controlled trials. N Engl J Med. 2000 Jun 22;342(25):1878-86.

The results of well-designed observational studies (with either a cohort or a case-control design) do not systematically overestimate the magnitude of the effects of treatment as compared with those in randomized, controlled trials on the same topic.
Concato J, Shah N, Horwitz RI. Randomized, controlled trials, observational studies, and the hierarchy of research designs. N Engl J Med. 2000 Jun 22;342(25):1887-92.

The outcomes of the 12 large randomized, controlled trials that we studied were not predicted accurately 35 percent of the time by the meta-analyses published previously on the same topics.
LeLorier J, Grégoire G, Benhaddad A, Lapierre J, Derderian F. Discrepancies between meta-analyses and subsequent large randomized, controlled trials. N Engl J Med. 1997 Aug 21;337(8):536-42.

As with many interventions intended to prevent ill health, the effectiveness of parachutes has not been subjected to rigorous evaluation by using randomized controlled trials. Advocates of evidence based medicine have criticized the adoption of interventions evaluated by using only observational data. We think that everyone might benefit if the most radical protagonists of evidence based medicine organized and participated in a double blind, randomized, placebo controlled, crossover trial of the parachute.
Individuals who insist that all interventions need to be validated by a randomized controlled trial need to come down to earth with a bump.
Smith GC, Pell JP. Parachute use to prevent death and major trauma related to gravitational challenge: systematic review of randomised controlled trials. BMJ. 2003 Dec 20;327(7429):1459-61.

There are perhaps 30,000 biomedical journals in the world, and they have grown steadily by 7% a year since the seventeenth century. Yet only about 15% of medical interventions are supported by solid scientific evidence.
Smith R. Where is the wisdom...? BMJ. 1991 Oct 5;303(6806):798-9.

Whiplash Injury

Evidence supports an organic basis for acute and chronic whiplash injuries. A review the anatomical sites within the neck that are potentially injured during these collisions. Include — facet joints, spinal ligaments, intervertebral discs, vertebral arteries, dorsal root ganglia, and neck muscles,

Clinically, whiplash patients present with neck, shoulder, or back pain; headaches; dizziness; paresthesias; vertigo; or cognitive/ psychological symptoms.

The cervical facet joints are the most common source of neck pain.
There are two facet joints between each pair of cervical vertebra from C2 to C7. The facet joint is a synovial joint enclosed by a thin, loose ligament known as the facet capsule. A synovial fold on the inner capsule extends between the margins of the articulating bony surfaces.
Cervical facet joints are innervated by the medial branches of the dorsal primary ramus from the two levels surrounding each joint. Several histologic and anatomic studies have identified mechanoreceptors and unmyelinated nociceptors in the cervical facet joint.
The facet capsule also contains Aδ- and C-fibers, both of which transmit nociceptive singals; i.e., pain.
Nociceptors reactive for substance P and calcitonin gene-related peptide have also been identified in the cervical facet capsules.

Magentic resonance and autopsy studies of whiplash patients have documented injuries to the neck ligaments and intervertebral discs in addition to the facet joints.
Whiplash-related symptoms may be due, in part, to injuries of cervical ligaments and discs and their embedded mechanoreceptive and nociceptive nerve endings. Ligament injuries may cause acute neck pain and lead to chronic spinal instability, and injured echanoreceptors may corrupt normal sensory signals and could lead to abnormal muscle response patterns and decreased neck mobility and proprioception.

No significant correlation was found between delta-V and the QTF grade for any of the collision types. There was no delta-V threshold associated with acceptable sensitivity and specificity for the prognosis of a cervical spine injury.
Elbel M, Kramer M, Huber-Lang M, Hartwig E, Dehner C. Deceleration during 'real life' motor vehicle collisions - a sensitive predictor for the risk of sustaining a cervical spine injury? Patient Saf Surg. 2009 Mar8;3(1):5.

Analysis of data revealed that the rear impact vector crash resulted in 2.8 times greater head linear acceleration than frontal crashes. Rear impact crashes resulted in biphasic, complex kinematics compared to the monophasic, less complex frontal crashes. Rear impact crashes were rated markedly less tolerable. *Croft AC, Haneline MT, Freeman MD. Low speed frontal crashes and low speed rear crashes: is there a differential risk for injury? Annu Proc Assoc Adv Automot Med. 2002;46:79-91.*

A substantial number of injuries are reported in crashes of little or no property damage. Property damage is an unreliable predictor of injury risk or outcome in low velocity crashes. *Croft AC, Freeman MD. Correlating crash severity with injury risk, injury severity, and long-term symptoms in low velocity motor vehicle collisions. Med Sci Monit. 2005 Oct;11(10):RA316-21.*

Healing
Phase **I** (acute inflammation) occurs during the first 72 hours. There is hematoma formation and acute inflammation manifested by swelling, redness, warmth, and pain.
Phase **II** (repair and regeneration) lasts from 48 to 72 hours after the injury until approximately six weeks after the injury. It is characterized by subsidence of inflammation and the beginning of healing.
Phase **III** (remodeling) requires 12 months or more to become maximal. The healing ligament becomes increasingly contracted, and demonstrates increasing tensile strength. The exact timing is unknown in humans but laboratory studies (including some in primates) indicate that maximum ligament scar maturation is not achieved before 12 months. Even then, the original tensile strength is not regained (50% to 70% is the probable range).
Woo SLY, Buckwalter JA. Injury and Repair of Musculoskeletal Soft Tissues. American Academy of Orthopedic Surgeons, 1988. pg. 106.

Range of Symptoms from Whiplash

Generalized hypersensitivity

Those with whiplash symptoms may have a generalized hypersensitivity, extending as far as the lower limbs, when compared with healthy volunteers.

It was suggested that WAD might lead to spinal cord hyperexcitability causing exaggerated pain on peripheral stimulation.

Injury may lead to increases in neuronal activity and prolonged changes in the nervous system.

Chronic pain may be seen as part of a central disturbance accompanied by disinhibition or sensitization of central pain modulation, mirrored in the immune and endocrine systems.

Davis C, JMPT 2001

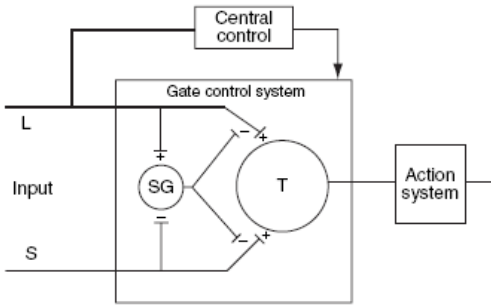


Diagram of the 'Gate Theory of Pain.'
Melzack, R. and Wall, P.D. 1965. Pain mechanisms: a new theory. Science 150, 971–979.

Hypersensitivity

Central hypersensitivity may explain exaggerated pain in the presence of minimal nociceptive input arising from minimally damaged tissues.
Curatolo M, Arendt-Nielsen L, Petersen-Felix S. Evidence, mechanisms, and clinical implications of central hypersensitivity in chronic pain after whiplash injury. Clin J Pain. 2004 Nov-Dec;20(6):469-76.

There is evidence for spinal cord hyperexcitability in patients with chronic pain after whiplash injury and in fibromyalgia patients. This can cause exaggerated pain following low intensity nociceptive or innocuous peripheral stimulation. Spinal hypersensitivity may explain, at least in part, pain in the absence of detectable tissue damage.
Banic B, Petersen-Felix S, Andersen OK, Radanov BP, Villiger PM, Arendt-Nielsen L, Curatolo M. Evidence for spinal cord hypersensitivity in chronic pain after whiplash injury and in fibromyalgia. Pain. 2004 Jan;107(1-2):7-15.

Findings demonstrate generalized hypoesthesia in acute whiplash associated disorders suggesting adaptive central nervous system processing mechanisms are involved, regardless of pain and disability.
Chien A, Eliav E, *Sterling M. Hypoesthesia occurs in acute whiplash irrespective of pain and disability levels and the presence of sensory hypersensitivity. Clin J Pain. 2008 Nov-Dec;24(9):759-66.*

Sensory hypoaesthesia and hypersensitivity co-exist in the chronic whiplash condition. These findings may indicate peripheral afferent nerve fiber involvement but could be a further manifestation of disordered central pain processing.
Chien A, Eliav E, Sterling M. Hypoaesthesia occurs with sensory hypersensitivity in chronic whiplash--further evidence of a neuropathic condition. Man Ther. 2009 Apr;14(2):138-46.

Patients with chronic whiplash syndrome may have a generalized central hyperexcitability from a loss of tonic inhibitory input (disinhibition) and/or ongoing excitatory input contributing to dorsal horn hyperexcitability.
Davis C. Chronic pain/dysfunction in whiplash-associated disorders. J Manipulative Physiol Ther. 2001 Jan;24(1):44-51.

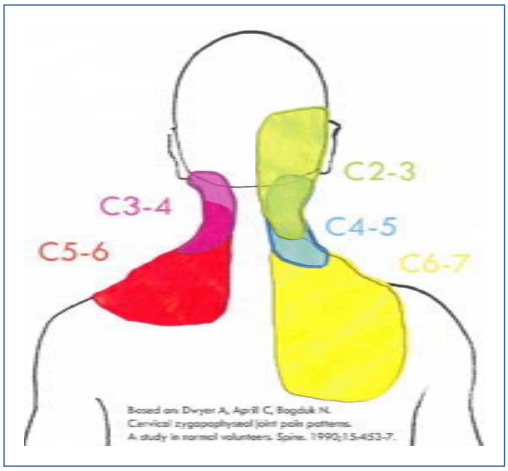
Range of Symptoms from Whiplash

Neck pain

Neck pain is the most commonly reported symptom of WAD. Furthermore specific segmental zygapophyseal (facet) joint blocks have demonstrated that the neck and surrounding tissues are the most common source of chronic pain for people with WAD. People involved in a rear end motor vehicle accident found the most commonly reported symptom was neck pain, followed by headache, neck stiffness, low back pain, upper limb symptoms, dizziness, nausea and visual problems. Tinnitus, temporomandibular joint pain, paraesthesia and concentration or memory disturbance may also be experienced.

Radiating pains to the head, shoulder, arms or interscapular area

Radiating pains to the head, shoulder, arms or interscapular area are often reported at some time post injury. These patterns of somatic referral do not necessarily indicate which structure is the primary source of the pain but rather suggest a referred type of pain from the facets or discs in the cervical spine.



Normal referred pain from cervical facets.

Referred pain is perceived in a region topographically displaced from the region of the source of the pain.

Radicular pain is produced in the distribution of a nerve root as a result of some sort of mechanical compression or irritation of that root.

Referred pain

Literature on referred pain goes back to Henry Head in 1894. More recent studies have investigated referred pain from spinal structures including the facets and discs.

Head H. On disturbances of sensation with special reference to the pain of visceral disease. Brain 1894;17: 339 – 480.
Kellgren JH. On the distribution of pain arising from deep somatic structure with charts of segmental pain areas. Clin Sci. 1939; 4:35-46.
Cloward RB. The clinical significance of the sinu-vertebral nerve of the cervical spine in relation to the cervical disk syndrome. J Neurol Neurosurg Psychiatry. 1960 Nov;23:321-6.
Hockaday JM, Whitty CW. Patterns of referred pain in the normal subject. Brain. 1967 Sep;90(3):481-96.
Kellgren JH. The anatomical source of back pain. Rheumatol Rehabil. 1977 Feb;16(1):3-12.
Bogduk N, Marsland A. The cervical zygapophysial joints as a source of neck pain. Spine. 1988 Jun;13(6):610-7.
O'Neill CW, Kurgansky ME, Derby R, Ryan DP. Disc stimulation and patterns of referred pain. Spine. 2002 Dec 15;27(24):2776-81.
Jinkins RJ. The anatomic and physiologic basis of local, referred and radiating lumbosacral pain syndromes related to disease of the spine. J Neuroradiol. 2004 Jun;31(3):163-80.
Slipman CW, Plastaras C, Patel R, Isaac Z, Chow D, Garvan C, Pauza K, Furman M. Provocative cervical discography symptom mapping. Spine J. 2005 Jul-Aug;5(4):381-8.

Range of Symptoms from Whiplash

Headache

Headache is the second most common symptom, often in the sub-occipital region with referral to the temporal area. These areas are innervated from the upper cervical levels and it was found that 50% of people complaining of headaches had pain arising from the C2/C3 segmental level.

Chronic daily headache (CDH) is defined by headache on 15 or more days per month.

Trauma to the cervical spine is probably the most important single factor *in* the causation of chronic headaches. Trauma produces a mechanical derangement of the structures of the cervical spine which may involve the cervical nerve roots, the cervico-cranial autonomic system, and/or the vertebral vessels. Chronic headache can be prevented by early recognition of the cervical lesion as the cause of the headache followed by adequate treatment directed towards the cervical spine.
Braaf MM, Rosne RS. Trauma of cervical spine as cause of chronic headache. J Trauma. 1975 May;15(5):441-6.

Head or neck injury increases the risk of chronic daily headache.

Couch JR, et al. Head or neck injury increases the risk of chronic daily headache: a population-based study. Neurology. 2007 Sep 11;69(11):1169-77.

The risk of developing post-traumatic chronic daily headache is greater for less severe head injury compared with moderate/severe head injury.

Couch JR. Headache 2001

Headache

Upper cervical pain and/or headaches originating from the C0 to C3 segments are pain-states that are commonly encountered in the clinic. The upper cervical spine anatomically and biomechanically differs from the lower cervical spine. Patients with upper cervical disorders fall into two clinical groups: (1) local cervical syndrome; and (2) cervicocephalic syndrome. Symptoms associated with various forms of both disorders often overlap, making diagnosis a great challenge. The recognition and categorization of specific provocation and limitation patterns lend to effective and accurate diagnosis of local cervical and cervicocephalic conditions.
Sizer PS Jr, Phelps V, Azevedo E, Haye A, Vaught M. Diagnosis and management of cervicogenic headache. Pain Pract. 2005 Sep;5(3):255-74.

This prospective study shows an association of low cervical prolapse with cervicogenic headache: headache and neck pain improves or disappears in 80% of patients after surgery for the cervical disc prolapse. These results indicate that pain afferents from the lower cervical roots can converge on the cervical trigeminal nucleus and the nucleus caudalis.
Diener HC, Kaminski M, Stappert G, Stolke D, Schoch B. Lower cervical disc prolapse may cause cervicogenic headache: prospective study in patients undergoing surgery. Cephalalgia. 2007 Sep;27(9):1050-4.

Anterior cervical discectomy and fusion appears to be quite effective for discogenic cervical headache, but should be reserved for patients who are extremely impaired and refractory to all other treatments.
Schofferman J, Garges K, Goldthwaite N, Koestler M, Libby E. Upper cervical anterior diskectomy and fusion improves discogenic cervical headaches. Spine. 2002 Oct 15;27(20):2240-4.

Visual disturbances

Visual disturbances are mentioned in the literature. Whiplash was associated with defective accommodation in the present select group of whiplash subjects. Oculomotor function seems to be impaired in patients with chronic symptoms of whiplash injury of the cervical spine. The smooth pursuit neck torsion test to identify eye movement disturbances in patients with whiplash are likely to be due to disturbed cervical afferentation.
Visual disturbances occur in 10 to 30% of whiplash patients with blurred vision the most common symptom.

Proprioceptive control of head and neck position

Proprioceptive control of head and neck position has been found to be reduced in people after whiplash injury. Individuals who have sustained a whiplash injury may have proprioceptive deficits that do not allow them accurately or reliably to calculate head position. This may be detrimental to their everyday function. The central nervous system (CNS) uses the information provided by the proprioceptors to build up an internal reference frame of our musculoskeletal system and to recalibrate it. Rehabilitation after whiplash injury should focus not only on range of motion and strength but on postural awareness.

Vertigo/Dizziness

Post-traumatic vertigo refers to dizziness that follows a neck or head injury. There are many potential causes of post-traumatic vertigo. Whiplash clinically is similar to post concussion syndrome, but with the addition of neck complaints. Dizziness occurs in 20-60%.

Impaired cognitive function

Cognitive function may be impaired in WAD with symptoms as a result of mild traumatic brain injury, chronic pain, chronic fatigue or depression. The cervicoenchephalic syndrome is characterized by headache, fatigue, dizziness, poor concentration, disturbed accommodation (eye movements), and impaired adaptation to light sensitivity.

Injuries to the neck due to whiplash can cause distortion of the posture control system as a result of disorganized neck proprioceptive activity.
Gimse R, Tjell C, Bjørgen IA, Saunte C. Disturbed eye movements after whiplash due to injuries to the posture control system. J Clin Exp Neuropsychol. 1996 Apr;18(2):178-86.
Heikkilä HV, Wenngren BI. Cervicocephalic kinesthetic sensibility, active range of cervical motion, and oculomotor function in patients with whiplash injury. Arch Phys Med Rehabil. 1998 Sep;79(9):1089-94.

The **proprioceptive deficit** caused by a ligament injury rarely is due only to sensory and mechanical dysfunction of the ligament.

A ligament injury is often accompanied by damages to other joint structures, e.g. the joint capsule and menisci, implying that the disturbed sensory feedback from these structures are likely to contribute to the reported proprioceptive deficits.

Even in the cases of an isolated ligament injury, contributing effects from the surrounding tissue cannot be excluded since the sprained or ruptured ligaments induce alterations of the normal biomechanics of the joint.

Thereby the loads imposed on different joint structures and muscles will change, causing altered sensory feedback from mechanoreceptors within and around the joints.
Sjolander P, Johansson H, Djupsjobacka M. Spinal and supraspinal effects of activity in ligament afferents. J Electromyogr Kinesiol. 2002 Jun;12(3):167-76.

The data support to the notion of a causal connection between the disturbed posture control system and some cognitive malfunctions.
Gimse R, Björgen IA, Tjell C, Tyssedal JS, Bø K. Reduced cognitive functions in a group of whiplash patients with demonstrated disturbances in the posture control system. J Clin Exp Neuropsychol. 1997 Dec;19(6):838-49.

