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Whiplash: a selective annotated bibliography

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Objective: *To review the literature on whiplash injury including an overview, collision mechanics, pathophysiology, neurobehavioral, imaging, treatment/ management, prognosis, outcomes, and litigation.*

Design: *An annotated bibliography.*

Methods: *A literature search of MEDLINE from 1987 to 1995 and CHIROLARS from 1900 to 1996, with emphasis on the last ten years, was performed. Conference proceedings and the personal files of the authors were searched for relevant citations. Key words utilized in the search were whiplash injury, acceleration/ deceleration injury, neck pain, head pain, cognitive impairment, treatment, imaging, prognosis and litigation.*

Results: *This annotated bibliography identifies key studies and potential models for future research.*

Conclusions: *There is currently a lack of clinical consensus both in practice and in the literature regarding the evaluation and management of an episode of whiplash injury. This annotated bibliography has been developed in an attempt to provide an overview of the literature regarding various issues surrounding an episode of whiplash injury.*
(JCCA 1997; 41(2):91–104)

KEY WORDS: whiplash, neck pain, acceleration/ deceleration, injury.

Objectif : *Examiner la documentation portant sur les coups de fouet, notamment un aperçu global, la mécanique des collisions, la pathophysiologie, les réactions neurologiques, l'imagerie, le traitement / la gestion, le prognostic, les résultats et les litiges.*

Dessein : *Une bibliographie commentée.*

Méthodes : *On a effectué une recherche de la documentation de MEDLINE de 1987 à 1995 et de CHIROLARS de 1900 à 1996, en mettant l'accent sur la dernière décennie. On a examiné les rapports de colloques et les dossiers personnels des auteurs afin de relever des citations pertinentes. Les mots clés utilisés pour la recherche étaient : coup de fouet, syndrome d'accélération-décélération, cervicalgie, céphalée, déficience cognitive, traitement, imagerie, prognostic et litiges.*

Résultats : *Cette bibliographie commentée identifie les principales recherches et les modèles possibles pour une recherche future.*

Conclusions : *On note présentement un manque de consensus à la fois dans la pratique et dans la documentation quant à l'évaluation et la gestion d'un épisode de coup de fouet. La présente bibliographie commentée a été conçue afin de fournir un aperçu de la documentation portant sur divers problèmes reliés aux coups de fouet.*
(JCCA 1997; 41(2):91–104)

MOTS CLÉS : coup de fouet, cervicalgie, syndrome d'accélération-décélération, traumatisme.

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Introduction

An episode of whiplash or acceleration/deceleration forces to the cervical spine connective tissues most commonly following an automobile versus automobile collision, and the potential health and economic sequelae, are presently a significant problem in society. According to the Insurance Corporation of British Columbia, cervical sprain injuries accounted for 67.1% of injuries suffered in automobile collisions in the province of British Columbia in the year 1990.[1] As well, Saskatchewan Government Insurance stated that 78% of all compensation claims for bodily harm involved whiplash injury including whiplash injury in combination with other injuries.[1] In Canada, the period of compensation related to an episode of whiplash has grown from 72 days in 1987 to 95 days in 1988 to 108 days in 1989.[1] Thus, not only is whiplash significant in terms of occurrence but also economically. A study out of Quebec showed that for the year 1985, 46% of physiotherapy treatment costs ($1.14 million) were attributable to cervical sprain injuries.[1] As well, a 1990 United States National Highway Traffic Safety Administration (NHTSA) report on the cost of motor vehicle crashes estimated the cost (medical and socioeconomic) of whiplash cervical spine/neck injuries at 28 billion dollars annually.[2]

Based on the aforementioned statistics, it is appropriate to presently consider whiplash injury a problem of epidemic nature, both medically and socioeconomically. Yet at the same time, within health care, controversy continues to exist concerning the potential relationship and or association of an episode of whiplash and the myriad of clinical complaints that may follow. There continues to be no global agreement or consensus as to what defines an episode of whiplash, what symptoms can be attributable to it, what criteria should be utilized in its diagnosis, what the most effective management protocols involve, and what role an event such as whiplash may play in development of long term neuromusculoskeletal pain, disability and cognitive impairment, if any. This lack of clinical consensus is expressed in the multitude of varying opinions offered and treatments rendered by practitioners ranging from chiropractors to physical therapists to medical doctors when dealing with an individual who has experienced an episode of whiplash.

