

Whiplash: diagnosis, treatment, and associated injuries

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CAD Injury on the Rise

What is CAD? CAD is cervical acceleration / deceleration injury. There have been numerous authors have reported a disturbing increase in the incidence of CAD in recent years (1326). Holm et al. (1271) reported an increase in medical impairment attributable to CAD (WAD or whiplash-associated disorder was their term) from 16% in 1989 to 28% in 1994, although the proportion of work disability remained the same. Richter et al. (1, 2) reported that the percentage of MVC-induced injuries described as "whiplash-type distortions" increased from 10% in 1985 to over 30% in 1997. ("Distortion" is a European--and particularly German--term for sprain.) Most were from frontal crashes. Galasko et al. (3) reported that in 1982, in the U.K., seat belt legislation was introduced and the next year the prevalence of CAD rose 268%. It subsequently continued to rise at an alarming rate averaging 152% yearly for the next 15 years. The compound percent yearly rise from 1982 to 1990 for all patients involved in road traffic accidents was reported to be 7.2% per annum, and for CAD cases 34%. However, seat belt use does not seem to explain the sharp rise in incidence. In a large population-based European study it was found that the increase from 1989 through 1995 was associated with stable belt

usage. There has been a substantial rise in belt use in the U.S. since the introduction of primary and secondary use laws and this has probably contributed to the rise in CAD injury incidence.

Increasing seat stiffness has also been a big factor. Krafft et al also showed that that the "relative risk" of being injured in a crash was related to model year such that the risk of being injured in a 1990s era model was 2.7 times that of being injured in a 1980s model, probably owing to the increase in vehicle stiffness in later model cars.

Study design and Objective:

To identify and synthesize the most current data pertaining to the diagnosis and treatment of whiplash and whiplash-associated disorders (WAD), and to report on whiplash-related injuries. Methods A search of OVID Medline (1996–January 2007) and the Cochrane database of systematic reviews was performed using the keywords whiplash and WAD. Articles under subheadings for pathology, diagnosis, treatment, and epidemiology were chosen for review after identification by the authors. Results A total of 485 articles in the English language literature were identified. Thirty-six articles pertained to the diagnosis, treatment, epidemiology of whiplash, and WAD, and were eligible for focused review. From these, 21 primary and 15 secondary sources were identified for full review. In addition, five articles were found that focused on whiplash associated cervical injuries. These five articles were also primary sources. Conclusions Whiplash is a common injury associated most often with motor vehicle accidents. It may present with a variety of clinical manifestations, collectively termed WAD. Whiplash is an important cause of chronic disability. Many controversies exist regarding the diagnosis and treatment of whiplash injuries. The multifactorial etiology, believed to underly whiplash injuries, make management highly variable between patients. Radiographic evidence of injury often cannot be identified in the acute phase. Recent studies suggest early mobilization may lead to improved outcomes. Ligamentous and bony injuries may go undetected at initial presentation leading to delayed diagnosis and inappropriate therapies.

Keywords: Whiplash, Whiplash associated disorders (WAD), Cervical spine injury
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Introduction

The Quebec task force (QTF) on whiplash associated disorders (WAD) defined whiplash as “bony or soft tissue injuries” resulting “from rear-end or side impact, predominantly in motor vehicle accidents, and from other mishaps” as a result of

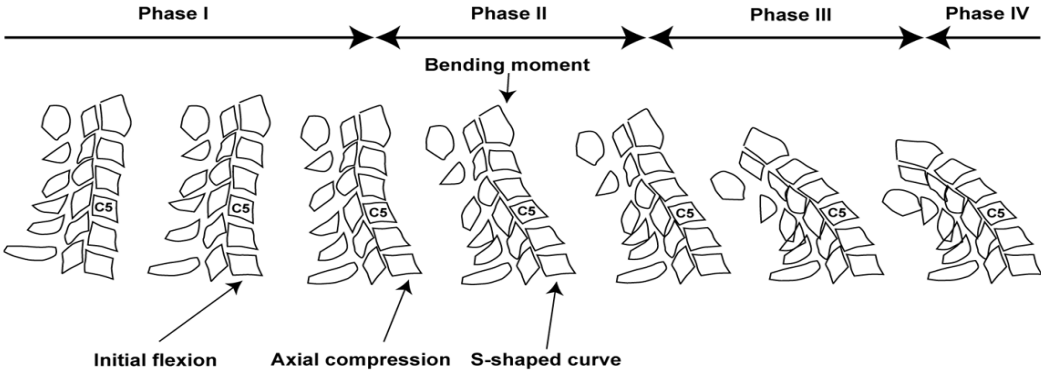
“an acceleration-deceleration mechanism of energy transfer to the neck” [The following popper user interface control may not be accessible. Tab to the next button to revert the control to an accessible version. Destroy user interface control1]. Whiplash is associated with a wide variety of clinical manifestations including neck pain, neck stiffness, arm pain and paresthesias, problems with memory and concentration, and psychological distress. This group of symptoms and signs are collectively termed WAD. The QTF developed a classification system for WAD based on severity of signs and symptoms (Table 1).