Thoracic outlet syndrome

There are various names for thoracic outlet syndrome (TOS) including: cervical rib, scalenus anticus, costoclavicular, hyperabduction, pectoralis minor, bachiocephalic, and fractured clavicle-rib syndromes, nocturnal paresthetic brachialgia, and effort vein thrombosis. Common whiplash TOS symptoms include: nausea, dizziness, numbness, aching pain, disorientation, neck stiffness, arm heaviness, incapacitating headache, easy fatigability of the arm, tingling and numbness in the ulnar aspect of the hand.

Neck pain	90%
Paresthesia	90%
Arm pain	84%
Headaches	80%
Shoulder pain	75%
Arm weakness	47%
Chest pain	10%
Raynaud's Phenomenon	1–3%
Swelling	1–4%

Sanders RJ, Pearce WH. The treatment of thoracic outlet syndrome: a comparison of different operations. J Vasc Surg. 1989 Dec;10(6):626–34.

Carpal Tunnel Syndrome

Carpal tunnel syndrome due to compression of the median nerve in the carpal tunnel syndrome, commonly presents with sensory disturbance and pain in the hand. The most useful diagnostic clues is the presence of sensory symptoms at night time relieved by changing hand posture. It is also worth remembering that carpal tunnel syndrome can sometimes present with symptoms in an ulnar or radial nerve distribution. There are as many ways of testing electrophysiogically for carpal tunnel syndrome. A common way is to compare median sensory conduction velocity across wrist with ulnar velocity. This should be supported by measurement of motor conduction across the wrist and motor conduction in the forearm segment.

D'Arcy CA. Does this patient have Carpal Tunnel Syndrome? JAMA 2000;283:3110-3117.

Complex Regional Pain Syndrome 1 (Reflex sympathetic dystrophy)

Pain	93%
Hyperesthesia	75%
Hypesthesia	69%
Muscular incoordination	54%
Tremor	49%

Veldman PH, Reynen HM, Arntz IE, Goris RJ. Signs and symptoms of reflex sympathetic dystrophy: prospective study of 829 patients. Lancet. 1993 Oct 23;342(8878):1012–6.

Double Crush Syndrome

Double crush syndrome means that nerves being irritated up in the neck or at some proximal location like the thoracic outlet (in the shoulder) are causing a peripheral nerve entrapment like carpal tunnel or ulnar entrapment at the elbow.

The hypothesis was that neural function could be impaired when single axons, having been compressed in one region, become especially susceptible to damage in another. They postulated that nonsymptomatic impairment of axoplasmic flow at more than one site along a nerve might summate to cause a symptomatic neuropathy. This was suggested by their clinical observation that the majority of their patients had a median or ulnar neuropathy associated with evidence of cervicothoracic root lesions.

Upton ARM, McComas AJ. The double crush in nerve entrapment syndromes. Lancet 2:359-361, 1973.

Cervical spondylosis and disc prolapsed in patients with C5-C6 and C6-C7 were on the same side as the symptoms in the wrists in 50% of the cases.

The higher incidence of narrowed cervical foramens in the patient patients and the concordance with affected nerve roots on the same side of CTS, supports the hypothesis of a double crush phenomenon.

Pierre-Jerome C, Bekkelund SI. Magnetic resonance assessment of the double crush phenomenon in patients with carpal tunnel syndrome: a bilateral quantitative study. Scan J Palst Reconstr Hand Surg. 2003; 37:46-53.

Structures Injured

Cervical Facets

The high yield of positive responders in this study probably reflects the propensity of patients with facet joint syndromes to gravitate to a pain clinic when this condition is not recognized in conventional clinical practice.
Bogduk N, Marsland A. The cervical zygapophysial joints as a source of neck pain. Spine. 1988 Jun;13(6):610-7.

Both a symptomatic disc and a symptomatic zygapophysial joint were identified in the same segment in 41% of the patients.
Bogduk N, Aprill C. On the nature of neck pain, discography and cervical zygapophysial joint blocks. Pain. 1993 Aug;54(2):213-7.

Painful joints were identified in 54% of the patients (95% confidence interval, 40% to 68%). In this population, cervical zygapophysial joint pain was the most common source of chronic neck pain after whiplash.
Barnsley L, Lord SM, Wallis BJ, Bogduk N. The prevalence of chronic cervical zygapophysial joint pain after whiplash. Spine. 1995 Jan 1;20(1):20-5; discussion 26.

Compared to a neutral head posture, the maximum principal strain in the facet capsule doubles on the side toward which the head is turned.
Excessive capsular strains experienced by some individuals during some whiplash conditions may be responsible for painful capsular whiplash injury.
Siegmund GP, Davis MB, Quinn KP, Hines E, Myers BS, Ejima S, Ono K, Kamiji K, Yasuki T, Winkelstein BA. Head-turned postures increase the risk of cervical facet capsule injury during whiplash. Spine. 2008 Jul 1;33(15):1643-9.

Facet joint components may be at risk for injury due to facet joint compression during rear-impact accelerations of 3.5 g and above. Capsular ligaments are at risk for injury at higher accelerations.
Pearson AM, Ivancic PC, Ito S, Panjabi MM. Facet joint kinematics and injury mechanisms during simulated whiplash. Spine. 2004 Feb 15;29(4):390-7.

Cervical Facets

Diagnostic blocks are a valid technique in the identification of painful zygapophysial joints.
Barnsley L, Lord S, Bogduk N. Comparative local anaesthetic blocks in the diagnosis of cervical zygapophysial joint pain. Pain. 1993 Oct;55(1):99-106.

The evidence obtained from literature review suggests that controlled comparative local anesthetic blocks of facet joints (medial branch or dorsal ramus) are reproducible, reasonably accurate and safe. The sensitivity, specificity, false-positive rates, and predictive values of these diagnostic tests for neck and low back pain have been validated and reproduced in multiple studies.
Sehgal N, Dunbar EE, Shah RV, Colson J. Systematic review of diagnostic utility of facet (zygapophysial) joint injections in chronic spinal pain: an update. Pain Physician. 2007 Jan;10(1):213-28.

Manual diagnosis by a trained manipulative therapist can be as accurate as can radiologically-controlled diagnostic blocks in the diagnosis of cervical zygapophysial syndromes.
Jull G, Bogduk N, Marsland A. The accuracy of manual diagnosis for cervical zygapophysial joint pain syndromes. Med J Aust. 1988 Mar 7;148(5):233-6.

Stretching the facet joint capsule beyond physiological range could result in altered axonal morphology that may be related to secondary or delayed axotomy changes similar to those seen in central nervous system injuries where axons are subjected to stretching and shearing. These may contribute to neuropathic pain and are potentially related to neck pain after whiplash events.
Kallakuri S, Singh A, Lu Y, Chen C, Patwardhan A, Cavanaugh JM. Tensile stretching of cervical facet joint capsule and related axonal changes. Eur Spine J. 2008 Apr;17(4):556-63.

Structures Injured

Clinical evidence suggests that disc injury and accelerated degeneration are common in whiplash patients.

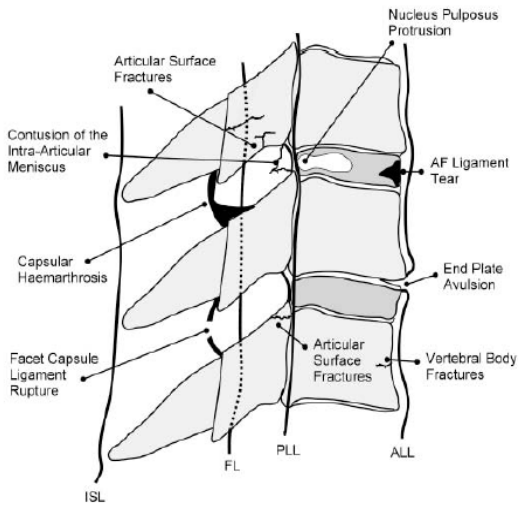
Cervical Discs

Microdissection and histologic studies were undertaken to determine the innervation of the cervical intervertebral discs. The cervical sinuvertebral nerves were found to have an upward course in the vertebral canal, supplying the disc at their level of entry and the disc above. Branches of the vertebral nerve supplied the lateral aspects of the cervical discs. Histologic studies of discs obtained at operation showed the presence of nerve fibers as deeply as the outer third of the anulus fibrosus.

Bogduk N, Windsor M, Inglis A. The innervation of the cervical intervertebral discs. Spine. 1988 Jan;13(1):2-8.

Nerve fibers appeared to enter the disc in the posterolateral direction and course both parallel and perpendicular to the bundles of the anulus fibrosus. Nerves were seen throughout the anulus but were most numerous in the middle third of the disc. Receptors resembling Pacinian corpuscles and Golgi tendon organs were seen in the posterolateral region of the upper third of the disc. These results provide further evidence that human cervical intervertebral discs are supplied with both nerve fibers and mechanoreceptors.

Mendel T, Wink CS, Zimny ML. Neural elements in human cervical intervertebral discs. Spine. 1992 Feb;17(2):132-5.



Cervical Discs

The results of recent experimental studies suggest that an injury to the anulus causes secondary cellular reaction in the nucleus pulposus, similar to the process observed in human disc degeneration.

Pettersson K, Hildingsson C, Toolanen G, Fagerlund M, Björnebrink J. Disc pathology after whiplash injury. A prospective magnetic resonance imaging and clinical investigation. Spine. 1997 Feb 1;22(3):283-7; discussion 288.

A high incidence of discoligamentous injuries was found in whiplash-type distortions. Most patients with severe persisting radiating pain had large disc protrusions on MRI that were confirmed as herniations at surgery.

Jónsson H Jr, Cesarini K, Sahlstedt B, Rauschning W. Findings and outcome in whiplash-type neck distortions. Spine. 1994 Dec 15;19(24):2733-43.

Excessive 150° fiber and disc shear strain occurred during simulated whiplash. These strains were greatest at the posterior region of the C5-6, and clinical date suggests that this is the most common location for disc herniation in whiplash patients. Disc injury may be the cause of acute pain and muscle spasm during the trauma, it could also lead to disc degeneration, facet osteoarthritis, and chronic neck pain.

Panjabi MM, Ito S, Pearson AM, Ivancic PC. Injury mechanisms of the cervical intervertebral disc during simulated whiplash. Spine. 2004 Jun 1;29(11):1217-25.

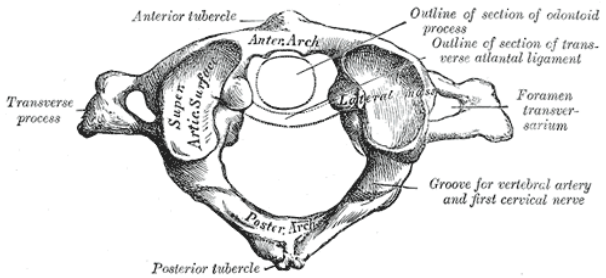
The disc injuries occurred at lower impact accelerations during rear impact as compared with frontal impact. The subfailure injuries of the cervical intervertebral disc that occur during frontal impact may lead to the chronic symptoms reported by patients, such as head and neck pain.

Ito S, Ivancic PC, Pearson AM, Tominaga Y, Gimenez SE, Rubin W, Panjabi MM. Cervical intervertebral disc injury during simulated frontal impact. Eur Spine J. 2005 May;14(4):356-65.

Upper Cervical Structures

MRI shows structural changes in ligaments and membranes after whiplash injury, and such lesions can be assessed with reasonable reliability. Lesions to specific structures can be linked with specific trauma mechanisms. There is a correlation between clinical impairment and morphologic findings.
Whiplash trauma can damage soft tissue structures of the upper cervical spine, particularly the alar ligaments.
Krakenes J, Kaale BR. Magnetic resonance imaging assessment of craniovertebral ligaments and membranes after whiplash trauma. Spine. 2006 Nov 15;31(24):2820-6.

Whiplash patients who had been sitting with their head/neck turned to one side at the moment of collision more often had high-grade lesions of the alar and transverse ligaments. Severe injuries to the transverse ligament and the posterior atlanto-occipital membrane were more common in front than in rear end collisions. The patients who had the head rotated at the instant of collision had more often high-grade MRI changes of the alar ligaments than those with the head in a neutral position. A total of 61.7% of the patients with rotated neck position had alar ligament grade 3 lesions, as opposed to only 4.4% in the patient group with neutral neck position.
Kaale BR, Krakenes J, Albrektsen G, Wester K. Head position and impact direction in whiplash injuries: associations with MRI-verified lesions of ligaments and membranes in the upper cervical spine. J Neurotrauma. 2005 Nov;22(11):1294-302.



Reliable assessment of the anatomy and function of the alar ligament can be achieved with MR imaging, preferably in coronal planes. MR imaging with the aid of a functional study may be a valuable imaging modality in the evaluation of alar ligament failure.
Kim HJ, Jun BY, Kim WH, Cho YK, Lim MK, Suh CH. MR imaging of the alar ligament: morphologic changes during axial rotation of the head in asymptomatic young adults. Skeletal Radiol. 2002 Nov;31(11):637-42.

High-signal changes of the alar and transverse ligaments are common in WAD1-2 and unlikely to represent age-dependent degeneration.
Vetti N, Kråkenes J, Eide GE, Rørvik J, Gilhus NE, Espeland A. MRI of the alar and transverse ligaments in whiplash-associated disorders (WAD) grades 1-2: high-signal changes by age, gender, event and time since trauma. Neuroradiology. 2009 Apr;51(4):227-35.

Whiplash trauma can damage the transverse ligament. By use of high-resolution proton-weighted MR images such lesions can be detected and classified.
Krakenes J, Kaale BR, Nordli H, Moen G, Rorvik J, Gilhus NE. MR analysis of the transverse ligament in the late stage of whiplash injury. Acta Radiol. 2003 Nov;44(6):637-44.

The results for the membranes appeared somewhat better than for the ligaments. When there was disagreement, the classifications obtained by the clinical test were significantly lower than the MRI grading, but mainly within one grade difference. When combining grade 0-1 (normal) and 2-3 (abnormal), the agreement improved considerably (range 0.70-0.90). Although results from the clinical test seem to be slightly more conservative than the MRI assessment, we believe that a clinical test can serve as valuable clinical tool in the assessment of WAD patients.
Kaale BR, Krakenes J, Albrektsen G, Wester K. Clinical assessment techniques for detecting ligament and membrane injuries in the upper cervical spine region--a comparison with MRI results. Man Ther. 2008 Oct;13(5):397-403.

Structures Injured

Shoulder Pain

52.6% of subjects with late whiplash syndrome had periarticular disorders of the shoulder joint and shoulder pain that was exaggerated by shoulder movement and tenderness in the tendons of the rotator cuff or the biceps tendon.
Magnusson T. Extracervical symptoms after whiplash trauma. Cephalalgia. 1994 Jun; 14(3):223- 7; discussion 181-2.

The shoulder is affected by irritation of a cervical nerve root or referred pain. The anteroposterior diameter of the spinal canal at C5 and C6 in the painful-shoulder group was significantly narrower than in the control group.
Mimori K, Muneta T, Komori H, Okawa A, Shinomiya K. Relation between the painful shoulder and the cervical spine with narrow canal in patients without obvious radiculopathy. J Shoulder Elbow Surg. 1999 Jul-Aug; 8(4):303-6.

There is evidence that the acromioclavicular joint of the seat-belt shoulder may be injured during an road traffic accidents. The joint involved was significantly more likely to be on the side restrained by the seat-belt. The acromioclavicular joints should be checked for involvement following whiplash injuries, particularly in women.
Saunders L. Acromioclavicular joint sprain and its prevalence with whiplash injuries. Physiotherapy 2001; 87(11);587-592.

Whiplash injuries can result in indirect acute shoulder trauma, possibly through an acceleration-deceleration mechanism, and may be a distinct entity.
Mudduen, et al. Whiplash injury of the shoulder: Is it a distinct clinical entity? Acta Orthop. Belg., 2005, 71, 385-387.

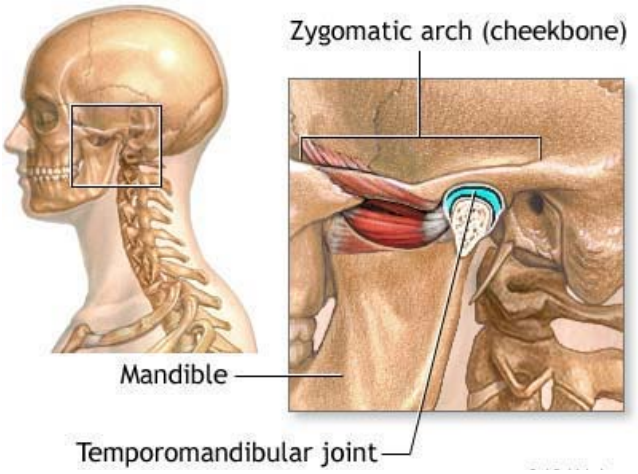
This study showed an incidence of 22% of shoulder pain after whiplash injury and is comparable with other studies.
Chauhan SK, Peckham T, Turner R. Impingement syndrome associated with whiplash injury. J Bone Joint Surg [Br] 2003;85-B:408-10.

Symptoms from the temporomandibular joint

Symptoms from the temporomandibular joint have been reported in the literature related to WAD. Symptoms of TMJ induced by whiplash may include headache, dizziness, and deep ear pain, pressure behind the eyes, earaches and stiff neck. TMJ symptoms will appear as an inability to open the jaw fully, a clicking or snapping of the jaw and changes in alignment when the jaw is opened or closed.

Observations suggest an association between neck injury and disturbed jaw function and therefore impaired eating behavior.
Grönqvist J, Häggman-Henrikson B, Eriksson PO. Impaired jaw function and eating difficulties in whiplash-associated disorders. Swed Dent J. 2008;32(4):171-7.

The TMJ and surrounding musculature should be examined similarly to other joints, with no preconceived notion that TMD pathology after whiplash is unlikely.
Friedman MH, Weisberg J. The craniocervical connection: a retrospective analysis of 300 whiplash patients with cervical and temporomandibular disorders. Cranio. 2000 Jul;18(3):163-7.



Structures Injured

Low back pain

Low back pain occurs in approximately 50% of these cases. Compression with biphasic lumbar spinal motions (increased/decreased lordosis) may cause injuries in the lumbar spine.