The bibliography is organized into categories covering specific aspects of whiplash injury such as overview, collision mechanics, pathophysiology, neurobehavioral, imaging, treatment/management, prognosis, outcomes and litigation. The literary search was accomplished by accessing MEDLINE (1987 to 1995) and CHIROLARS (1900 to 1996, with emphasis on the last ten years) as well as utilizing content experts and primary article reference lists. Key words utilized in the search were whiplash injury, acceleration/deceleration injury, neck pain, head pain, cognitive impairment, treatment, imaging, prognosis and litigation.

OVERVIEW

1 Pearce JMS. Polemics of chronic whiplash injury. Neurology 1994; 44:1993–1997.

The author provides the reader with thorough yet concise information on the major aspects of whiplash injuries. Topics covered are mechanisms of injury, examination and prognosis as well as the overall dynamic picture of a patient with persistent/chronic neck symptoms. This is an excellent article for a busy healthcare provider who requires a greater understanding of whiplash injury yet may be constrained by time.

2 Jahn WT. Acceleration-deceleration injury. Journal of Manipulative and Physiological Therapeutics 1978; 1(1):95–102.

This article provides the reader with practical information through the use of forms and charts on history taking and examination procedures when dealing with a patient that has sustained whiplash injury. The author further addresses the correct terms to use in generating an accurate diagnosis as well as a brief overview of the possible pathophysiological ramifications of whiplash injury. Treatment/management from the acute stage to the chronic stage that can be rendered in office by the practitioner or at home by the patient is also outlined.

3 Hirsch SA, Hirsch PJ, Hiramoto H, Weiss A. Whiplash syndrome. Fact or fiction? Orthopedic Clinics on North America 1988; 19(4):791–795.

A concisely written article that supports the view that whiplash injury/syndrome is in fact real and that the associated symptoms are consistent with anatomic injury. The article offers a definition of whiplash injury and covers the major aspects involved in such an injury including mechanism, evaluation, treatment and prognosis.

4 Barnsley L, Bogduk N, Lord S. Clinical review: whiplash injury. Pain 1994; 58:283–307.

The authors provide the reader with a review article that extends and elaborates on the work of Teasell RW et al. in Spine: State of the Art Review: Cervical flexion-extension/whiplash injuries. This article is an excellent source of information on the dynamics of whiplash injuries including basic and clinical aspects along with the supportive evidence.

5 Peace JMS. Whiplash injury: a reappraisal. Journal of Neurology, Neurosurgery, and Psychiatry 1989; 52:1329–1331.

A selective review of whiplash injury is presented by the authors in an attempt to assemble and appraise the facts as well as the fallacies concerning whiplash injuries. The article provides information on the major aspects concerning whiplash injuries such as mechanism, acute and chronic syndromes and prognosis all of which are accompanied by selected studies that have been done concerning each topic. The article concludes with a list of the current facts and the authors opinions concerning whiplash injuries.

6 Teasell RW. The clinical picture of whiplash injuries. Spine: State of the Art Reviews 1993; 7(3):373–389.

This paper provides the reader with an excellent comprehensive look at the clinical aspects of whiplash injury. Besides addressing the region that is thought to be most commonly injured in a whiplash injury i.e. ... the neck, the author also presents information on involvement of the low back and the temporomandibular joint.

7 Evans RW. Some observations on whiplash injuries. Neurologic Clinics 1992; 10(4):975–997.

The author provides the reader with all inclusive information on the dynamics of whiplash injury. The article addresses epidemiological data that is not routinely included in the majority of review papers on whiplash injury as well as interesting historical aspects. The majority of the article covers issues ranging from clinical signs and symptoms to pathology, prognosis, treatment and litigation.

8 Quebec Task Force on Whiplash-Associated Disorders. Walter O. Spitzer, Chairman. Whiplash-Associated Disorders (WAD)/Redefining "Whiplash" and its Management 1995.