Table 1
 QTF classification of whiplash-associated disorders I

Whiplash is the most common injury associated with motor vehicle accidents, affecting up to 83% of patients involved in collisions, and is a common cause of chronic disability.

The overall economic burden of whiplash injury, including medical care, disability, and sick leave, is estimated at \$3.9 billion annually in the US. If litigation is included, the costs are greater than \$29 billion. The incidence of WAD is widely variable in the literature. In the US, it is estimated at 4 per 1,000 persons.

The most recent literature suggests that whiplash injury may occur as a result of hyperextension of the lower cervical vertebrae in relation to a relative flexion of the upper cervical vertebrae, which produces an S-shape of the cervical spine at the time of impact.



This differs from the normal physiology where motion of the cervical spine begins with the upper vertebrae. This theory suggests an abnormal physiologic basis for the development of whiplash injuries.

The current review provides a summary of recent literature focused on the diagnosis and treatment of whiplash injury and WAD. In addition, we offer a focused review of whiplash associated cervical injuries including ligamentous injury, loss of lordosis, and fractures of the superior articulating facet.

Discussion

Many controversies exist regarding the diagnosis, treatment, and prognosis of whiplash injuries. The wide variety in the number of patients reporting injury and the inability in many cases to find firm diagnostic evidence of injury has led many to question the authenticity of whiplash injury and WAD.

Clinical diagnosis

The diagnosis of whiplash remains clinical. The mechanism of injury must be elicited. The clinical syndrome of whiplash and WAD includes:

- ✓ Neck pain or stiffness
- ✓ Arm pain and paresthesias
- ✓ Temporomandibular dysfunction
- ✓ Headache
- ✓ Visual disturbances
- ✓ Memory and concentration problems
- ✓ Psychological distress.

There are no specific neuropsychological studies or electrophysiological tests that can diagnose whiplash injury.

A wide variety of psychosocial symptoms may be associated with whiplash including:

- ✓ Depression
- ✓ Anger
- ✓ Fear
- ✓ Anxiety
- ✓ Hypochondriasis

A so-called whiplash profile has been described, which includes high scores on subscales of somatization, depression, and obsessive-compulsive behavior in patients with WAD.

Radiographic diagnosis

Injury most often is not identified radiographically in the acute phase.

A prospective study of 100 patients with normal plain radiography and no neurologic deficit evaluated MRI findings of the brain and cervical spine within 3 weeks of injury. Only one patient had findings associated with trauma (prevertebral edema).

The most common radiographic findings associated with whiplash injury are:

- ✓ Preexisting degenerative disease or slight loss of the normal lordotic curve of the cervical spine.
- ✓ Flexion-extension x-rays at the time of injury may also reveal a kyphotic angle.
- ✓ It is postulated that this is due to hypermobility at a level adjacent to a level of hypomobility secondary to muscle spasm

A prospective study of 39 patients with grade two to three whiplash injury who underwent MRI within a mean of 11 days from injury and a follow-up MRI after two years found that 33% (13 patients) had medullary or dural impingement by cervical discs. At two year follow-up, all patients with medullary impingement (seven patients) had persistent or increased symptoms and three patients with no or slight changes on MRI had persistent symptoms.

At the time of initial presentation, MRI is not indicated because of high false positive results. CT and MRI are generally reserved for patients with suspected disc or spinal cord injury, fracture, or ligamentous injury. CT and MRI may also be indicated in patients with long term persistent arm pain, neurologic deficits, or clinical signs of nerve root compression.

Treatment in the acute setting

Whiplash injuries are difficult to treat for many reasons. Patients may have subjective complaints of pain or paresthesias without any radiologic or clinical evidence of injury. Complex interactions of psychosocial, legal, and physical factors make effective treatment highly variable among different patients. Initial treatment has traditionally included a soft cervical collar to restrict cervical range of motion. More recent studies suggest, however, that early mobilization may lead to improved outcomes and that rest and motion restriction may hinder recovery. Thus, providing early manipulation and mobilization is helping these injured victims.

Rosenfeld et al. followed 97 patients exposed to whiplash trauma over a three year period prospectively. The patients were randomized either to an early intervention using frequent active cervical rotation or to a standard intervention of initial rest, recommended soft collar, and gradual self-mobilization. Patients who received active intervention had significantly reduced pain intensity and sick leave at 6 months and 3 years respectively. In addition, patients receiving early active intervention had a total cervical range of motion similar to that of matched uninjured controls at 3 year follow-up.