Lower back pain is associated with whiplash trauma

Author	Year	% with Low Back Complaints
Cassidy et al	2003	61
Berglund et al	2001	20
Sqiures	1996	48
Sturzenegger	1995	46
Radanov et al	1994	39
Magnusson	1994	47
Teasel	1993	40
Hildingson	1990	25
Hohl	1974	35

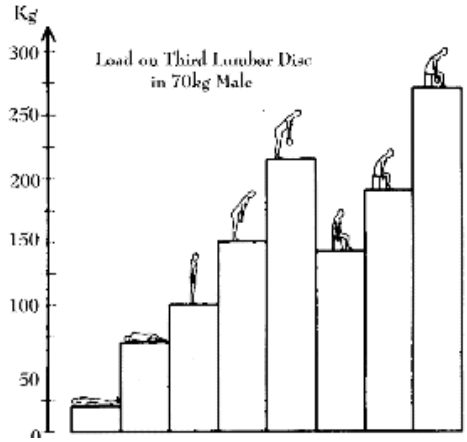
Low Back Pain in Acceleration/Deceleration Collisions

Lumbar spine injury mechanisms

Lumbar Spinal Strains Associated with Whiplash Injury, reported that up to half of the persons involved in these accidents (rear-end collisions) may develop low back pain but the mechanisms leading to and sustaining the low back pain still remain unclear as there is scant biomechanical data dealing with the low back after whiplash injuries.

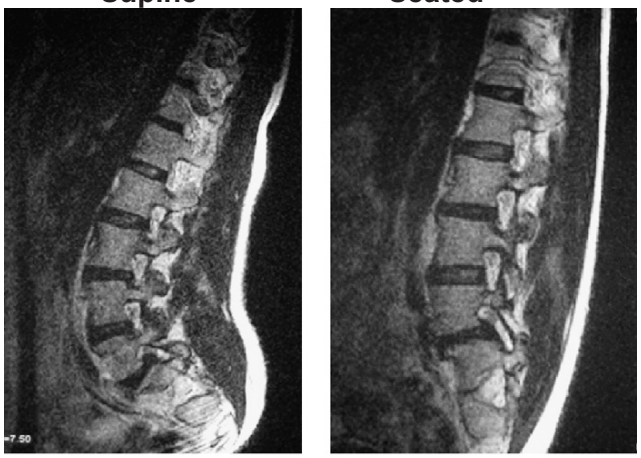
Following a rear-end collision injury mechanisms include traction (tensile stretching) and compression together with shear forces affecting lumbar vertebrae, and that the forces could produce soft tissue injuries to muscles, ligaments, capsules.

Fast A, Sosner J, Begeman P, Thomas MA, Chiu T. Lumbar Spinal Strains Associated with Whiplash Injury: A Cadaveric Study. Am J Phys Med Rehabil. 2002 Sep;81(9):645-650.



Nachemson A. In vivo discometry in lumbar discs with irregular nucleograms. Acta Orthop Scand. 1965;36(4):418-34.

Supine **Seated**



From a standing to sitting position, the lumbar lordosis decreases by on average 38°

Andersson G et al. The influence of backrest inclination and lumbar support on lumbar lordosis. Spine,1981;4(1): 52-58.

Evaluation - Initial

History & Physical Examination
Diagnostics & Imaging

↓

Classify WAD grade
Assess Pain – Pain Scale (VAS/NPS) and
Disability – Neck Disability Index (NDI)
Pain Drawing

↓

Define WAD grade
WAD I WAD II WAD III

↓

Apply recommended treatments

- Mobilization/Manipulation
- Modalities/ Exercise/Nutrition
- Prescribed Functional Activities

7 Days

Improving	**Not Improving**
Continue recommended treatments	(VAS/NPS and NDI still high) Consider more concerted treatment. Other treatments therapies may be considered

↓

3 Weeks

Reassess

(Should include VAS/NPS and NDI, may include a psychological measure (for e.g., IES)

Improving	**Not Improving**
Continue recommended treatments	(e.g., VAS and NDI still high/unchanged) Consider refer to Specialist: Specialist exam should include specialized physical examination

↓

6 Weeks

Reassess

(Should include VAS/NPS and NDI, may include IES)

Resolving	**Not Resolving**
Reduce treatment **Resolved** – cease treatment	VAS/NPS and NDI still high/unchanged) Refer to Specialist: Specialist exam should include specialized physical examination

↓

3 Months

Resolution expected (≈ 50%)	**Not Resolving (≈ 50%)**
Discharge from care or Treatment as needed	Follow recommendation from whiplash specialist and ensure coordinated care. Special studies (VF, MRI ect.)

Initial Assessment
Classify the injury Whiplash (WAD) injury. Although higher WAD grades indicate greater severity, poor prognosis is most likely associated with a high Visual Analogue Scale (VAS)/numeric pain score (NPS) >7/10) or high Neck Disability Index (NDI) score (>20/50). The SF-36 may be also be used. Orthopedic & neurological examination. Clinician determines imaging necessity.
Apply recommended treatments.

Seven Day Reassessment
Reassess, including the VAS/NPS and NDI. If the VAS/NPS and NDI are high or unchanged, treatment type and intensity should be reviewed. Other treatments may be considered.
The effectiveness of such treatments should be closely monitored and only continued if there is evidence of benefit (at least 10% change on VAS and NDI).

Three Week Reassessment
Reassess, including the VAS/NPS and NDI. If the VAS/NPS and NDI are unchanged, a more complex assessment may need to be considered and treatment type and intensity should again be reviewed. The Impact of Event Scale (IES) may be used as a baseline for psychological assessment. Other recommended scales can be used. If pain and disability are still high (VAS, NPS >5.5) and NDI (>20/50) or unchanged, consider referral to a specialist in Whiplash Associated Disorders (WAD).

A specialist is considered a practitioner with specialized expertise in the management of WAD. These may include chiropractors, medical physicians, pain medicine specialists and other physicians who specialize in WAD. Among other things, if the VAS/NPS and NDI are unchanged, the specialist should undertake a more complex physical and/or psychological examination. They should direct more appropriate care and liaise with the treating practitioner to ensure this is implemented.

Six Week Reassessment
Reassess again at this point. In at least 30% of cases resolution should be occurring, and the process of reducing treatment in these cases should commence or continue. If resolution is not occurring and the VAS/NPS and NDI have not changed by at least 10% from the last review, specialist care should still be followed, or a specialist should be referred to if this has not already been done. Prescribe home programs for functional improvement. Consultation with a whiplash specialist may be needed if pain or disability are still high (VAS, NPS > 5.5, NDI > 20/50) or unchanged.

Three Month Reassessment
Assessment should Include VAS/NPS and NDI. Resolution usually occurs in approximately 50% of cases. If the patient is still improving, continue treatment; independence should be promoted (e.g., focus on active exercise). In these resolving cases, the patient should be reviewed intermittently over the next six to 12 months until resolution. Prescribe home programs to maintain improvement. Consultation with a whiplash specialist is usually required. At this point, referral to a clinical psychologist may also be considered if the psychological assessment data is markedly below norms (for the IES this means a score of > 26 at six weeks after injury).

Coordinated Care
Patients whose VAS/ NPS and/or NDI scores are not improving at this point are likely to require coordinated care that is multidisciplinary. It is likely that a combination of physical, psychological and medical care is required. The primary practitioner should facilitate this process.

Range of Possible Symptoms in Whiplash Disorders

Neck Pain
Neck pain is the most commonly reported symptom of WAD. Furthermore specific segmental zygapophyseal (facet) joint blocks have demonstrated that the neck and surrounding tissues are the most common source of chronic pain for people with WAD. People involved in a rear end motor vehicle accident found the most commonly reported symptom was neck pain, followed by headache, neck stiffness, low back pain, upper limb symptoms, dizziness, nausea and visual problems. Tinnitus, temporomandibular joint pain, paraesthesia and concentration or memory disturbance may also be experienced.

Headache
Headache is the second most common symptom, often in the sub-occipital region with referral to the temporal area. These areas are innervated from the upper cervical levels and it was found that 50% of people complaining of headaches had pain arising from the C2/C3 segmental level.

Radiating Pains to the Head, Shoulder, Arms or Interscapular area
Radiating pains to the head, shoulder, arms or interscapular area are often reported at some time post injury. These patterns of somatic referral do not necessarily indicate which structure is the primary source of the pain but rather suggest a referred type of pain from the facets or discs in the cervical spine.

Generalized Hypersensitivity
Those with whiplash symptoms may have a generalized hypersensitivity, extending as far as the lower limbs, when compared with healthy volunteers. It was suggested that WAD might lead to spinal cord hyperexcitability causing exaggerated pain on peripheral stimulation.

Paresthesia and Muscle Weakness
Paresthesia and muscle weakness may be caused by cervical radiculopathy, thoracic outlet syndrome and spinal cord compression.

Symptoms from the Temporomandibular joint
Symptoms from the temporomandibular joint have been reported in the literature related to WAD. Symptoms of TMJ induced by whiplash may include headache, dizziness, deep ear pain, pressure behind the eyes, earaches and stiff neck. TMJ symptoms will appear as an inability to open the jaw fully, a clicking or snapping of the jaw and changes in alignment when the jaw is opened or closed.

Visual Disturbances
Visual disturbances are mentioned in the literature. Whiplash was associated with defective accommodation in the present select group of whiplash subjects. Oculomotor function seems to be impaired in patients with chronic symptoms of whiplash injury of the cervical spine. The smooth pursuit neck torsion test to identify eye movement disturbances in patients with whiplash are likely to be due to disturbed cervical afferentation.

Proprioceptive Control of Head and Neck Position
Proprioceptive control of head and neck position has been found to be reduced in people after whiplash injury. Individuals who have sustained a whiplash injury may have proprioceptive deficits that do not allow them accurately or reliably to calculate head position. This may be detrimental to their everyday function. The central nervous system (CNS) uses the information provided by the proprioceptors to build up an internal reference frame of our musculoskeletal system and to recalibrate it. Rehabilitation after whiplash injury should focus not only on range of motion and strength but on postural awareness.

Vertigo/Dizziness
Post-traumatic vertigo refers to dizziness that follows a neck or head injury. There are many potential causes of post-traumatic vertigo. Peripheral vertigo may be either a lesion of the inner ear via the vestibular nerve or afferents from the cervical spine: major differential would be dizziness with turning the head but not with rotation of head and body together.
Whiplash clinically is similar to post concussion syndrome, but with the addition of neck complaints. Dizziness occurs in 20-60%.

Impaired Cognitive Function
Cognitive function may be impaired in WAD with symptoms as a result of mild traumatic brain injury, chronic pain, chronic fatigue or depression. The cervicoenchephalic syndrome is characterized by headache, fatigue, dizziness, poor concentration, disturbed accommodation (eye movements), and impaired adaptation to light sensitivity.

Low Back Pain
Low back pain occurs in approximately 50% of these cases. Compression with biphasic lumbar spinal motions (increased/decreased lordosis) may cause injuries in the lumbar spine.

Carpal Tunnel Syndrome
The carpal tunnel is an opening through the wrist to the hand that is formed by the bones of the wrist on one side and the transverse carpal ligament on the other. This opening forms the carpal tunnel.
The median nerve passes through the carpal tunnel into the hand. It gives sensation to the thumb, index finger, long finger, and half of the ring finger. It also sends a nerve branch to control the thenar muscles of the thumb. Any condition that causes abnormal pressure in the tunnel can produce symptoms of CTS.

Double Crush Syndrome
Double crush syndrome means that nerves being irritated up in the neck or at some proximal location like the thoracic outlet (in the shoulder) are causing a peripheral nerve entrapment like carpal tunnel or ulnar entrapment at the elbow.

Delay in Symptoms
Delay in symptoms is not uncommon. Symptoms may be delayed for hours, days, or longer.

Physical Examination

Taking Patient History

Taking a patient's history is important during all visits for the treatment of patients with WAD of all grades. A patient's history should include information about: date of birth, gender and education level; circumstances of injury such as relevant crash factors; symptoms, particularly including pain intensity (using the Visual Analogue Scale (VAS) or similar). Stiffness, numbness, weakness and associated extra cervical symptoms; localization, time of onset and profile of onset should also be recorded for all symptoms; disability level, preferably using the Neck Disability Index (NDI). Other scales such as the Functional Rating Index, Patient-Specific Functional Scale, Short Form Health Survey SF-36, or similar may also be used. Such an assessment should be conducted on a patient's second visit at seven days, if not initially; and prior history of neck problems including previous whiplash injury.
Where appropriate, further assessment to determine psychological status may be undertaken at three or six week review. The preferred tool is the Impact of Event Scale (IES), which is a validated tool. Other scales may be useful. History details should be recorded. A standard form may be used.

Observation (particularly of head position / posture); palpation for tender points; assessment of range of movement (ROM) including flexion (chin to chest), extension, rotation and lateral flexion; neurological testing; assessment of associated injuries; and an assessment of general medical condition(s), including psychological state (as appropriate).
A further, more specialized, physical examination assessment might include: assessment of joint position error; assessment of neck muscle activity; and an assessment of widespread sensitivity (which may include cold sensitivity, pressure pain threshold and / or the brachial plexus provocation test, qualitative sensory perception).
Tools, such as a universal goniometer or inclinometer, can be used to measure neck ROM, and are more reliable than observation.
A standardized form may be used.

History and Physical Examination

Date of birth, gender, height weight, blood pressure, pulse rate, education level
Prior medical history, general medical condition, and pre-existing conditions
Symptoms including stiffness, numbness, onset of symptoms
Prior history of whiplash symptoms. neck injury or pain or chronic pain symptoms
Observation of head position and posture
Palpation for tenderness in the neck region
Cervical range of motion
Neurological testing of sensation, reflexes and muscle strength
Assess associated injuries and co-morbidities

Baseline Assessment

Disability level using self report instrument (NDI)
Pain intensity using a visual analogue scale (VAS) or numeric pain scale (NPS)

Look for lacerations, fractures, or other abnormalities requiring urgent intervention.
Note any deformities, swelling, asymmetry, atrophy or erythema.
Feel the areas of pain and surrounding structures. Examine for tenderness, deformity, crepitus and muscle spasm. Flaccidity, fasiculations and spasticity may indicate nervous system damage. Note particularly sensitive areas of palpation as this may help to determine etiology of pain (e.g., muscular versus facet).

Palpate the temporomandibular joints (TMJs) and adjacent musculature, including the masseter and temporalis muscles. Assess these joints by having the patient open, close and move the jaw from side to side. Note any pain, tenderness, clicking, popping or asymmetric jaw movement. Make note of jaw excursion and the location of pain that limits it.
Have the patient move the region being tested. If the patient's movement is restricted, passive movement should be attempted as the pain allows. It may not be possible to passively move the region farther due to pain, but this also allows the examiner to gauge the source of pain, limitation and degree of musculature tautness.

Screening Neurological Motor Exam
The integrity and mobility of the nervous system needs to be examined and tests should include:
• The integrity of the nervous system including testing myotomes, dermatomes and reflexes when indicated by the distribution of the symptoms
• Mobility tests may include passive neck flexion (PNF), upper limb tension tests (ULTT), passive knee bend, straight leg raise (SLR) and the slump test
• The plantar response should be examined to exclude an upper motor neuron lesion
• Tests for clonus, should be carried out to exclude an upper motor neuron lesion.

Cervical Spine

	C5	C6	C7	C8
Arm Pain	Lateral upper arm	Lateral arm	Posterior arm	Medial arm
Sensory change in fingers	None	Thumb +/- index	Index/long +/- ring	Little +/- ring
Motor weakness	Deltoid +/- biceps	Biceps +/- Brachioradialis	Triceps	Finger Intrinsics
Diminished Tendon reflexes	Biceps	Brachioradialis	Triceps	N/A

Myotome	Movement
C5	Shoulder abduction (deltoid, axillary nerve) Elbow flexion (biceps, musculocutaneous nerve)
C6	Wrist extension (wrist extensors, radial/posterior interosseus nerve)
C7	Elbow extension (triceps, radial nerve)
C8	Grip strength (finger flexors, ulnar and median nerves)
T1	Finger abduction (interossei, ulnar nerve)
L2	Hip flexion (iliopsoas, femoral nerve)
L3	Knee extension (quadriceps, femoral nerve)
L4	Ankle dorsiflexion (tibialis anterior, peroneal nerve)
L5	Great toe extension (extensor hallicus, peroneal nerve)
S1	Ankle plantarflexion (gastrocnemius/soleus, tibial nerve)

Sclerotome pain referrals:
C1 posterior neck, suboccipital, occipital, and behind eye,
C2 posterior neck and suboccipital,
C3 posterior neck to top of proximal shoulder,
C4 posterior neck to top of distal shoulder,
C5 across top of shoulder and upper mid scapular,
C6 across top of shoulder, mid scapular, and posterior elbow,
C7 across top of shoulder, mid and inferior scapular, anterior chest, and down the medial forearm,
C8 across top and posterior shoulder, entire lateral shoulder, and down medial forearm into 4th and 5th fingers, T1 across the shoulder blade.

Subluxation Assessment

Vertebral Position Assessed Radiographically; Abnormal Segmental Motion Assessed Radiography

To demonstrate a subluxation based on physical examination, two of the four criteria mentioned below are required, one of which must be **asymmetry/misalignment** or **range of motion abnormality**.

- **P**ain/tenderness evaluated in terms of location, quality, and intensity; Pain, facet syndrome, trigger points, etc.
- **A**symmetry/misalignment identified on a sectional or segmental level; Asymmetric or Hypertonic Muscle Contraction.
- **R**ange of motion abnormality (changes in active, passive and accessory joint movements resulting in an increase or decrease of sectional or segmental mobility); Abnormal Segmental Motion/Lack of Joint End-play.
- **T**issue, tone changes in the characteristics of contiguous, or associated soft tissues, including skin, fascia, muscle, and ligament; Soft Tissue Compliance and Tenderness.

Special Tests

- Thoracic outlet syndrome. Various tests for this complex syndrome include the Allen Test, Adson's maneuver and provocative elevation tests.
- Upper cervical stability. Test for instability in the presence of certain signs (inability to support the head, dysphagia, tongue paraesthesia, a metallic taste in the mouth, facial or lip paraesthesia, bilateral limb paraesthesia, quadrilateral limb paraesthesia, nystagmus, gait disturbance).