In 1989–90, the Vice-President of the Quebec Automobile Insurance Society and a committee of senior advisors approached the Chairman of this Task Force, Walter O. Spitzer, about the possibility of an in-depth analysis of clinical, public health, social and financial determinants of what was commonly referred to as "the whiplash problem". What came about as a result of this meeting was the formation of a multi disciplinary panel/task force and the eventual creation of this document. The basic approach utilized by the task force in creating this document was to initially rely on the best evidence available and if this was not available to then rely upon expert opinion. Following an international literature search of the peer-reviewed journals, a predetermined and explicit criteria of selection was utilized to include or exclude a paper. What was concluded following this process was that, to date, there is a paucity of well conducted studies on whiplash injury and thus unequivocal recommendations on the various issues concerning whiplash is virtually impossible. This publication is an excellent evidence-based analysis of what is currently known about whiplash injury.

9 Stovner LJ. The nosologic status of the whiplash syndrome: a critical review based on a methodological approach. Spine 1996; 21(23):2735–2746.

This paper addresses the current level of scientific evidence and degree of validity for a "whiplash syndrome" from the view of methodological study design. The author begins the paper by reminding the reader of the limitations and varying strengths of the different types of study designs such as descriptive (case series/population correlation/cross-sectional), case-control, cohort and experimental, presented in increasing order of strength. The paper then proceeds to review examples of each of these designs as well as defining the various types of validity such as face, descriptive, construct, and predictive. The conclusions of the author are that the overall validity of the whiplash syndrome seems rather low, pain is real in these patients but it may have various causes and mechanisms, and that the concept of a "whiplash syndrome" will probably lead to a predominantly trauma-oriented approach to pain

in these individuals and may possibly divert the research from other, more fruitful approaches. It is felt that carefully conducted studies that attempt to assess the contribution of trauma to the production of head and neck pain are urgently needed.

COLLISION MECHANICS

10 Gough JP. Human occupant dynamics in low-speed rear end collisions: an engineering perspective. Journal of Musculoskeletal Pain 1996; 4(4):11–19.

The author of this article has attempted to address, through a reconstruction engineer's perspective, a hotly debated issue concerning an episode of whiplash: the relationship of low-speed rear-end collision and the development of symptoms. Recent utilization of human subjects in contrast to the previous use of anthropometric dummies in collision research, as well as the development of better seat/headrest design, has provided new insight into the components of motion of the cervical spine following a low-speed rear end collision other than the traditional concept of pure hyperflexion/hyperextension found in higher speed impacts. Key messages delivered by the author were that based on human volunteer staged collision studies dealing with a speed change of less than 8km/h, hyperflexion/hyperextension mechanisms of injury are not likely to occur. As well, no significant post-impact symptoms have been reported in human volunteers in these staged studies on low-speed rear-end impacts at 8km/h.

11 Bailey M. Assessment of impact severity in minor motor vehicle collisions. Journal of Musculoskeletal Pain 1996; 4(4):21–38.

The author of this article addresses, through a reconstruction engineers perspective, the various types of minor collisions such as rear-end, frontal and lateral impacts and their relationship to severity of impact and the development of symptoms in staged human collision tests. Findings based on these studies were that minor short duration symptoms occur in rear-end collisions at the 8km/h change in velocity level; symptoms are not observed in frontal or lateral collisions until about 2 to 3 times this level; and in rear-end collisions the 8km/h change in velocity level can sometimes be achieved without vehicle damage. The author concludes by addressing the limitations of being able to liberally generalize the results of studies because all of the human volunteers were healthy with no pre-existing medical conditions and only approximately 5% of the subjects were female.

12 Croft AC. Low speed rear impact collisions: In search of an injury threshold. Journal of Musculoskeletal Pain 1996; 4(4):39–46.

The author of this article presents the results of various studies that have attempted to address certain collision related elements of low-speed rear impact collisions. Aspects covered are transfer of energies, kinematics, symptom development and residuals, the prevalence of chronic symptoms and the threshold for injury. The author feels that based on existing evidence the following can be stated about low-speed rear impact collisions: significant transfer of energy occurs, the kinematics are quite complex, a portion of persons injured in these collisions continues to suffer from residuals of those injuries, the prevalence of chronic symptoms from these injuries in the United States is estimated to range from 1–12%, the threshold of injury has not yet been adequately investigated to allow reasonable conclusions to be made about persons at risk of injury, and that there does not appear to be any scientifically or empirically sound basis for reliably gauging injury potential from vehicle property damage or other aspects of a crash, such as speed of the involved vehicles. Suggestions for further research are submitted by the author as well.