Treatment in the chronic phase

The QTF review did not report on evidence regarding the independent benefit of exercise in chronic WAD. Studies of patients with chronic neck pain, not necessarily motor vehicle related, suggest that exercise and mobilization may improve long-term outcomes.

A prospective uncontrolled study of patients with Type I and Type II whiplash followed patients through a multimodal treatment program including exercise, group therapy, and occupational therapy. Vendrig et al. found that at 6 month follow-up, 65% of subjects reported complete return to work, 92% reported partial or complete return to work, and 81% reported no medical or paramedical treatments over 6 months.

Bunketorp et al. analyzed 47 patients involved in an ongoing randomized controlled trial. Multiple regression analysis found that self-efficacy, a measure of how well an individual believes he can perform a task or specific behavior and emotional reaction in stressful situations, was the most important predictor of persistent disability in patients with WAD.

Manual Traction

Patients are placed in a supine and relaxed position. The therapist places his fingers on the neck and around the occiput and applies steady axial traction with about 10 degrees of neck flexion. A variant of this technique is to place the right hand over the right trapezial ridge and the left at the occiput. Another method is to use webbing material tied in a circle. The therapist drapes it around his back and around the hands. While traction is applied, the therapist leans backward, thereby adding some leverage to the pull.

Manual traction is useful preparatory to CMT in some cases but, as a routine treatment, it is time consuming and very difficult to maintain. Its primary use is as a screening measure for mechanical traction: When patients feel some measure of relief with it, they then become candidates for both mechanical and home traction.

Mechanical Traction

The effects of mechanical traction include stretching of muscles and ligaments, distraction of vertebrae, separation of facet joints, enlargement of IVF, and possibly an interruption of neural feedback mechanisms facilitated by intracapsular or shunt muscle proprioceptors and intradiscal mechanoreceptors.

Contraindications include spinal malignancy, osteomyelitis, bleeding diathesis, marked osteoporosis, vertebrobasilar insufficiency, severe carotid artery atherosclerosis, rheumatoid arthritis (or other inflammatory arthritides), and severe ligamentous instability.

Most modern machines can be set for progressive static traction (a gradually increasing steady pull) or progressive intermittent (an on and off form of traction, where subsequent pulls increase in force). Progressive static is preferable for relief of muscle spasm, although this may require 20 to 30 minutes. In most instances, progressive intermittent is used. Patients hold a kill switch that enables them to instantly release all pressure if necessary.

Most authors suggest between 20 degrees to 30 degrees of flexion for supine cervical traction. Cailliet (1089-p128), for example, recommends 20 degrees as optimal. However, it is important to remember that the human neck does not behave like a spring, in which pulling both ends results in equal separation of all coils. As a result of a number of complex interrelations in the neck, forward flexed postures enable maximal traction at lower cervical segments, while traction in a neutral position is concentrated in the upper segments.

Prognosis

Studies of long-term outcome for patients with whiplash and WAD offer widely variable rates of recovery. Most studies suggest persistent symptoms in 25–40% of patients after 1 year. Other studies have reported symptoms in as high as 39.6% of patients as far as 7 years after injury.

A number of factors have been consistently associated with delayed recovery including female gender, older age, initial intensity of neck pain, neurologic deficit, preexisting neck pain.

The variability in recovery in WAD is a source of considerable controversy. The multivariable nature of WAD suggests that further investigations of clinical, demographic, and psychological factors are warranted in order to improve treatment outcomes.

Whiplash associated cervical injuries

The QTF report focuses on patients with WAD Grade I through III injuries following a motor vehicle collision. Grade IV injuries, which include patients with neck complaints and fracture or dislocation, were not specifically addressed. The literature is peppered with case reports of patients with WAD and missed fractures on presentation. The most common radiographically identified abnormalities are loss of cervical lordosis and spondylotic changes.

Conclusions

Whiplash and WAD are a common and costly burden on the health care system. Associated disabilities and absence from work create a large impact on economic productivity. Diagnosis of these injuries can be difficult for the practitioner and frustrating for the patient. The most recent literature suggests that whiplash injury may occur as a result of hyperextension of the lower cervical vertebrae in relation to a relative flexion of the upper cervical vertebrae, this is very significant connection between the short-term and the long-term injuries.

Treatment can be delayed and confused by multiple social, economic, and psychologic factors. Recent literature suggests that early mobilization and return to activity may offer the best chance for recovery. Still, a highly variable rate of

recovery is reported in the literature. The absence of clear diagnostic and treatment options for this common medical problem suggest that further research is duly warranted.

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