Radiographic Imaging

Age ≥ 65 yr, dangerous mechanism, paresthesias in extremities, midline cervical spine tenderness, unable to rotate neck 45 degrees left and right, pain or limitation of motion, suspected spinal instability, x-rays are recommended. MRI may be indicated early in radiculopathy/myelopathy.

THE EXAMINATION

CPT code 99203 includes a detailed examination. A detailed, single-organ system examination should include at least 12 elements identified by a bullet within the system/body area(s) being examined according to the 1997 documentation guidelines on E/M services.

99203 – Usually the presenting problem(s) are of moderate severity and the physician typically spends 30 minutes face-to-face with the patient and/or family. E/M requires the following three key components:
Detailed history.
Detailed examination.
Medical decision making of low complexity.

6 weeks to 3 months

With continued moderate/severe complaints:
Dynamic sEMG
MRI
Videofleuroscopy
Quantitative sensory testing

Specialized imaging techniques

WAD Grade III

Specialized imaging techniques might be
used in selected patients;
e.g., nerve root compression or
suspected spinal cord injury, WAD Grade III,
on the advice of a whiplash, medical or surgical specialist.

Specialized examinations

Examples of such examinations include
electroencephalography (EEG), electromyographic (EMG)
specialized neurological tests, depending on signs/symptoms.

Standard MRI may be used signs and symptoms of radicular disorders.
Evaluating soft tissues after trauma or surgery, STIR or T2-weighted fat-suppressed fast-spin-echo sequences are recommended. (ACR PRACTICE GUIDELINE MRI of the Adult Spine 2006)
Fast spin-echo (FSE) sequences can be used to decrease imaging times, to increase resolution, or to improve signal-to-noise ratios on T2-weighted images.
MRI proton-density weighted sequences of 2mm or less may show damage to the alar ligaments and ligamentous structures in the craniovertebral junction.
Alterations in the static alignment of the cervical curvature cause alterations in the dynamic kinematics of the cervical spine during cervical flexion-extension. (Takeshima T, Omokawa S, Takaoka T, Araki M, Ueda Y, Takakura Y. Sagittal alignment of cervical flexion and extension: lateral radiographic analysis. Spine. 2002 Aug 1;27(15):E348-55.)
Motion MRI (kinetic MRI) has been shown to demonstrate significant differences in biomechanical function between normal patients and injured patients following rear, low-impact motor vehicle collisions.
kMRI delivers the ability to scan patients in neutral, flexion, and extension positions, which may allow for improved diagnosis. A significant increase in the degree of lumbar disc herniation was found by examining flexion and extension views when compared with neutral views alone. kMRI views provide valuable added information, especially in situations where symptomatic radiculopathy is present without any abnormalities demonstrated on conventional MRI.
SPECT/CT may be helpful in certain conditions.
Surface electromyography may be helpful in patients with cervical spine and low back disorders.
Patients with whiplash associated disorder Grade II can be distinguished from healthy control subjects according to the presence of cervical muscle dysfunction, as assessed by surface electromyography of the upper trapezius muscles.
Videofluoroscopy screening may be useful in for and evaluating for cervical instability injuries.
Quantitative sensory testing may be useful in identifying small or large fiber sensory abnormalities.

For addressing chiropractic use of x-rays see: www.pccrp.org.

Kinetic MRI

A significant increase in the degree of lumbar disc herniation was found by examining flexion and extension views when compared with neutral views alone.
kMRI views provide valuable added information, especially in situations where symptomatic radiculopathy is present without any abnormalities demonstrated on conventional MRI.
Zou J, Yang H, Miyazaki M, Wei F, Hong SW, Yoon SH, Morishita Y, Wang JC. Missed lumbar disc herniations diagnosed with kinetic magnetic resonance imaging. Spine. 2008 Mar 1;33(5):E140-4.

kMRI is effective for diagnosing, evaluating, and managing degenerative disease or injury within the spine.
Morishita Y, Hymanson H, Miyazaki M, Zhang HH, He W, Wu G, Kong MH, Wang JC. Review article: Kinematic evaluation of the spine: a kinetic magnetic resonance imaging study. J Orthop Surg (Hong Kong). 2008 Dec;16(3):348-50.

The STIP scoring method is a practical, noninvasive method of determining the degree of clinical impairment, as a basis for distinguishing injury requiring medical treatment from injury requiring surgical treatment, in cases of subacute cervical spine trauma.
Giuliano V, Giuliano C, Pinto F, Scaglione M. Soft tissue injury protocol (STIP) using motion MRI for cervical spine trauma assessment. Emerg Radiol. 2004 Apr;10(5):241-5.

Functional magnetic resonance imaging is a radiological technique that can visualize injuries of the ligaments and the joint capsules, and accompanying pathological movement patterns.
Johansson BH. Whiplash injuries can be visible by functional magnetic resonance imaging. Pain Res Manag. 2006 Autumn;11(3):197-9.

This study showed that the presences of either Grade IV DD or grade 3 Facet joint osteoarthritis with ligament flavum hypertrophy at L4-L5 were good indicators for segmental instability. Using these parameters simultaneously in patients with segmental instability would be useful for determining candidacy for surgical treatment.
Jang SY, Kong MH, Hymanson HJ, Jin TK, Song KY, Wang JC. Radiographic parameters of segmental instability in lumbar spine using kinetic MRI. J Korean Neurosurg Soc. 2009 Jan;45(1):24-31.

Assessment

Among the 200 patients investigated, 30 showed instability of the ligamentous dens complex. Of the same 200, 4% had a complete rupture and 11% an incomplete rupture of the alar ligament, with instability signs. In another 22.5% patients, fMRI-video showed evidence of instability, and all these patients had coexisting intraligamentous signal pattern variation, probably due to granulation tissue.
40% had signal indifference without demonstrable video instability signs, and 21.5% of patients (showed no evidence of instability and no signal variation in the alar ligaments. On the basis of recognition of instability and the malfunction of the ligaments, the fibrous capsula, and the tiny dens capsula, we now can distinguish between lesions caused by rotatory trauma to the craniocervical junction and those from classic whiplash injury.
Volle E. Functional magnetic resonance imaging--video diagnosis of soft-tissue trauma to the craniocervical joints and ligaments. Int Tinnitus J. 2000;6(2):134-9.

MRI with lateral tilting and rotatory evaluation is a useful tool for investigating craniocervical instability. For patients who are recalcitrant to following a program of conservative therapy, surgical stabilization of the craniocervical junction appears to be justified.
Volle E, Montazem A. MRI video diagnosis and surgical therapy of soft tissue trauma to the craniocervical junction. Ear Nose Throat J. 2001 Jan;80(1):41-4, 46-8.

Disk herniations were observed in 28% (28 of 100) patients. Biomechanical changes in the herniated disk were noted, with mildly increased spinal stenosis following flexion. The authors conclude that flexion and extension MR can be a valuable adjunct examination in the evaluation of patients in the clinical setting of subacute cervical spine trauma.
Giuliano V, Giuliano C, Pinto F, Scaglione M. The use of flexion and extension MR in the evaluation of cervical spine trauma: initial experience in 100 trauma patients compared with 100 normal subjects. Emerg Radiol. 2002 Nov;9(5):249-53.

Examination - Videofluoroscopy

The following signs may be helpful in the selection of patients for musculoskeletal videofluoroscopy in those cases with persistent signs and symptoms following an appropriate conservative management:
a. hypermobility
b. hypomobility
c. aberrant motion
d. instability
e. aberrant coupling
f. paradoxical motion
g. evaluation of spinal arthrodesis

Cervical Spine Examinations:

A. Minimum Examination. (Includes the following, but must be preceded and supported by clinical and radiographic findings.) A minimum of three repetitions should be performed and all fluoroscopic exposure must be recorded digitally or videotaped.
1. Lateral projection.
a. nodding
b. full range "forced" flexion and extension.
c. relaxed flexion and extension.
2. Oblique right and left full range "forced" flexion and extension.
B. Additional Examinations (as indicated): Right and left lateral flexion (open mouth and lower cervical).
C. Optional Examination: Unsupported cross table lateral flexion/extension.
D. Check Ligament (ALAR) Examination
1. Lateral view, nodding.
2. Right and left lateral flexion open mouth.
3. Passive Stress views. Cases of incomplete tear can only be demonstrated by a passively forced lateral flexion maneuver.

Lumbar Spine Examinations:

1. Lateral projection in flexion and extension.
2. A-P right and left lateral bending.

American Chiropractic Association. American Chiropractic College of Radiology and Council on Diagnostic Imaging. Guideline for the use of musculoskeletal videofluoroscopy. 2005. http://www.dacbr.com/ACCRvideoflouroscopy.pdf

VF Assessment

The alterations in the static alignment of the cervical curvature cause alterations in the dynamic kinematics of the cervical spine during cervical flexion–extension.
Takeshima T, Omokawa S, Takaoka T, Araki M, Ueda Y, Takakura Y. Sagittal alignment of cervical flexion and extension: lateral radiographic analysis. Spine. 2002 Aug 1;27(15):E348-55.

Changes in sagittal alignment of the cervical spine affect the kinematics. Consequently, it may cause changes in the segment subjected to maximum load for overall motion and accelerate its degeneration.
Miyazaki M, Hymanson HJ, Morishita Y, He W, Zhang H, Wu G, Kong MH, Tsumura H, Wang JC. Kinematic analysis of the relationship between sagittal alignment and disc degeneration in the cervical spine. Spine. 2008 Nov 1;33(23):E870-6.

Cineradiography adds another diagnostic method of evaluating suspected soft-tissue injuries of the cervical spine by demonstrating its motion during active exercise. It is reasonable to anticipate that abnormal motion will accelerate degenerative change in the spine and will complicate the cineradiographic analysis. The cineradiographic study will have its greatest value if it can detect abnormal motion in patients who show normal spines on standard roentgenograms and before degenerative changes have occurred.
Buonocore E, Hartman JT, Nelson CL. Cineradiograms of cervical spine in diagnosis of soft-tissue injuries. JAMA. 1966 Oct 3;198(1):143-7.

Imaging Examination

SPECT/CT

The CT-SPECT scanning modality combines the virtues of functional and anatomical imaging, aiding the clinician in making the diagnosis of painful facet arthropathy.
McDonald M, Cooper R, Wang MY. Use of computed tomography-single-photon emission computed tomography fusion for diagnosing painful facet arthropathy. Technical note. Neurosurg Focus. 2007 Jan 15;22(1):E2.

Higher spatial resolution SPECT images are better accepted by referring physicians who correlate them with CT or MR images. The high negative predictive value allows radionuclide bone imaging to be used to select appropriate patients to undergo the invasive facet injection procedure.
Holder LE, Machin JL, Asdourian PL, Links JM, Sexton CC. Planar and high-resolution SPECT bone imaging in the diagnosis of facet syndrome. J Nucl Med. 1995 Jan;36(1):37-44.

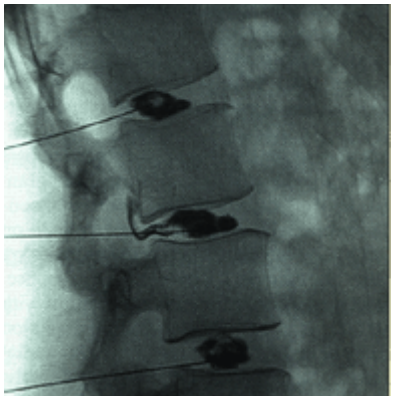
A "fire scan," involves the digital fusion or overlay of a CT scan of the area of interest with a bone scan with SPECT imaging. The fire scan provides the anatomic resolution of the CT scan plus the sensitivity of the bone scan. The premise is that combining the results of these 2 complementary studies with the clinical assessment will enhance the diagnostic capabilities of identifying a distinct structure as a source of pain. The CT portion of the study also provides useful osseous information, for example, the extent of zygapophysial (facet) joint arthropathy when considering an intra-articular injection.
Willick SE, et al. An Emerging Imaging Technology to Assist in the Localization of Axial Spine Pain
Physical Medicine and Rehabilitation 2009;1:89-92.

Discography

Significant cervical disc anular tears often escape magnetic resonance imaging detection, and magnetic resonance imaging cannot reliably identify the source(s) of cervical discogenic pain.
Schellhas KP, Smith MD, Gundry CR, Pollei SR. Cervical discogenic pain. Prospective correlation of magnetic resonance imaging and discography in asymptomatic subjects and pain sufferers. Spine. 1996 Feb 1;21(3):300-11; discussion 311-2.

These results confirm the observations of prior investigators that cervical internal disc disruption can elicit axial and peripheral symptoms. The particular patterns of pain generation allow the discographer to preprocedurally anticipate disc levels to assess.
Slipman CW, Plastaras C, Patel R, Isaac Z, Chow D, Garvan C, Pauza K, Furman M. Provocative cervical discography symptom mapping. Spine J. 2005 Jul-Aug;5(4):381-8.

Eighty-seven of 100 of the high-intensity zone discs proved concordantly painful at discography. All 87 painful and concordant discs exhibited abnormal morphology with anular tears extending either well into or through the outer third of the anulus fibrosus. Sixty-five of 67 non-high-intensity zone control discs were nonconcordant and of lower sensation intensity than the high-intensity zone discs. Only one high-intensity zone was found in the control subjects. In patients with symptomatic low back pain, the high-intensity zone is a reliable marker of painful outer anular disruption.
Schellhas KP, Pollei SR, Gundry CR, Heithoff KB. Lumbar disc high-intensity zone. Correlation of magnetic resonance imaging and discography. Spine. 1996 Jan 1;21(1):79-86.



Facet Blocks

Available literature pointed to strong evidence for controlled comparative local anesthetic facet joint medial branch blocks in the diagnosis of neck and low back pain. There was moderate evidence in the diagnosis of pain arising from thoracic facet joints. The evidence obtained from literature review suggests that controlled comparative local anesthetic blocks of facet joint nerves (medial branch or dorsal ramus) are reproducible, reasonably accurate, and safe. The sensitivity, specificity, false-positive rates, and predictive values of these diagnostic tests for neck and low back pain have been validated and reproduced in multiple studies.

Sehgal N, Shah RV, McKenzie-Brown AM, Everett CR. Diagnostic utility of facet (zygapophysial) joint injections in chronic spinal pain: a systematic review of evidence. Pain Physician. 2005 Apr;8(2):211-24.

Pain maps based on areas in which patients are relieved of pain by controlled blocks provide a more representative guide to the recognition of the segmental origin of cervical zygapophysial joint pain than do maps derived from normal volunteers.

Cooper G, Bailey B, Bogduk N. Cervical zygapophysial joint pain maps. Pain Med. 2007 May-Jun;8(4):344-53.

Cervical zygapophysial joint pain is common among patients with chronic neck pain after whiplash. This nosologic entity has survived challenge with placebo-controlled, diagnostic investigations and has proven to be of major clinical importance.

Lord SM, Barnsley L, Wallis BJ, Bogduk N. Chronic cervical zygapophysial joint pain after whiplash. A placebo-controlled prevalence study. Spine. 1996 Aug 1;21(15):1737-44; discussion 1744-5.

Facet Blocks

Spine physicians diagnose zygapophysial joint pain based on analgesic response to anesthetic injections into the zygapophysial joints or at their nerve supply. Studies on treatment of isolated zygapophysial joint pain are limited.

Dreyer SJ, Dreyfuss PH. Low back pain and the zygapophysial (facet) joints. Arch Phys Med Rehabil. 1996 Mar;77(3):290-300.

The evidence obtained from literature review suggests that controlled comparative local anesthetic blocks of facet joints (medial branch or dorsal ramus) are reproducible, reasonably accurate and safe. The sensitivity, specificity, false-positive rates, and predictive values of these diagnostic tests for neck and low back pain have been validated and reproduced in multiple studies.

Sehgal N, Dunbar EE, Shah RV, Colson J. Systematic review of diagnostic utility of facet (zygapophysial) joint injections in chronic spinal pain: an update. Pain Physician. 2007 Jan;10(1):213-28.

Standard treatment modalities for lumbar zygapophysial joint pain include intraarticular steroid injections and radiofrequency denervation of the medial branches innervating the joints, but the evidence supporting both of these is conflicting. In this article, the authors provide a comprehensive review of the anatomy, biomechanics, and function of the lumbar zygapophysial joints, along with a systematic analysis of the diagnosis and treatment of facet joint pain.

Cohen SP, Raja SN. Pathogenesis, diagnosis, and treatment of lumbar zygapophysial (facet) joint pain. Anesthesiology. 2007 Mar;106(3):591-614.

This study demonstrated that in an interventional pain management setting, facet joints are clinically important spinal pain generators in a significant proportion of patients with chronic spinal pain.

Manchikanti L, Boswell MV, Singh V, Pampati V, Damron KS, Beyer CD. Prevalence of facet joint pain in chronic spinal pain of cervical, thoracic, and lumbar regions. BMC Musculoskelet Disord. 2004 May 28;5:15.

MRI

A high incidence of discoligamentous injuries was found in whiplash-type distortions. Most patients with severe persisting radiating pain had large disc protrusions on MRI that were confirmed on surgery.
Jonsson H Jr, Cesarini K, Sahlstedt B, Rauschning W. Findings and outcome in whiplash-type neck distortions. Spine. 1994 Dec 15;19(24):2733–43.

Whiplash trauma can damage the tectorial and posterior atlanto-occipital membranes; this can be shown on high-resolution MRI.
Krakenes J, Kaale BR, Moen G, Nordli H, Gilhus NE, Rorvik J. MRI of the tectorial and posterior atlantooccipital membranes in the late stage of whiplash injury. Neuroradiology. 2003 Sep;45(9):585–91.

Whiplash injuries can be visible by functional (kinematic) magnetic resonance imaging.
Johansson BH. Whiplash injuries can be visible by functional magnetic resonance imaging. Pain Res Manag. 2006 Autumn;11(3):197–9.

MRI - Cervical Muscles

There is significantly greater fatty infiltration in the neck extensor muscles, especially in the deeper muscles in the upper cervical spine, in subjects with persistent WAD when compared with healthy controls.
Elliott J, Jull G, Noteboom JT, Darnell R, Galloway G, Gibbon WW. Fatty infiltration in the cervical extensor muscles in persistent whiplash-associated disorders: a magnetic resonance imaging analysis. Spine. 2006 Oct 15;31(22):E847-55.