PATHOPHYSIOLOGY

13 Bogduk N. The anatomy and pathophysiology of whiplash. Clinical Biomechanics 1986; 1:92–101.

The author, following review of the literature on whiplash injury, feels that there is enough biomechanical and experimental data to substantiate an organic basis for the clinical symptoms and signs that a patient may develop following a whiplash type injury. The article presents an excellent review of the biomechanics involved in whiplash injuries as well as the anatomical and pathological injuries possible. A unique review of the mechanism of symptoms is provided such as neck and head pain, blurred vision, tinnitus, concussion, paraesthesia and dysphagia.

14 Bogduk N, Lord S, Barnsley L. The pathophysiology of whiplash. Spine: State of the Art Reviews 1993; 7(3):329–349.

In addition to presenting the major aspects of whiplash injury such as etiology, mechanisms, pathology and clinical symptoms, the authors have taken time to address the entire spectrum of possible mechanisms of injury to the neck such as lateral flexion, extension, flexion and shear forces. The section on pathology provides the reader with a breakdown of the possible tissues damaged following whiplash injury. The authors conclude their paper with possible explanations for the range of clinical symptoms in whiplash injury.

15 Lord SM, Barnsley L, Wallis BJ, Bogduk N. Chronic cervical zygapophyseal joint pain after whiplash/a placebo-controlled prevalence study. Spine 1996; 21(15):1737–1745.

The authors, through the use of a double-blind, placebo (saline) and controlled (dual anesthetic blocks) study, attempted to determine the prevalence of cervical zy gapophyseal joint pain in a sample of patients with chronic neck pain following an episode of whiplash. With the use of this methodologically sound study, the authors have shown that in this particular sample of patients, up to 60% had cervical zygapophyseal joint(s) pain. The authors feel that such as high percentage has significant clinical importance.

16 Heikkila H, Astrom PG. Cervicocephalic kinesthetic sensibility in patients with whiplash injury. Scandinavian Journal of Rehabilitation 1996; 28:133–138.

This study was designed to assess whether or not there was a difference in cervicocephalic proprioceptive ability between a group of individuals who had previously been subjected to an episode of whiplash and were symptomatic and a group of asymptomatic individuals who had no history of whiplash episodes. The authors designed an apparatus that was worn on the head of the subjects that allowed quantitative assessment of neutral head positioning and repositioning to neutral following active movements. Neutral repositioning measurements followed active extension, flexion and right/left rotation. Following assessment of each group, a number of the whiplash injury subjects were entered into a rehabilitative program that was tailored toward their proprioceptive abnormalities and designed to assess whether there was any change pre and post therapy. The results of the study were that the whiplash injury subjects were less accurate in cervicocephalic proprioception as compared to the control subjects. Concerning rehabilitation, head repositioning was more precise in the whiplash subjects following a 5 week course of therapy.

17 Taylor JR, Twomey LT. Acute injuries to cervical joints. An autopsy study of neck sprain. Spine 1993; 18(9):1115–1122.

This article describes the findings of a comparative study of cervical spines from 16 subjects who died from major trauma and 16 control subjects who died of natural causes. The spines from the major trauma victims showed distinct lesions at the level of the intervertebral discs as well as at the facet joints with no directly comparable lesions in the controls subjects. The authors go on to state that these lesions in the cervical spinal tissues following whiplash injury can plausibly explain the clinical symptoms and signs.

NEUROBEHAVIORAL ASPECTS

18 Awerbuch MS. Whiplash in Australia: illness or injury? The Medical Journal of Australia 1992; 157:193–196.

This article addresses the confusing and at times frustrating nature of whiplash injuries. The author initially provides the reader with baseline information on anatomical and mechanistic aspects of whiplash injury and then focuses on the multifaceted nature of whiplash injuries. Factors that are suggested to be intimately intertwined in whiplash injuries, such as litigation, iatrogenicity and cultural/social components are described.

19 Ettlin TM, Kischka U, Reichman S, Radii EW, Heim S, Wengen DA, Benson DF. Cerebral symptoms after whiplash injury of the neck: prospective clinical and neuropsychological study of whiplash injury. Journal of Neurological Neurosurgical Psychiatry 1992; 55:943–948.