Fatty infiltrates in the cervical extensor musculature and widespread hyperalgesia were not features of the insidious-onset neck pain group in this study; whereas these features have been identified in patients with chronic WAD. This novel finding may enable a better understanding of the underlying pathophysiological processes in patients with chronic whiplash.
Elliott J, Sterling M, Noteboom JT, Darnell R, Galloway G, Jull G. Fatty infiltrate in the cervical extensor muscles is not a feature of chronic, insidious-onset neck pain. Clin Radiol. 2008 Jun;63(6):681-7.

MRI High-intensity zone

The current study suggests that the high-intensity zone (HIZ) of the lumbar disc on MRI in the patient with low back pain could be considered as a reliable marker of painful outer anular disruption.
Peng B, Hou S, Wu W, Zhang C, Yang Y. The pathogenesis and clinical significance of a high-intensity zone (HIZ) of lumbar intervertebral disc on MR imaging in the patient with discogenic low back pain. Eur Spine J. 2006 May;15(5):583-7.

The lumbar disc HIZ observed on MRI in patients with low back pain is likely to represent painful internal disc disruption.
Lam KS, Carlin D, Mulholland RC. Lumbar disc high-intensity zone: the value and significance of provocative discography in the determination of the discogenic pain source. Eur Spine J. 2000 Feb;9(1):36-41.

Perianular enhancement associated with anular tears revealed thick linear patterns (2.5-7 mm thickness) along margins of anular tears on contrast enhanced axial T1-weighted images with fat suppression. Locations of perianular enhancement adjacent to anular tears were at foraminal and extraforaminal portions. CT discography showed a leak of contrast from anular tear to the perianular regions. Pain reproduction at contrast leak level during discography showed concordant pain. There was an apparent correlation between perianular enhancement on MRI and clinical symptoms or provocative epidural nerve root injection in all cases. The perianular enhancement adjacent to anular tears on MRI may be relevant in the diagnosis of symptomatic chemical radiculitis.
Byun WM, Ahn SH, Ahn MW. Significance of perianular enhancement associated with anular tears on magnetic resonance imagings in diagnosis of radiculopathy. Spine. 2008 Oct 15;33(22):2440-3.

Modic changes type 1 reflects earlier and acute stages of inflammation, whereas Modic changes type 2 are thought to be a result of previous inflammation and more progressive degeneration.
Albert HB, Manniche C. Modic changes following lumbar disc herniation. Eur Spine J. 2007 Jul;16(7):977–82

Muscle Dysfunction

Patients with whiplash associated disorder Grade II can be distinguished from healthy control subjects according to the presence of cervical muscle dysfunction, as assessed by surface electromyography of the upper trapezius muscles. Particularly the decreased ability to relax the trapezius muscles seems to be a promising feature to identify patients with whiplash associated disorder Grade II. Assessment of the muscle (dys)function by surface electromyography offers a refinement of the whiplash associated disorder classification and provides an indication to a suitable therapeutic approach.
Nederhand MJ, IJzerman MJ, Hermens HJ, Baten CT, Zilvold G. Cervical muscle dysfunction in the chronic whiplash associated disorder grade II (WAD-II). Spine. 2000 Aug 1;25(15):1938-43.

These findings may indicate that peripheral nociceptive processes are activated in WAD with generalized hypersensitivity for pressure and they are not identical with those reported in chronic work-related trapezius myalgia, which could indicate different pain mechanisms.
Gerdle B, Lemming D, Kristiansen J, Larsson B, Peolsson M, Rosendal L. Biochemical alterations in the trapezius muscle of patients with chronic whiplash associated disorders (WAD)--a microdialysis study. Eur J Pain. 2008 Jan;12(1):82-93.

Patients with whiplash showed a distinct pattern of trigger point distribution that differed significantly from other patient groups and healthy subjects. The semispinalis capitis muscle was more frequently affected by trigger points in patients with whiplash, whereas other neck and shoulder muscles and the masseter muscle did not differentiate between patients with whiplash and patients with nontraumatic chronic cervical syndrome or fibromyalgia.
Ettlin T, Schuster C, Stoffel R, Brüderlin A, Kischka U. A distinct pattern of myofascial findings in patients after whiplash injury. Arch Phys Med Rehabil. 2008 Jul;89(7):1290-3.

Cervical Curve

Average normal values and ideal normal values do exist in the literature for spinal alignment on radiographs. In the cervical spine, average 34 degrees with an ideal value of 43 degrees.
Harrison DD, Janik TJ, Troyanovich SJ, Holland B. Comparisons of lordotic cervical spine curvatures to a theoretical ideal model of the static sagittal cervical spine. Spine. 1996 Mar 15;21(6):667–75.

A statistically significant association between cervical pain and lordosis < 20 degrees and a “clinically normal” range for cervical lordosis of 31 degrees to 40 degrees. Maintenance of a lordosis in the range of 31 degrees to 40 degrees could be a clinical goal for treatment
McAviney J, Schulz D, Bock R, Harrison DE, Holland B. Determining the relationship between cervical lordosis and neck complaints. J Manipulative Physiol Ther. 2005 Mar–Apr;28(3):187–93.

The loss of cervical lordosis increases the risk of injury to the cervical spine following axial loading.
Oktenoglu T, Ozer AF, Ferrara LA, Andalkar N, Sarioglu AC, Benzel EC. Effects of cervical spine posture on axial load bearing ability: a biomechanical study. J Neurosurg. 2001 Jan;94(1 Suppl):108–14.

Localized kinking greater than 10 degrees and fanning greater than 12 mm are useful measurements by which to separate patients with true whiplash injuries from those with minor ligamentous tears. Flexion and extension views are essential to help define whiplash and other ligamentous injuries of the cervical spine.
Griffiths HJ, Olson PN, Everson LI, Winemiller M. Hyperextension strain or "whiplash" injuries to the cervical spine. Skeletal Radiol. 1995 May;24(4):263-6.

The spinal canal was significantly smaller in the patients with persistent symptoms than in the asymptomatic group. A significant difference also was found between men and women.
Narrow diameter of the cervical spinal canal is unfavorable in patients with whiplash.
Pettersson K, Kärrholm J, Toolanen G, Hildingsson C. Decreased width of the spinal canal in patients with chronic symptoms after whiplash injury. Spine. 1995 Aug 1;20(15):1664-7.

Red Flags

Defining Red Flags

Red flags are defined as indicators of serious pathology. Unlike the red flag guidelines for low back pain, there are no published guidelines on red flags for whiplash or cervical spine injury. However there is some consensus on the signs and symptoms that should alert the clinician to the presence of potential serious pathology. The list below includes the range of signs and symptoms that should be treated as potential red flags. They have been divided into two categories i.e. those requiring immediate investigation via the nearest accident and emergency department and those that should be considered precautions to treatment.

Symptoms needing urgent investigation if they develop after whiplash injury include:

- Bilateral paraesthesia in upper / lower limbs
- Gait disturbance - tripping or coordination difficulty
- Spastic paresis
- Positive Lhermittes sign i.e. shooting pain or paraesthesia into lower limbs or all four limbs with cervical flexion
- Hyperreflexia - Autonomic dysreflexia, also known as hyperreflexia, is a state that is unique to patients after spinal cord injury at a T-5 level and above.
- Nerve root signs at more than two adjacent levels
- Progressively worsening neurological signs - motor weakness, areflexia and sensory loss,
- Symptoms of upper cervical instability
- Non-mechanical pain which is unremitting and severe.

Symptoms and signs of infection (e.g. fever) Risk factors for infection (e.g. underlying disease process, immunosuppression, penetrating wound)	Infection
Past history of malignancy Age > 50 years Failure to improve with treatment Unexplained weight loss Pain at multiple sites Pain at rest	Cancer
Low back pain - Absence of aggravating features	Aortic aneurysm

Red Flags - Spinal Conditions

Myelopathy

Cervical Myelopathy is a condition where the spinal cord gets compressed in the neck. Typically is no pain with a cervical myleopathy, only loss of function. There are different types of spinal cord injuries but the most common with trauma would be cord compression usually secondarily to swelling.
We divide cord compression into 4 types:
1- lateral cord associated with the classic Brown-Séquard, characterized by features of a motor loss on the same side of the spinal injury and loss of sensation on the opposite side.
2- anterior cord (most common) associated with truncal weakness especially the pernium,
3- posterior cord (associated with spinal stenosis/kyphosis/ligament flavum hypterophy associated with abnormal propriception (positive Rhomberg's), head neck positioning, etc. and
4- central cord associated with an expanding syrnix associated with shawl like distribution of pain and temp loss (symetrical) and if large enough ventral horn cell disease as seen with a nerve root lesion.

Patients with cervical myelopathy will generally have these symptoms: neck stiffness; unilateral or bilateral deep, aching neck, arm and shoulder pain; and stiffness or clumsiness while walking

Cauda Equina Syndrome

Cauda equina syndrome is a condition caused by compression of the spinal nerves in the lowest region of the spinal canal (lumbar spine). Patients who have cauda equina may require emergency surgical treatment in order to relieve pressure on the affected nerves.

Medical screening for Red Flags

Category I: Factors that require immediate medical attention	• Blood in sputum • Loss of consciousness or altered mental status • Neurological deficit not explained by monoradiculopathy • Numbness or paresthesia in the perianal region • Pathological changes in bowel and bladder • Patterns of symptoms not compatible with mechanical pain (on physical examination) • Progressive neurological deficit • Pulsatile abdominal masses
Category II: Factors that require subjective questioning and precautionary examination and treatment procedures	• Age > 50 • Clonus (could be related to past central nervous system disorder) • Fever • Elevated sedimentation rate • Gait deficits • History of a disorder with predilection for infection or hemorrhage • History of a metabolic bone disorder • History of cancer • Impairment precipitated by recent trauma • Long-term corticosteroid use • Long-term worker's compensation • Nonhealing sores or wounds • Recent history of unexplained weight loss • Writhing pain
Category III: Factors that require further physical testing and differentiation analysis	• Abnormal reflexes • Bilateral or unilateral radiculopathy or paresthesia • Unexplained referred pain • Unexplained significant upper or lower limb weakness

Sizer PS Jr, Brismée JM, Cook C. Medical screening for red flags in the diagnosis and management of musculoskeletal spine pain. Pain Pract. 2007 Mar;7(1):53-71.

Prognosis

The rate of recovery following whiplash injury, symptoms within 7 days of accident: 86% symptomatic, 14% symptom free. Patients were more likely to improve between 3 months and 1 year and deteriorate between 1 and 2 years. Between 2 and 7.5 years, 12% described improved symptoms, 29% complained of continuing pain and 33% reported increased severity of symptoms since the accident. Symptoms largely stabilized within 3 months but there was significant fluctuation in symptom severity between 3 months and 2 years.

Symptoms

Poor outcomes following whiplash are associated with high initial: pain intensity (e.g., pain > 7/10 on VAS/NPS scale); and disability (e.g., NDI > 20/50).
The presence of either of these two factors should alert the practitioner to the potential need for more intensive treatment or earlier referral.

Radiological Findings

There is evidence that cervical kyphosis, and motion segment integrity are associated with ongoing pain symptoms following whiplash.

Crash-Related Factors

The relevance of crash-related factors in predicting outcome in whiplash is inconclusive. Vehicle damage has not been related to whiplash disorders. Rear-end impacts, being unaware, having the head turned/rotated.

Physical Impairment

Factors related to poor outcome (ongoing disability) include: hypersensitivity to specific sensitivity testing; and decrease in cervical range of motion (ROM). AMA Impairments may include motion segment integrity, sleep disturbance and other factors.

Prior History/Previous Symptoms

Previous neck pain may be associated with poor outcome in terms of ongoing disability.

Factors Associated With Poor Prognosis

High initial pain intensity, High initial disability, Injury to the facet, disc or alar ligament.
Degenerative changes are associated with a poor prognosis.
Early onset of symptoms, radiating pain and numbness and objective neurological signs Impaired neck movement, history of pretraumatic headache, history of head trauma, higher age, initial neck pain intensity, initial headache intensity, nervousness score, neuroticism score and test score on focused attention.

Features of accident mechanisms were associated with more severe symptoms: an unprepared occupant; rear-end collision, with or without subsequent frontal impact; and rotated or inclined head position at the moment of impact.
An association between development of arm pain, upper limb numbness or paraesthesia and bilateral trapezius pain and persistence of whiplash related symptoms has also been observed.

Poor Prognostic Indicators

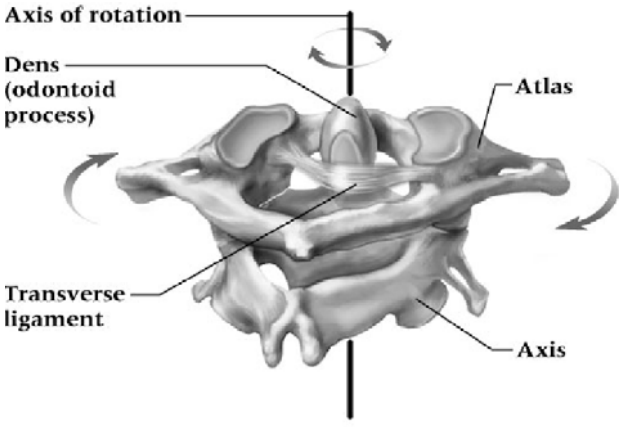
High initial disability
Sensory sensitivity
Rear-end impact
High number of complaints
High initial pain scores (VAS>7/10)
Decrease of range of motion
Prior history of neck pain or headache
Head turned at impact

Head Turned at Impact

Compared to a neutral head posture, the maximum principal strain in the facet capsule doubles on the side toward which the head is turned.
Excessive capsular strains experienced by some individuals during some whiplash conditions may be responsible for painful capsular whiplash injury.
Siegmund GP, Davis MB, Quinn KP, Hines E, Myers BS, Ejima S, Ono K, Kamiji K, Yasuki T, Winkelstein BA. Head-turned postures increase the risk of cervical facet capsule injury during whiplash. Spine. 2008 Jul 1;33(15):1643-9.

Potential ganglion compression in patients with a non-stenotic foramen at C5-6 and C6-7; in patients with a stenotic foramen the injury risk greatly increases and spreads to include the C3-4 through C6-7 as well as C4-5 through C6-7 nerve roots.
Tominaga Y, Maak TG, Ivancic PC, Panjabi MM, Cunningham BW. Head-turned rear impact causing dynamic cervical intervertebral foramen narrowing: implications for ganglion and nerve root injury. J Neurosurg Spine. 2006 May;4(5):380-7.

Head-turned rear impact caused significantly greater injury at C0-C1 and C5-C6, as compared to head-forward rear and frontal impacts, and resulted in multiplanar injuries at C5-C6 and C7-T1.
Panjabi MM, Ivancic PC, Maak TG, Tominaga Y, Rubin W. Multiplanar cervical spine injury due to head-turned rear impact. Spine. 2006 Feb 15;31(4):420-9.



A Atlas and axis

Analyzing accident mechanisms separately, rotated or inclined head position was the primary feature related to symptom persistence.
Sturzenegger M, Radanov BP, Di Stefano G. The effect of accident mechanisms and initial findings on the long-term course of whiplash injury. J Neurol. 1995 Jul;242(7):443-9.

Rotated or inclined head position at the moment of impact was associated with a higher frequency of multiple symptoms with more severe symptoms and signs of musculoligamental cervical strain and of neural, particularly radicular and damage.
Sturzenegger M, DiStefano G, Radanov BP, Schnidrig A. Presenting symptoms and signs after whiplash injury: the influence of accident mechanisms. Neurology. 1994 Apr;44(4):688-93.

The transverse and alar ligaments could be irreversibly overstretched or even ruptured when the head is rotated and, in addition, flexed by impact trauma, especially in unexpected rear-end collisions.
Saldinger P, Dvorak J, Rahn BA, Perren SM. Histology of the alar and transverse ligaments. Spine. 1990 Apr;15(4):257-61.

Elongation-induced vertebral artery injury is more likely to occur in those with rotated head posture at the time of rear impact, as compared to head-forward.
Ivancic PC, Ito S, Tominaga Y, Carlson EJ, Rubin W, Panjabi MM. Effect of rotated head posture on dynamic vertebral artery elongation during simulated rear impact. Clin Biomech (Bristol, Avon). 2006 Mar;21(3):213-20.

Criteria for Discharge

Utilizing outcomes questionnaires as a component in determining when a patient has reached maximum improvement and is ready to be discharged from therapeutic care.
A return to normal function, or a plateau in improvement, in these criteria may be used to indicate that a patient has reached maximum benefit from care.
Range of motion: A goniometer or inclinometer provides an accurate tool to assess this function.
Muscle testing: Assess muscle strength, endurance and flexor-extensor ratios utilizing manual or computerized testing devices.
Postural analysis: Assess anterior translation of the head, spinal curves and other postural landmarks with computerized devices, digital photos or plumb-line analysis.
Special functional goals for care: Evaluate other ADLs, essential functions and critical demands of employment necessary for the patient to return to pre-injury status.

Maximum Improvement is achieved when there is no improvement in clinical status for a period of 2 months as assessed with standard measurement outcomes (visual analog scale, Oswestry, Neck Disability Index, SF-36, etc.)

If treatment is withdrawn and the patient's clinical status becomes worse, the patient has not achieved Maximum Medical Improvement.

Croft AC. Treatment Paradigm for Cervical Acceleration/Deceleration Injuries (Whiplash). ACA J. 1993 January:41-45.
Schofferman J, Wasserman S. Successful treatment of low back pain and neck pain after a motor vehicle accident despite litigation. Spine. 1994 May 1;19(9):1007-10.

Resolved	
VAS, NPS	< 3/10
NDI	< 4/50

Clinical guidelines for best practice management of acute and chronic whiplash associated disorders: Clinical resource guide. TRACsa: Trauma and Injury Recovery, South Australia. Adelaide 2008.
www.tracsa.org.au/resources-whiplashassociated_disorders_information_for_health_practitioners

Treatment of Acute Whiplash-Associated Disorders

- maintaining normal life activities
- staying active is important in the recovery process
- focus on improvements in function

Treatment Recommendations for Whiplash in the Acute Stage (zero to two weeks after injury)

Manual treatment – Adjustments/mobilization

- Adjustments/Manual mobilization should be considered for the reduction of neck pain
- Adjustments/Manual mobilization should be considered to increase neck range of movement
- Adjustments/Manual mobilization should be considered to improve function
- Soft tissue techniques should be considered for the reduction of pain

Exercise therapy

- Active exercise should be used to reduce pain
- Active exercise for pain reduction should be started within four days of injury
- An active exercise program devised for each individual following assessment should be considered for the reduction of pain

Modalities (including electrotherapy) may be used in support of active therapy and flare-ups

- TENS could be considered for reducing pain
- Traction
- Ultrasound treatment
- Laser treatment
- Massage
- Acupuncture
- PEMT

Education and advice

- Advice on self-management should be provided, to reduce patients' symptoms
- Returning to normal activities as soon as possible should be encouraged
- Providing education about the origin of the pain should be considered for reducing pain
- Providing advice about coping strategies may be helpful for the reduction of pain
- Relaxation should be considered for reducing pain

Combining Manipulation/Adjustments and Exercise

- A combination of manipulation and exercise may be more effective than manipulation alone in:
  - Reducing pain
  - Improving function
  - Increasing patient satisfaction

Prescribed Function, Work Alteration

Prescribed function (i.e., return to usual activity as soon as possible) is recommended. Rehabilitation programs, which may include alteration to an individual's work schedule, may assist recovery depending on symptoms (e.g., pain, ability to concentrate) and psychosocial factors.

Exercise

ROM and muscle re-education exercises to restore appropriate muscle control and support to the cervical region in patients with WAD should be implemented immediately, if necessary in combination with intermittent rest when pain is severe. Clinical judgment is crucial if symptoms are aggravated by exercise.

Exercise Therapy

• Combined advice about coping strategies and exercise may be more effective than exercise alone in assisting people's return to normal activity
• Mobilizing exercises should be considered for the reduction of pain
• Group exercise should be considered to improve function
• Proprioceptive exercises should be considered to improve function
• Strengthening exercises may be more effective than passive treatment in improving function and in reducing pain
• Exercise based on individual assessment is likely to be better than general exercise in improving function
• Standard exercise (stretching, isometric, isotonic) to improving function
• Extension retraction exercises could be considered to improve neck function

Nutritional & Medications

• Omega 3 fatty acids, anti-oxidants and natural anti-inflammatories.
• Only simple analgesics should be prescribed for WAD Grade I.
• NSAIDs and non-opioid analgesics may be used for short term pain relief in WAD Grade II and III.

Medical Pharmacology

Medical pharmacology includes simple analgesics/non steroidal anti-inflammatory drugs (NSAIDs).
WAD Grade I – no medication other than simple analgesics should be prescribed.
WAD Grades II and III – non-opioid analgesics and NSAIDs can be used to alleviate pain in the short term. Their use should be limited to a few weeks and should be weighed up against known side effects, which appear to be dose related.
Opioid analgesics are not recommended for patients with WAD Grade I. They may be prescribed for pain relief in patients with acute WAD Grades II and III experiencing severe pain (VAS > 8) for a limited period of time.
Psychopharmacologic drugs are not recommended in patients with acute and subacute WAD of any grade. However, they can be used occasionally for symptoms such as insomnia or tension or as an adjunct to activating interventions in the acute phase.
Use of high dose intravenous methylprednisolone infusion for acute management of WAD Grades II and III is not recommended.
Opioid analgesics may be prescribed for short term pain relief of severe pain (VAS > 8) in acute WAD Grade II and III.

Postural Advice

Postural advice should be given in combination with manual and physical therapies and exercise.

Traction

A regime of traction should only be given to patients with WAD in combination with manual and physical therapies and exercise, with evidence of continuing measurable improvement.

Acupuncture

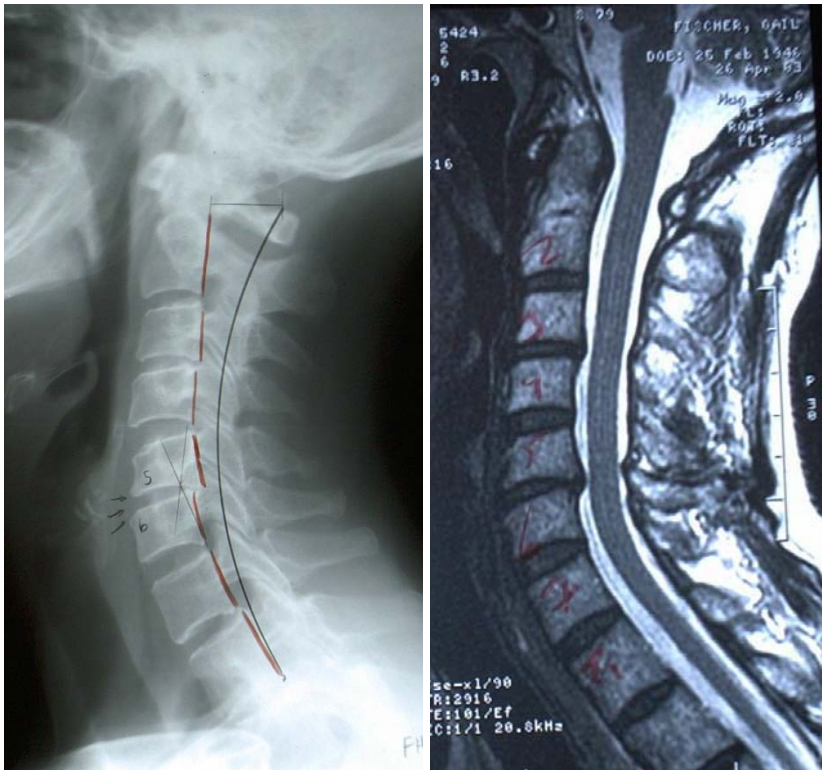
A regime of acupuncture should only be given to patients with WAD in combination with manual and physical therapies and exercise, with evidence of continuing measurable improvement.

Modalities
For acute whiplash and flare-ups, other professionally administered passive modalities/ electrotherapies are optional adjuncts to manual and physical therapies and exercise, with emphasis on return to usual activity as soon as possible.
Modalities/ electrotherapies include heat, ice, massage, transcutaneous electrical nerve stimulation (TENS), pulsed electromagnetic treatment (PEMT), electrical stimulation, ultrasound, laser, and shortwave diathermy.

Manipulation Under Anesthesia/Sedation
During the treatment Manipulation under anesthesia/sedation may be beneficial in patients with chronic pain that affects work or activities of daily living. This procedure has been shown to be effective in selected cases. *(*Gerber, JAOA 1960;60:212-216; Davis, JNMS 1996;4:102-116; Herzog, JMPT 1999;22:166-170; West, JMPT 1999;22:299-308**)**

Surgical Treatment
Surgery is uncommon in patients with WAD. Surgery may be indicated in Grade III with persistent arm pain consistent with cervical radiculopathy (supported by appropriate investigations) that does not respond to conservative management, or with rapidly progressing neurological deficit. Other invasive measures may be needed depending upon the case.

Regeneration Injection Therapy
Invasive Intraarticular regeneration injection therapy can improve pain and function. RIT can last as long as or longer than patients with radiofrequency neuronatomy. When combined with spinal manipulation, exercise and other co-interventions, prolotherapy may improve chronic back pain and disability.



X-ray and MRI of the same person.

Treatment – Chiropractic

Treatment

Pain data from randomized cntroled trials (RCTs) did not support claims of restricting Chiropractic care to 6-12 visits for headaches, neck pain, cervicobrachial pain, and/or upper back pain. In fact, assuming a constant linear dosage response, the data indicated a minimum of 24 visits on average would be needed to document, resolve, and stabilize these conditions.
Maltby J, et al. Frequency & Duration of Chiropractic Care for Headaches, Neck and Upper Back Pain. J. Vertebral Subluxation Res. August 21, 2008.

Patients received an average of 30.6 treatment sessions over 11.1 weeks. Patients had significant debilitating pain and complications from neck injuries secondary to MVA. After application of SCALE methods, 84% of the patients experienced complete or near complete resolution of their pain and other neck related complications. All patients reported significant improvements in their conditions with 53% of the patients experiencing complete recovery. Range of motion (ROM) and other measurements of cervical spine function also improved. These findings showed durability for the duration of the measured post-treatment period.
Carleton J, et al. Resolution of Cervical Complications Secondary to Motor Vehicle Accidents by the Application of Stereotactic Cervical Alignment (SCALE) Methods: Statistical Review of 54 Patients. Journal of Whiplash & Related Disorders, Vol. 5(1) 2006: 15-24.

Mean visits: WAD I: 19.9; WAD II: 34.7
Range: WAD I: 6 – 30; WAD II: 15 – 66
In this study Grade I patients almost completely recover with this type of treatment and Grade II patients improve substantially. Chiropractic therapy in acute whiplash patients Grade I & II appears to provide at least short-term benefits despite ongoing pending litigation.
Davis CG. Chiropractic Treatment in Acute Whiplash Injuries: Grades I & II. J. Vertebral Subluxation Res. May 19, 2008.

Treatment

A retrospective study was undertaken to determine the effects of chiropractic in a group of 28 patients who had been referred with chronic 'whiplash' syndrome. 93 per cent of patients improved following chiropractic treatment. Techniques used included specific spinal manipulation, proprioceptive neuromuscular facilitation (PNF) and cryotherapy. Spinal manipulation is a high-velocity low-amplitude thrust to a specific vertebral segment aimed at increasing the range of movement in the individual facet joint, breaking down adhesions.
Woodward MN, Cook JC, Gargan MF, Bannister GC. Chiropractic treatment of chronic 'whiplash' injuries. Injury. 1996 Nov;27(9):643-5.

The results from this study provide further evidence that chiropractic is an effective treatment for chronic whiplash symptoms. Patients underwent a mean of 19.3 treatments (range 1 - 53), over a period of 4.1 months.
Khan S, Cook J, Gargan M, Bannister G. A symptomatic classification of whiplash injury and the implications for treatment. Journal of Orthopaedic Medicine 1999;21(1):22-25.

The results of this efficacy study suggest that spinal manipulation, if not contraindicated, may be superior to needle acupuncture or medication for the successful treatment of patients with chronic spinal pain syndrome, except for those with neck pain. The Neck Disability Index showed that for neck pain, acupuncture achieved a better result than manipulation.
Giles LGF, Muller R. Chronic spinal pain - a randomized clinical trial comparing medication, acupuncture, and spinal manipulation. Spine *2003;28:1490-1503.*

Our best evidence synthesis suggests that therapies involving manual therapy and exercise are more effective than alternative strategies for patients with neck pain; this was also true of therapies which include educational interventions addressing self-efficacy.
Hurwitz EL, Carragee EJ, van der Velde G, Carroll LJ, Nordin M, Guzman J, Peloso PM, Holm LW, Côté P, Hogg-Johnson S, Cassidy JD, Haldeman S; Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. Treatment of neck pain: noninvasive interventions: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. Spine. 2008 Feb 15;33(4 Suppl):S123-52.

Treatment – Electrical Stimulation

Electrical stimulation of peripheral nerves leads to inhibitory input to the pain pathways at the spinal cord level.
Hanai F. Effect of electrical stimulation of peripheral nerves on neuropathic pain. Spine 2000; 25:1886-92.

The same TENS protocol had different degrees of antinociceptive influence on chronic and acute pain in chronic low back pain patients.
Cheing GL, Hui-Chan CW. Transcutaneous electrical nerve stimulation: nonparallel antinociceptive effects on chronic clinical pain and acute experimental pain. Arch Phys Med Rehabil. 1999 Mar;80(3):305-12.

After the six-week treatment, patients in the TENS and exercise group had a better and clinically relevant improvement in disability, isometric neck muscle strength, and pain. All the improvements in the intervention groups were maintained at the six-month follow-up.
Chiu TT, Hui-Chan CW, Chein G. A randomized clinical trial of TENS and exercise for patients with chronic neck pain. Clin Rehabil. 2005 Dec;19(8):850-60.

The overall results showed a significant decrease in pain with electrical nerve stimulation (ENS) therapy using a random-effects model ($p<0.0005$). These results indicate that ENS is an effective treatment modality for chronic musculoskeletal pain and that previous, equivocal results may have been due to underpowered studies.
Johnson M, Martinson M. Efficacy of electrical nerve stimulation for chronic musculoskeletal pain: a meta-analysis of randomized controlled trials. Pain. 2007 Jul;130(1-2):157-65.

Transcutaneous electrical nerve stimulation (TENS) is a nonpharmacologic treatment for pain relief. TENS has been used to treat a variety of painful conditions. Clinical trials suggest that adequate dosing, particularly intensity, is critical to obtaining pain relief with TENS.

These results suggest that 2000 Hz stimulation excites selectively A-beta fibers and 5 Hz stimulation activates noxious transmission mediated mainly through C fibers. Although 250 Hz stimulation activates both A-delta and A-beta fibers, tactile sensation would not be perceived when painful sensation is produced at the same time. Therefore, 250 Hz was effective stimulus frequency for activation of A-delta fibers initiating noxious sensation. Thus, the transcutaneous sine-wave stimulation can be applied to evaluate functional changes of sensory transmission by comparing thresholds with the three stimulus frequencies.
Koga K, Furue H, Rashid MH, Takaki A, Katafuchi T, Yoshimura M. Selective activation of primary afferent fibers evaluated by sine-wave electrical stimulation. Mol Pain. 2005 Mar 25;1:13.

Greater benefit would be obtained using short-duration (2-4 millisecond), rectangular bursts of kilohertz-frequency AC with a frequency chosen to maximize the desired outcome.
Ward AR. Electrical stimulation using kilohertz-frequency alternating current. Phys Ther. 2009 Feb;89(2):181-90.

Shifting between low- and high-frequency stimulation for 3 seconds each (2hz/100hz stimulation) produced a more potent analgesic effect than induced by constant frequency stimulation.
Han JS. Acupuncture: neuropeptide release produced by electrical stimulation of different frequencies. TINS 2003;26(1):17-22.

For pain relief, electrical nerve stimulation (ENS) was significantly better than EMS; but for the improvement of ROM, electrical muscle stimulation (EMS) was significantly better than ENS. It is concluded that ENS is more effective for immediate relief of myofascial trigger point pain than EMS, and EMS has a better effect on immediate release of muscle tightness than ENS.
Hsueh TC, Cheng PT, Kuan TS, Hong CZ. The immediate effectiveness of electrical nerve stimulation and electrical muscle stimulation on myofascial trigger points. Am J Phys Med Rehabil. 1997 Nov-Dec;76(6):471-6.

Treatment – Nutrition

N-3 fatty acids inhibit TNF alpha and IL-1 beta synthesis (pro-inflammatory cytokines).
Caughey GE, Mantzoris E, Gibson RA, Cleland LG, James MJ. The effect on tumor necrosis factor alpha and interleukin 1 beta production of diets enriched in n-3 fatty acids from vegetable oil or fish oil. Am J Clin Nutr 1996; 63:116-22.

The results demonstrate n-3 PUFA (EPA) positively affect the healing characteristics of ligament cells and therefore may represent a possible noninvasive treatment to improve ligament healing.
Hankenson KD, Watkins BA, Schoenlein IA, Allen KGD, Turek JJ. Omega-3 fatty acids enhance ligament fibroblast collagen formation in association with changes in interleukin-6 production. Proceedings of the Society for Experimental Biology and Medicine: PSEBM 2000; 223:88-95.

Trials of glucosamine and chondroitin preparations for osteoarthritis symptoms demonstrate moderate to large effects, but quality issues and likely publication bias suggest that these effects are exaggerated. Nevertheless, some degree of efficacy appears probable for these preparations.
McAlindon TE, LaValley MP, Gulin JP, Felson DT. Glucosamine and chondroitin for treatment of osteoarthritis: a systematic quality assessment and meta-analysis JAMA 2000 Mar 15;283(11):1469-75.

Qxidative damage to mitochondrial DNA may play a significant role in normal aging.
Lin MT, Beal MF. The oxidative damage theory of aging. Clinical Neuroscience Research 2003;305–315.

The results support the hypothesis that antioxidants decrease genetic damage. The supplement consisted of vitamin C (100 mg/day), vitamin E (100 mg/day), β-carotene (6 mg/day) and selenium (50µg/day). Supplementation with antioxidants was associated with a decrease in the percentage of cells with chromosome aberrations in the group of rural controls (0.63% before compared with 0.27% after supplementation. The largest effect of supplementation was seen in smokers.
Dusinska M et al. Nutritional supplementation with antioxidants decreases chromosomal damage in humans. Mutagenesis 2003;18(4):371–376.

Pycnogenol (Maritime Pine Bark) Pycnogenol, like white willow bark, is a nutraceutical material that has been used since ancient times. Hippocrates mentions its use as an anti-inflammatory agent. It contains a potent blend of active polyphenols that includes catechin, taxifolin, procyanidins, and phenolic acids. It is one of the most potent antioxidant compounds currently known. Pycnogenol inhibits TNFa-induced NF-kB activation as well as adhesion molecule expression in the endothelium.
Curcumin is known to inhibit inflammation by suppressing NF-kB, 4 restricting various activators of NF-kB as well as stemming its expression it regulates the activity of several enzymes and cytokines by inhibiting both COX-1 and-2.
Uncaria tomentosa (Cat's Claw) has been shown to prevent the activation of the transcriptional factor NF-kB64,144,149 and it directly inhibits TNFa production by up to 65 to 85%.
Capsaicin (Chili Pepper) Capsaicin potently activates transient receptor potential vanilloid 1, which is a main receptor underlying nociception. It also inhibits NF-kB, thus producing an anti-inflammatory effect.
Maroon JC, Bost JW, Borden MK, Lorenz KM, Ross NA. Natural antiinflammatory agents for pain relief in athletes. Neurosurg Focus. 2006 Oct 15;21(4):E11.

Nutritional deficiencies can impede wound healing, and several nutritional factors required for wound repair may improve healing time and wound outcome. Vitamin A is required for epithelial and bone formation, cellular differentiation, and immune function. Vitamin C is necessary for collagen formation, proper immune function, and as a tissue antioxidant. Bromelain reduces edema, bruising, pain, and healing time following trauma and surgical procedures. Adequate dietary protein is absolutely essential for proper wound healing, and tissue levels of the amino acids arginine and glutamine may influence wound repair and immune function.
MacKay D, Miller AL. Nutritional support for wound healing. Altern Med Rev. 2003 Nov;8(4):359-77.