This article is relatively unique in that it presents a prospective study on whiplash injury with neuropsycholo-

gical evaluation being performed in the acute stages. This was different from most studies that are retrospectively designed with patients suffering a chronic course. The authors state that they are aware of only two other such studies on whiplash patients in the acute stage. The article is intriguing in that the authors suggest that the results of the study could imply organic involvement to the various areas of the central nervous system following whiplash injuries.

20 Radanov BP, Dvorak J, Valach L. Cognitive deficits in patients after soft tissue injury of the cervical spine. Spine 1992; 17(2):127–131.

This paper presents the results of a study that assessed fifty one patients suffering from soft tissue injury of the cervical spine following an episode of whiplash. The patients underwent clinical and psychometric examination and based on the data, the authors suggest that there is evidence for organic involvement of the central nervous system following whiplash injury.

21 Olsnes BT. Neurobehavioral findings in whiplash patients with long-lasting symptoms. Acta Neurologic Scandinavia 1989; 80:584–588.

This article presents the findings of a study including 34 patients with persistent symptoms following whiplash injury and 21 controls with somatic complaints resembling those of the whiplash patients, but with no history of trauma. All the subjects were assessed through neuropsychological test variables. The results of this study were that the whiplash patients with chronic symptoms are not much impaired in their performance as compared with controls. The authors conclude that the results reported do not constitute evidence for brain damage as a cause of whiplash symptoms, but also they do not unequivocally exclude this possibility.

22 Mayou R, Bryant B, Duthie R. Psychiatric consequences of road traffic accidents. British Medical Journal 1993; 307:647–651.

This article addresses the psychiatric consequences of being a road traffic accident victim. The findings of the study show that psychological consequences of road accidents are a major clinical problem with important social, economic, and health service implications. The authors believe that the extent, pattern and relevance of such consequences have previously been greatly underestimated.

23 Radanov B, Stefano G, Schnidrig A, Ballinari P. Role of Psychosocial stress in recovery from common whiplash. Lancet 1991; 338:712–715.

The authors designed this follow-up study to look at the ability of psychosocial stress, somatic symptoms and subjectively assessed cognitive impairment in predicting delayed recovery from common whiplash. The results of the study lead the authors to conclude that psychosocial factors, negative affectivity and personality traits were not significant in predicting the outcome. However, initial neck pain intensity, injury-related cognitive impairment and age were significant factors in predicting illness behavior.

24 Green MM, McFarlane AC, Hunter CE, Griggs WM. Undiagnosed post-traumatic stress disorder following motor vehicle accidents. The Medical Journal of Australia 1993; 159:529–534.

The purpose of this longitudinal study was to determine the pattern of emergence of post-traumatic stress disorder (PTSD) among motor vehicle accident victims and to examine the influence of PTSD on subsequent levels of disability. The results of the study suggest that PTSD after motor vehicle accidents is an important cause of disability which may also become the focus for damages in litigation. The authors of this article also address the important point that there is a need for further investigation of the early patterns of distress so that preventive programs can be designed for victims of road accidents.

25 Shapiro A, Teasell R, Steenhuis R. Mild traumatic brain injury following whiplash. Spine: State of the Art Reviews 1993; 7(3):455–470.

This paper critically reviews the evidence for mild traumatic brain injury following whiplash, little of which is convincing in the authors opinion. The authors provide an excellent review of the literature on the biomechanics and mechanisms of brain injury following whiplash as well as the effect of pain, depression, and anxiety on cognitive function. Human studies with neuropsychological

evalution and neuropathological findings from animal studies on whiplash are presented.

26 Radanov BP, Dvorak J. Spine update/impaired cognitive functioning after whiplash injury of the cervical spine. Spine 1996; 21(3):391–397.