Treatment – Laser therapy

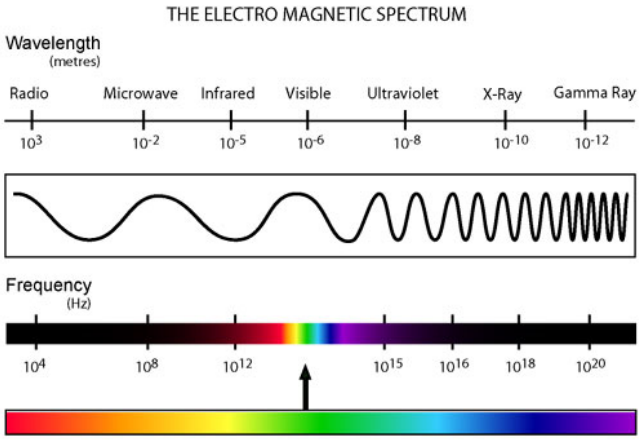
Low-Level Laser Therapy (LLLT)

The patients were submitted to 12 sessions on alternate days to a total energy dose of 5 J each. Those in the placebo group submitted to the same number of sessions following an identical procedure, the only difference being that the laser apparatus was nonoperational. Pain was monitored using the Italian version of the McGill pain questionnaire and the Scott-Huskisson visual analogue scale. The results show a pain attenuation in the treated group and a statistically significant difference between the two groups of patients, both at the end of therapy and at the 3-month follow-up examination.

Ceccherelli F, Altafini L, Lo Castro G, Avila A, Ambrosio F, Giron GP. Diode laser in cervical myofascial pain: a double-blind study versus placebo. Clin J Pain. 1989 Dec;5(4):301-4.

The mean VAS pain scores improved by 2.7 in the treated group and worsened by 0.3 in the control group (difference 3.0, 95% CI 3.8-2.1). Significant improvements were seen in the active group compared to placebo for SF-36-Physical Score (SF36 PCS), NPNQ, NPAD, MPQVAS and SAI. The results of the SF-36 - Mental Score (SF36 MCS) and other MPQ component scores (afferent and sensory) did not differ significantly between the two groups. Low-level laser therapy (LLLT), at the parameters used in this study, was efficacious in providing pain relief for patients with chronic neck pain over a period of 3 months.

Chow RT, Heller GZ, Barnsley L. The effect of 300 mW, 830 nm laser on chronic neck pain: a double-blind, randomized, placebo-controlled study. Pain. 2006 Sep;124(1-2):201-10.



In active laser group, statistically significant improvements were detected in all outcome measures compared with baseline while in the placebo laser group, significant improvements were detected in only pain score at rest at the 1 week later of the end of treatment. The score for self-assessed improvement of pain was significantly different between the active and placebo laser groups (63 vs. 19%). This study revealed that short-period application of LLLT is effective in pain relief and in the improvement of functional ability and QoL in patients with MPS.

Gur A, Sarac AJ, Cevik R, Altindag O, Sarac S. Efficacy of 904 nm gallium arsenide low level laser therapy in the management of chronic myofascial pain in the neck: a double-blind and randomize-controlled trial. Lasers Surg Med. 2004;35(3):229-35.

Significant positive effects were reported in four of five trials in which infrared wavelengths (lambda = 780, 810-830, 904, 1,064 nm) were used. This review provides limited evidence from one RCT for the use of infrared laser for the treatment of acute neck pain (n = 71) and chronic neck pain from four RCTs (n = 202).

Chow RT, Barnsley L. Systematic review of the literature of low-level laser therapy (LLLT) in the management of neck pain. Lasers Surg Med. 2005 Jul;37(1):46-52.

LLLT seemed to be beneficial for pain in MPS by using algometry and thermography.

Hakgüder A, Birtane M, Gürcan S, Kokino S, Turan FN. Efficacy of low level laser therapy in myofascial pain syndrome: an algometric and thermographic evaluation. Lasers Surg Med. 2003;33(5):339-43.

Pain, paravertebral muscle spasm, lordosis angle, the range of neck motion and function were observed to improve significantly in the low-power laser (LPL) group, but no improvement was found in the placebo group. LPL seems to be successful in relieving pain and improving function in osteoarthritic diseases.

Ozdemir F, Birtane M, Kokino S. The clinical efficacy of low-power laser therapy on pain and function in cervical osteoarthritis. Clin Rheumatol. 2001;20(3):181-4.

Treatment – Massage

The Fibromyalgia Impact Questionnaire and a physical examination scoring tender points (number, pain intensity). Evaluations were conducted at the screening visit, after 7 sessions, and after completion of 15 sessions.
Most of the parameters (pain intensity, physical function, number of tender points) showed a significant improvement at visit 15 compared with screening. The findings suggest the possibility that the studied intervention might be associated with positive outcomes in women with fibromyalgia.
Gordon C, Emiliozzi C, Zartarian M. Use of a mechanical massage technique in the treatment of fibromyalgia: a preliminary study. Arch Phys Med Rehabil. 2006 Jan;87(1):145-7.

Massage therapy is effective in reducing pain, stress hormones and symptoms associated with chronic low back pain.
Adults (Mean age=39.6 years) with low back pain with a duration of at least 6 months received two 30-min massage or relaxation therapy sessions per week for 5 weeks. Participants receiving massage therapy reported experiencing less pain, depression, anxiety and their sleep had improved. They also showed improved trunk and pain flexion performance, and their serotonin and dopamine levels were higher.
Hernandez-Reif M, Field T, Krasnegor J, Theakston H. Lower back pain is reduced and range of motion increased after massage therapy. Int J Neurosci. 2001;106(3-4):131-45.

Sixty-four such patients were randomized to receive up to 10 massages over 10 weeks or a self-care book At 10 weeks, more participants randomized to massage experienced clinically significant improvement on the Neck Disability Index [39% vs. 14% of book group; relative risk (RR)=2.7; 95% confidence interval (CI), 0.99-7.5] and on the symptom bothersomeness scale (55% vs. 25% of book group. After 26 weeks, massage group members tended to be more likely to report improved function.
Massage is safe and may have clinical benefits for treating chronic neck pain at least in the short term.
Sherman KJ, et al. Randomized Trial of Therapeutic Massage for Chronic Neck Pain. Clin J Pain 2009;25:233–238.

21 female patients suffering from chronic tension headache received 10 sessions of upper body massage consisting of deep tissue techniques in addition to softer techniques in the beginning. When found, trigger points were carefully and forcefully massaged. The range of cervical movements, surface ENMG on mm. frontalis and trapezius, visual analogue scale (VAS) and Finnish Pain Questionnaire (FPQ), and the incidence of neck pain during a two week period before and after the treatment, and at 3 and 6 months during the follow-up period together with Beck depression inventory were taken for evaluation and follow-up. The range of movement in all directions increased, and FPQ, VAS and the number of days with neck pain decreased significantly. There was a significant change in ENMG on the frontalis muscle whereas changes in trapezius remained insignificant. Beck inventory showed an improvement after the treatment. This study confirmed clinical and physiological effects of massage.
Puustjärvi K, Airaksinen O, Pöntinen PJ. The effects of massage in patients with chronic tension headache. Acupunct Electrother Res. 1990;15(2):159-62.

Headache frequency decreased from 4.7+/-0.7 episodes per week during baseline to 3.7+/-0.9 during treatment period 2; reduction was also noted during the follow-up phase (3.2+/-1.0). Secondary measures of headache also decreased across the study phases with headache intensity decreasing by 30% and headache duration from 4.0+/-1.3 to 2.8+/-0.5 hours. A corresponding improvement in Headache Disability Index was found with massage. This pilot study provides preliminary evidence for reduction in headache pain and disability with massage therapy that targets myofascial trigger points.
Moraska A, Chandler C. Changes in Clinical Parameters in Patients with Tension-type Headache Following Massage Therapy: A Pilot Study. J Man Manip Ther. 2008;16(2):106-12.

Stages of Injury	
Stage I	**Acute;** Inflammatory phase; Up to 72 hours
Stage II	**Subacute;** Repair phase; 72 hours to 14 weeks
Stage III	**Remodeling phase;** 14 weeks to 12 months or more
Stage IV	**Chronic;** Permanent

Adapted from Croft, AC: "A Proposed Classification of Cervical Acceleration/Deceleration Injuries with a Review of Prognostic Research" Palmer J Research 1994; 1(1): 10-21. (78)

Stages of Care: The Mercy Document (Table II, Pg. 120, Mercy) (79)

Passive Care

The doctor is doing most of the work

Acute Intervention

1. To promote anatomical rest
2. To diminish muscular spasm
3. To reduce inflammation
4. To alleviate pain

Active Care

The doctor and patient are doing the work together

Remobilization

1. To increase pain-free ROM
2. To minimize deconditioning

Rehabilitation

1. To restore strength and endurance
2. To increase physical work capacity

Life Style Adaptations

1. To modify social and recreational activity
2. To diminish work environment risk factors
3. To adapt psychological factors affecting or altered by the spinal disorder

1. Croft, AC: "A Proposed Classification of Cervical Acceleration/Deceleration Injuries with a Review of Prognostic Research" Palmer J Research 1994; 1(1): 10-21.
2. The Guidelines for Chiropractic Quality Assurance and Practice Parameters, Proceedings of the Mercy Center Consensus Conference, held January 25-30, 1992, Aspen Publishers Inc., 200 Orchard Ridge Drive, Gaithersburg, MD 20878.

Grades of Severity of Injury

Grade I Minimal; No limitation of motion; No ligamentous injury; No neurological findings

Grade II Slight; Slight: Limitation of motion; no ligamentous injury; no neurological findings. Neck complaint and musculoskeletal signs.

Grade III Moderate; Limitation of motion; ligamentous instability; neurological symptoms. Common symptoms: Neck and arm pain; Cervical herniated disc; Neck pain with headache; Cervicoscapulalgia (pain referred to upper back)

Grade IV Moderate to Severe; Limitation of motion; some ligamentous injury; neurological symptoms; fracture or disc derangement.

Grade V Severe; Requires surgical management/stabilization

Norris & Watt (1983)

Group 1 comprised patients complaining of symptoms related to their injuries but with no abnormality on physical examination.

Group 2 comprised patients who in addition to symptoms had a reduced range of movement of the cervical spine but no abnormal neurological signs.

Group 3 comprised patients with symptoms, a reduced range of cervical movement and evidence of objective neurological loss.

Norris SH, Watt I. The prognosis of neck injuries resulting from rear-end vehicle collisions. J Bone Joint Surg Br. 1983 Nov;65(5):608-11.

Croft (1993)

I Minimal: no limitation of motion; no igamentous injury or neurological findings

II Slight: limitation of motion; no ligamentous injury or neurological findings

III Moderate: limitation of motion; some ligamentous injury; neurological findings may be present

IV Moderate to severe: limitation of motion; ligamentous instability; neurological findings present; fracture or disc derangement*

V Severe: requires surgical management/stabilization

Croft AC. Treatment paradigm for cervical acceleration/deceleration injuries (whiplash). ACA Journal of Chiropractic 30(1):41-45, 1993.

Quebec Task Force on Whiplash (1995)

0 No complaints about the neck, no physical signs

1 Neck complaints of pain, stiffness, or tenderness only No physical signs

2 Neck complaint AND Musculoskeletal signs (decreased range of motion and point tenderness)

3 Neck complaint AND neurological signs (decreased or absent deep tendon reflexes, weakness, and sensory deficits)

4 Neck complaint AND fracture or dislocation

Symptoms and disorders that can be manifest in all grades include deafness, dizziness, tinnitus (ringing in the ears), headache, memory loss, dysphagia (difficulty swallowing), and temporomandibular joint pain.

Walter O. Spitzer et al. Scientific Monograph of the Quebec Task Force on Whiplash - Associated Disorders: Redefining "Whiplash" and its Management. Spine, Volume 20, Number 8S, 1995.

FREQUENCY AND DURATION GUIDELINES

Guidelines for Frequency and Duration of Care in Cervical Acceleration/Deceleration Trauma

	Daily	3x/wk	2x/wk	1x/wk	1x/mo	T_D [1]	T_N [2]
Grade I	1 wk	1-2 wk	2-3 wk	<4 wk	....[3]	<11 wk	<21
Grade II	1 wk	<4 wk	<4 wk	<4 wk	<4 mo	<29 wk	<33
Grade III	1-2 wk	<10 wk	<10 wk	<10 wk	<6 mo	<56 wk	<76
Grade IV	2-3 wk	<16 wk	<12 wk	<20 wk	....[3]	....[3]	....[3]
Grade V	**Surgical stabilization necessary--chiropractic care is post-surgical**						

Adapted from: Croft AC. Treatment paradigm for cervical acceleration/deceleration injuries (whiplash). Am Chiro Assoc J Chiro 30(1): 41-45, 1993.

[1] T_D indicates treatment duration; T_N treatment total number; [2] Possible follow-up at 1 month.

[3] May require permanent monthly or p.r.n. treatment.

Do the guidelines include provisions for flare-ups of the condition? No, they do not. Those cases with several flare-ups, complicating factors, and/or risk factors are inherently almost impossible to assign meaningful treatment and duration parameters. In such cases, the treating doctor is in the best possible position to determine the medical necessity for treatment.

Lewkovich GN. Questions and Answers Regarding the Croft Whiplash Treatment Guidelines with Arthur C. Croft, DC, MS, DABCO. Calif Chiro Assn J 2003, April:22-26.

Mercy conference guidelines

Acute uncomplicated case (<6 wks symptoms): Up to 5 visits a week for the first 2 weeks, then 3 visits a weeks after that for a maximum of 6–8 weeks (maximum 28 visits) to return to preepisode status.

Subacute case (>6 but less than 16 weeks): average 2 visits a week for 6 to 16 weeks (max 16 visits) to return to preepisode status.

Chronic case: passive care not indicated unless there has been an acute exacerbation of the chronic condition.

Complicated case: exceeds the recommended duration of care but still fits within the guidelines.

Pain >8 days duration before presenting for care may take 1.5x longer to recover.

Severe pain may take 2x longer to recover.

4 to 7 previous episodes may take 2x longer.

Pre-existing conditions, underlying pathologies or anomalies may take 1.5 to 2 times longer.

Factors complicating recovery:

- biomechanical stress

- psychological stress
- poor compliance
- prolonged static stress
- re-injury exacerbation
- multilevel DJD
- spondylolisthesis

All may delay recovery and necessitate a need for additional care that may exceed the recommended guidelines for simple uncomplicated cases.

Haldeman S, Chapman-Smith S, Peterson SM. Guidelines for Chiropractic Quality Assurance and Practice Parameters: Proceedings of the Mercy Center Consensus Conference. Frederick, Maryland, U.S.A. Aspen Pub. 1992. Chapter 8.

Recently published the Council on Chiropractic Guidelines and Practice Parameter (CCGPP) recommendations in support of manipulation for both acute and chronic low back pain closely mirrors that of the Mercy Conference and other reviews.

Frequency and duration for continuing courses of treatments

Stage of condition	Frequency	Duration (wk)	Reevaluate after (no. of treatments)
Acute	2-3× weekly	2-4	4-12
Subacute	2-3× weekly	2-4	4-12
Chronic	1-3× weekly	2-4	2-12
Recurrence/flare-up	1-3× weekly	1-2	1-6

Globe GA, Morris CE, Whalen WM, Farabaugh RJ, Hawk C; Council on Chiropractic Guidelines and Practice Parameter. Chiropractic management of low back disorders: report from a consensus process. J Manipulative Physiol Ther. 2008 Nov-Dec;31(9):651-8.

International Chiropractic Association Best Practice Guidelines
Equivalent treatment parameters

Grade I #1C

1C) 3 visits per week for 7 weeks + 1 visit per week for 4 weeks + 1 follow-up exam visit (which is 25 visits in 11 weeks)

Grade II #2C

2 C) 3 visits per week for 7 weeks + 12 visits for 4 weeks + 1 visit per week for 4 weeks + 1 follow-up exam visit; (which is 37 visits in 15 weeks).

Grade III #6C

6 C) 3 visits per week for 7 weeks + 60 visits for 20 weeks + 1 visit per week for 4 weeks + 1 follow-up exam visit; (which is 85 visits in 31 weeks)

ICACBPG Chapter 11 Frequency & Duration Recommendations.
www.icabestpractices.org

Common Factors Potentially Complicating Whiplash Trauma Management

1. Advanced age
2. Metabolic disorders
3. Congenital anomalies of the spine
4. Developmental anomalies of the spine
5. Degenerative disc disease
6. Disc protrusion (HNP)
7. Spondylosis
8. Facet arthrosis
9. Rheumatoid arthritis or other arthritides affecting the spine
10. Ankylosing spondylitis or other spondylarthropathy
11. Scoliosis
12. Prior cervical spinal surgery [1]
13. Prior lumbar spinal surgery [1]
14. Prior vertebral fracture
15. Osteoporosis
16. Paget's disease or other disease of bone
17. Spinal stenosis or foraminal stenosis
18. Paraplegia or quadriplegia
19. Prior spinal injury

[1] Especially laminectomy and discectomy.

From Croft AC: Treatment paradigm for cervical acceleration/deceleration injuries (whiplash). Am Chiro Assoc J 1993; 30(1): 41-45.

Imaging - Significant Signs of Cervical Spine Trauma

Significant signs of cervical spine trauma

I. Abnormal soft tissues
- A. Widened retropharyngeal space
- B. Widened retrotracheal space
- C. Displacement of prevertebral fat stripe
- D. Tracheal deviation and laryngeal dislocation

II. Abnormal vertebral alignment
- A. Loss of lordosis
- B. Acute kyphotic angulation
- C. Torticollis
- D. Widened interspinous space
- E. Rotation of vertebral bodies

III. Abnormal joints
- A. Widened middle atlanto-axial joint
- B. Abnormal intervertebral disc
- C. Widening of the apophyseal joints

Clark WM, Gehweiler JA, Laib R. Twelve significant signs of cervical spine trauma*. Skeletal Radiol. 1979; 3: 201-205.*

Treatment Adjuncts in Cervical Acceleration/Deceleration Trauma				
Modality	**Stage I**	**Stage II**	**Stage III**	**Stage IV**
Cervical pillow	All grades	All grades	All grades	All grades
Cervical collars	As needed, temporary use.			
- **Rigid**	Grades III-V	Grades III-V	--------	--------
- **Soft**	Grades II and III	--------	--------	--------
Home traction	--------	Grades II-IV Unless contraindicated	Grades II-IV	Grades II-IV
Home exercise	--------	Grades II-IV Unless contraindicated	Grades II-IV Unless contraindicated	--------
Ice	All grades	All grades	As needed	--------
Vit/min. suppl.	All grades	All grades	All grades	Recommended
DTM Deep tissue massage	Grades II-IV	Grades II-IV	As needed	--------

Foreman SM, Croft AC (eds): Whiplash Injuries: the Cervical Acceleration/Deceleration Syndrome, 3rd edition, Lippincott Williams & Wilkins, Baltimore, 2001. Pg. 539.

Chronic Whiplash Pathway > 12 weeks

Improving - Continue recommended treatments.
Resolving
Reduce frequency of treatment.
Promote independence in program.

Not Improving
Review treatment regime. Other treatments not initially recommended may be considered. Passive treatment in combination with active treatment.

12 + 6 weeks post initial presentation in chronic phase
Reassess patient - should include pain scale (VAS,NRS) and NDI and reassessment of psychological status

Improving - Continue recommended treatments.
Resolving
Reduce frequency of treatment.
Promote independence in program.

Not Improving
Refer to specialist or consider type and dose of current treatment

12 + 12 weeks post initial presentation in chronic phase
Reassess patient - should include pain scale (VAS,NRS) and NDI and reassessment of psychological status

Improving - Continue recommended treatments.
Resolving
Reduce frequency of treatment.
Promote independence in program.

Not resolving
If pain and disability remain high (VAS, NRS >5.5. NDI >20/50) or unchanged refer to specialist

Resolved
VAS, NRS < 3/10
NDI < 4 /50
Cease treatment

12 weeks + 6 months post initial presentation in chronic phase. Resolution should have occurred in up to 65% of cases 12 months post accident. In these cases treatment should have ceased. At this point, even if resolution has not occurred and provided 6 months of appropriate treatment has been undertaken, treatment should be reduced. Patients at this stage should receive periodic review. Practitioners should encourage patients to continue an *active exercise* program and should emphasize *self-directed active management* strategies. Alternatively, discharge from your treatment and refer back to primary practitioner. When there is no demonstrable evidence of benefit*, consider appropriate referral to another relevant practitioner.

Resolving
Continue treatment with periodic review (suggested monthly).

Not resolving
Consider other therapy.
Follow specialist recommendation.

Periodic review as required, encourage and emphasize continued active self-directed management.
Continue active exercise program.
Alternatively, discharge from your treatment and refer back specialist.

Course of Recovery After Whiplash

Time after injury	% Recovered*	Pain Mean: scale 0-100† (95%CI)	Disability Mean: scale 0-100‡ (95%CI)
1 month	44%	38.0 (21.8-54.1)	28.6 (20.4-36.7)
12 months	65%	25.3 (11.7-39.0)	19.0 (13.0-25.0)
2 years	No data available	21.5 (3.4-39.6)	15.6
5 years	75%	No data available	No data available

**Recovery defined by individual studies (absence or minimal pain and/or disability)*

†Where 0 is no pain and 100 is worst pain imaginable ‡Where 0 is no disability and 100 is total disability

TRACsa: Trauma and Injury Recovery. Clinical guidelines for best practice management of acute and chronic whiplash-associated disorders - Evidence Report. Adelaide, SA: TRACsa; 2008.

Emergency department cases

At 1 year 36% Intermittent pain 58% symptomatic 6% Severe pain

Deans GT, McGalliard IN, Kerr M, Rutherford WH. Neck sprain - a major cause of disability following car accidents. Injury 1987;18:10-12.

At 2 years 14% Minor discomfort 44% Major complaints

Hildingsson C, Toolanen G. Outcome after soft tissue injury of the cervical spine: a prospective study of 93 car accident victims. Acta Orthop Scand 1990;61:357-9.

At 10 years 28% Intrusive symptoms 12% Severe symptoms

Gargan MF, Bannister GC. Long term prognosis of soft tissue injuries of the neck. J Bone Joint Surg 1990;72B: 901-3.

Research clinic

Symptomatic patients 44% at 3 months; 31% at 6 months; 24% at 12 months

Radanov BP, Sturzenegger M, DiStefano G, Schnidrig A. Relationship between early somatic, radiological, cognitive and psychosocial findings and outcome during a one year follow-up in 117 patients suffering from common whiplash. BrJ RheumatoI1994;33:442-8.

Authors Study	Year of Studied	No. Collisions	Type of Follow-up	# Years	% Chronic
Hohl	1974	146	Mixed	>5	43
Norris & Watt	1983	61	Rear	2	44–90
Radanov et al.	1991	78	Mixed	1	27
Gargan & Bannister	1994	50	Rear	2	62
Radanov et al.	1994	117	Mixed	1	24
Borchgrevinck et al.	1996	345	Rear	>2.5	58
Brison	2000	380	Rear	2	36
Berglund et al	2000	138	Mixed	7	39.6
Bunkertorp et al	2002	108	Mixed	17	55

Following a motor vehicle collision, 15% to 40% of patients with acute neck pain develop chronic neck pain.

Schofferman J, Bogduk N, Slosar P. Chronic whiplash and whiplash-associated disorders: an evidence-based approach. J Am Acad Orthop Surg. 2007 Oct;15(10):596-606.

Mild Traumatic Brain Injury

Definition

A patient with mild traumatic brain injury is a person who has had a traumatically induced physiological disruption of brain function as manifested by at least one of the following:

- Any period of loss of consciousness
- Any loss of memory for events immediately before or after the accident
- Any alteration in mental state at the time of the accident
- Focal neurological deficits that may or may not be transient but where the severity of the injury does not exceed the following:

-loss of consciousness of approximately 30 minutes or less
-After 30 minutes, an initial Glasgow Coma Scale (GCS) of 13-15
-Post traumatic amnesia (PTA) not greater than 24 hours.

Mild Traumatic Brain Injury Committee of the Head Injury Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine. Definition of mild traumatic brain injury. The Journal of Head Trauma Rehabilitation 1993;8(3):86-87.

Symptoms

Physical: headache, dizziness, nausea, sleep difficulties, fatigue, blurred vision
Cognitive: decreased attention span, concentration, mental speed and short term memory, confusion
Behavioral: irritability, emotional lability (pathological expression of laughter, crying, or smiling), depression, anxiety

Post Concussion Symptoms

Definition

Post-Concussion Syndrome (PCS) is defined as:
1 – History of head trauma with loss of consciousness preceding symptom onset by maximum of 4 weeks
2 – Three or more symptom categories:
a. Headache, dizziness, malaise, fatigue, noise intolerance
b. Irritability, depression, anxiety, emotional lability
c. Subjective concentration, memory, or intellectual difficulties without neuropsychological evidence of marked impairment
d. Insomnia
e. Reduced alcohol tolerance
f. Preoccupation with above symptoms and fear of brain damage with hypochondriacal concern and adoption of sick role.

Diagnosis

The Rivermead Post-Concussion Symptoms Questionnaire (RPQ) is a useful tool for identifying patients with this syndrome. The RPQ has predictive validity in PCS patients compared to those without PCS. However, the validity and reliability of RPQ was found to be less predictive at 6 months compared with 3 months and 7-10 days.

King NS, Crawford S, Wenden FJ, Moss NE, Wade DT. The Rivermead Post Concussion Symptoms Questionnaire: a measure of symptoms commonly experienced after head injury and its reliability. J Neurol. 1995 Sep;242(9):587-92.

Outcome Measures in Whiplash Subjects

Pain

The Visual Analogue Scale (VAS)
The Numeric Pain Scale (NPS)

Categories of Pain relation to 0- 10 pain scales:

Mild	0-3
Moderate	4-6
Severe	7 and higher.

Li KK, Harris K, Hadi S, Chow E. What should be the optimal cut points for mild, moderate, and severe pain? J Palliat Med. 2007 Dec;10(6):1338-46.
Serlin RC, Mendoza TR, Nakamura Y, Edwards KR, Cleeland CS. When is cancer pain mild, moderate or severe? Grading pain severity by its interference with function. Pain. 1995 May;61(2):277-84.

Function/ Quality of life

The Neck Disability Index
Core Whiplash Outcome Measure
Owestry Disability Index (low back)
Northwick Park Neck Pain Questionnaire
Pain Disability Questionnaire (PDQ)
The Short Form 36 Health Survey Questionnaire (SF-36)
Bournemouth Questionnaire

Anxiety and depression

Impact of Event Scale

Sleep Problems

Epworth Sleepiness Scale

Mild Traumatic Brain Injury/Concession

Rivermead Post-Concussion Symptoms Questionnaire (RPQ)

Pain, functional limitations, and work status are related, but are not equivalent and should not be regarded as interchangeable.

Dionne CE, et al. A comparison of pain, functional limitations, and work status indices as outcome measure in back pain research. Spine 1999;24:2339-45.

The Neck Disability Index (NDI)

The NDI is designed to measure neck-specific disability and is based on the Oswestry Disability Questionnaire. The questionnaire has 10 items concerning pain and activities of daily living including personal care, lifting, reading, headaches, concentration, work status, driving, sleeping and recreation. Each item is scored out of 5 (with the no disability response given a score of 0) giving a total score for the questionnaire out of 50. Higher scores represent greater disability. The result can be expressed as a percentage or as raw scores (out of 50). The NDI is translated into over 20 languages. In these guidelines use of the raw score is recommended.

Raw Score Level of Disability:

0 - 4 No Disability;

5 - 14 Mild Disability;

15 - 24 Moderate Disability;

25 - 34 Severe Disability;

35 - 50 Completely Disabled

Vernon H, Mior S, 'The Neck Disability Index: A Study of Reliability and Validity'. J. Manip. and Physiological Therapeutics 1991; 14: 409-415.

Core Whiplash Outcome Measure

The Core Whiplash Outcome Measure (CWOM) is a five-item scale that is brief and user friendly for clinicians. It helps clinicians measure several constructs of health including pain symptoms, function and well-being. In addition, it enables the number of days taken off work to be measured, which is a useful measure for CTP insurers.
The CWOM has high construct validity with the Functional Rating Index and the NDI, and equal responsiveness in the short-term and long-term as these lengthier measures.

Instructions

Score as follows:
Questions 1 and 2: Score from 1-5
Question 3: Score from 5-1
Questions 4 and 5: Score as follows
0-5 days = 1;
6-11 days = 2;
12-17 days = 3;
18- 23 days = 4;
24 + days = 5.

The total score is created by summating the scores from each of the five items, where the minimum score for each item is 1 and the maximum score for each item is 5. Hence, the total score for the CWOM varies from 5-25.

Rebbeck T, Refshauge K, Maher C. 'Evaluation of the Core Outcome Measure in Whiplash'. Spine 2007; 32 (6):696-702.

Impact of Event Scale (IES)

The Impact of Event Scale (IES) was developed by Horowitz, Wilner, and Alvarez to measure current subjective distress related to a specific event. The IES is a self-report measure of post traumatic disturbance and is very widely used.

Scoring Method

Each item is scored:
Not at all = 0
Rarely = 1
Sometimes = 3
Often = 5

The item scores are summed. A total score of 26 or more, at 6 weeks after injury is in the "moderate" range. A score of > 43 is "severe".

Horowitz M, Wilner M, Alvarez W. 'Impact of Event Scale: A measure of subjective stress'. Psychosom. Med. 1979; 41: 209–218.

Pain Disability Questionnaire (PDQ)

The PDQ is made up of two factors: a Functional Status Component and Psychosocial Component. To differentiate these two you must separate the scores.
1. Functional total items 1,2,3,4,5,6,7,12 and 13. (Max score 90)
2. Psychosocial total items 8,9,10,11,14 and 15 (Max Score 60)

3. Total PDQ Score = Total Score of all items.
Blank items are pro-rated. If one left an item blank you would determine which item it is from, Functional or Psychosocial. Take that category and sum the score divided by the total items for the category which is your mean (Average score per item in that category). You than add the mean to the black item and re-sum. Ex you have 9 items on the functional, the patient left one blank…you sum the 8 items and the total was 48…48 divided by 8 = 6 is the mean…you now assign a 6 to the blank item and resum the total…9 X 6 = 54.
The higher the total the higher the disability. Also you can differentiate between functional disability and psychosocial.

Anagnostis C et al: The Pain Disability Questionnaire: A New Psychometrically Sound Measure for Chronic Musculoskeletal Disorders. Spine 2004; 29 (20): 2290-2302.

Administering the Pain Disability Questionnaire *(AMA 6th Guidelines of Impairment)*

The Pain Disability Questionnaire is used in Chapter 3, Pain-Related Impairment, on pages 43-44, and in Chapter 17, The Spine and Pelvis, on pages 599-600.

Follow these instructions for administering and scoring the PDQ:
1. Ask the patient to complete all items on the questionnaire.
2. If necessary, the patient may complete the form with the assistance of a translator or reader. Be certain all 15 questions are answered. If the patient is unable to complete the PDQ, no functional assessment score will be given.
3. The evaluating doctor will score the PDQ by adding together the marked integer in each question.
4. If the patient fails to mark a question, the default score for that question is 0.

The PDQ scores can be divided into 5 distinct categories:

score of 0 -	no disability
scores of 1 to 70 -	mild
scores of 71 to 100 -	moderate
scores of 101 to 130 -	severe
scores of 131 to 150 -	extreme

Core Whiplash Outcome Measure

Instructions

Please answer questions 1 to 5

Name: _____ Date: _____

1. During the past week, how bothersome have your whiplash symptoms been?

_____ not at all bothersome
_____ slightly bothersome
_____ moderately bothersome
_____ very bothersome
_____ extremely bothersome

2. During the past week, how much did your whiplash injury interfere with your normal work (including both work outside the home and housework)?

_____ not at all
_____ a little bit
_____ moderately
_____ quite a bit
_____ extremely

3. If you had to spend the rest of your life with the whiplash symptoms you have right now, how would you feel about it?

_____ very dissatisfied
_____ somewhat dissatisfied
_____ neither satisfied nor dissatisfied
_____ somewhat satisfied
_____ very satisfied

4. During the past four weeks, about how many days did you cut down on the things you usually do for more that half the day because of your whiplash symptoms?

_____number of days

5. During the past four weeks, how many days did your whiplash symptoms keep you from going to work or school?

_____number of days

Impact of Event Scale

On _____ you experienced a motor vehicle accident.
Below is a list of comments made by people after stressful life events. Using the following scale, please indicate with an 'x' how frequently each of these comments were true for you DURING THE PAST SEVEN DAYS. If they did not occur during that time please mark the 'NOT AT ALL' column.

	Not at all	Rarely	Sometimes	Often
1. I thought about it when I didn't mean to.				
2. I avoided letting myself get upset when I thought about it or was reminded of it.				
3. I tried to remove it from memory.				
4. I had trouble falling asleep or staying asleep because pictures or thoughts about it came into my mind.				
5. I had waves of strong feelings about it.				
6. I had dreams about it.				
7. I stayed away from reminders about it.				
8. I felt as if it hadn't happened or it wasn't real.				
9. I tried not to talk about it.				
10. Pictures about it popped into my mind.				
11. Other things kept making me think about it.				
12. I was aware that I still had a lot of feelings about it, but I didn't deal with them.				
13. I tried not to think about it.				
14. Any reminder brought back feelings about it.				
15. My feelings were kind of numb.				

Pain Disability Questionnaire

Patient Name _____ Date _____

Instructions: These questions ask your views about how your pain now affects how you function in everyday activities. Please answer every question by making an "X" along the line to show how much your pain problem has affected you (from having no problems at all to having the most severe problems you can imagine).

1. Does your pain interfere with your normal work inside and outside the home?
Work normally — Unable to work at all
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

2. Does your pain interfere with personal care (such as washing, dressing, etc.)?
Take care of myself completely — Need help with all my personal care
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

3. Does your pain interfere with your traveling?
Travel anywhere I like — Only travel to see doctors
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

4. Does your pain affect your ability to sit or stand?
No problems — Cannot sit /stand at all
0--------] -------] --------] --------] --------] --------] --------] --------] --------]

5. Does your pain affect your ability to lift overhead, grasp objects, or reach for things?
No problems — Cannot do at all
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

6. Does your pain affect your ability to lift objects off the floor, bend, stoop, or squat?
No problems — Cannot do at all
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

7. Does your pain affect your ability to walk or run?
No problems — Cannot walk/run at all
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

8. Has your income declined since your pain began?
No decline — Lost all income
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

9. Do you have to take pain medication every day to control your pain?
No medication needed — On pain medication throughout the day
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

10. Does your pain force you to see doctors much more often than before your pain began?
Never see doctors — See doctors weekly
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

11. Does your pain interfere with your ability to see the people who are important to you as much as you would like?
No problem — Never see them
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

12. Does your pain interfere with recreational activities and hobbies that are important to you?
No interference — Total interference
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

13. Do you need the help of your family and friends to complete everyday tasks (including both work outside the home and housework) because of your pain?
Never need help — Need help all the time
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

14. Do you now feel more depressed, tense, or anxious than before your pain began?
No depression/tension — Severe depression / tension
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

15. Are there emotional problems caused by your pain that interfere with your family, social and or work activities?
No problems — Severe problems
0 --------] -------] --------] --------] --------] --------] --------] --------] --------]

Area of Spine	Names of Vertebrae	Number of Vertebrae	Short Form or Other Name
Neck	Occiput	7	Occ, C0
	Cervical		C1 thru C7
	Atlas		C1
	Axis		C2
Back	Dorsal or	12	D1 thru D12
	Thoracic		T1 thru T12
	Costovertebral		R1 thru R12
	Costotransverse		R1 thru R12
Low Back	Lumbar	5	L1 thru L5
Pelvis	Ilia, R and L		I, Si
Sacral	Sacrum, Coccyx		S, SC