The authors provide the reader with an excellent review of the literature on impaired cognitive function following an episode of whiplash. A definition of cognitive function is provided as well as what may cause cognitive impairment. The paper addresses whether whiplash can lead to lesions of the brain tissue and provides a definition of whiplash injury. The results from previous research with whiplash patients is offered as well. The authors of this paper felt that the majority of the previous studies, to date, on whiplash and cognition were methodologically flawed as to a lack of clear definitions, patient selection bias, small numbers of patients and inadequate to no followup assessment. The paper also addresses the influence of pain, preexisting and new psychological involvement, pharmaceutical use on cognition and the lack of considering these variables in conjunction in most of the studies. Based on prospective studies with unselected patients, the authors state that cognitive impairment following an episode of whiplash relates to either trauma induced somatic symptoms (pain) or psychologic symptoms resulting from problems adjusting to trauma related somatic symptoms. As well, cognitive disturbances after whiplash show a fair rate of recovery, which parallels recovery from trauma related somatic symptoms. Current research does not indicate disturbances in higher cognitive functions after whiplash.

27 Wallis B, Bogduk N. Faking a profile: can naive subjects simulate whiplash responses? Pain 1996; 66:223–227.

This paper addresses the validity of the SCL-90-R psychological symptom checklist in identifying or differentiating between chronic pain patients who had previously been involved in an episode of whiplash and asymptomatic individuals who had been instructed to fake symptoms related to a hypothetical episode of whiplash. The SCL-90-R was initially designed and utilized in the psychiatric assessment of general patients and later in the assessment of chronic pain patients. As well, the SCL-90-R had previously been shown to have high test-retest correlation, high internal consistency of items and convergence between subscales of the MMPI. One of the authors of this paper had previously shown that the SCL-90-R, when administered to individuals following whiplash injury, exhibited a characteristic profile indicative of genuine psychological distress. In this current paper, the SCL-90-R was validated against the McGill Pain Questionnaire and the Visual Analog Scale. The results of the study were that there was a statistical significant difference between the chronic pain patients and the individuals feigning symptoms with the feigning individuals exhibiting significantly higher scores across the items on the SCL-90-R. The implication of this was that the feigning individuals overestimated the degree of distress and the level of pain and in so doing displayed a noncharacteristic profile on the SCL-90-R. In turn, characteristic profiles cannot be faked, and thus are indicative of genuine psychological distress.

28 Hagstrom Y, Carlsson RTP. Prolonged functional impairments after whiplash injury. Scandinavian Journal of Rehabilitative Medicine 1996; 28:139–146.

In this study, thirty patients were examined 1 to 55 months after an episode of whiplash. A control group comprised of 30 healthy individuals was used for comparison as well as a third reference group representing the population of the surrounding city. Assessment tools used were the visual analog scale, pain characteristics, pain drawing, manual palpation and algometer (muscle tenderness), inclinometer(ROM), grip strength and Mood Adjective Check List. The results of the study showed that compared with healthy controls, the patients were more tender in the neck, shoulder and arm muscles and had reduced neck mobility, lower handgrip strength and poorer mental well-being. The authors conclude that patients with prolonged disability after a whiplash injury present a complex clinical picture, with both somatic and mental symptoms, most of which are hard to explain.

29 Schrader H, Obelieniene D, Bovim G, Surkiene D, Mickeviciene D, Miseviciene I, Sand T. Natural evolution of late whiplash syndrome outside the medicolegal context. Lancet 1996; 347:1207–1211.

Through the use of a retrospective cohort study, the authors have attempted to address the issue of the natural history of late whiplash syndrome. The study was inten-

tionally conducted in a country where the greater populace apparently knows very little about whiplash injury and the associated medical/legal ramifications. As well, the authors state that the majority of the driving populace does not have automobile insurance. They feel that both of these conditions eliminate many of the medical/legal confounding factors that are inherent in a large proportion of the previous studies dealing with this same subject. Following identification through the local police department, a group of subjects, who had been previously rearended in their automobile were sent a series of questionnaires about any head, neck or low back pain or any other symptoms including cognitive/psychological abnormalities they were experiencing. A control group, both age and sex matched, were also sent the questionnaires. The main outcomes assessed were chronic neck pain and headache and any neck pain or headache. The results of the study confirmed previous findings that neck pain, headache and subjective cognitive dysfunction are common complaints in the general populace. After adjustment for age and sex, the frequency of chronic neck pain in the accident group was 10% and the control group 8%. As well, the frequency of neck pain, headache of any degree, and cognitive dysfunction among accident victims and the controls were of the same order of magnitude as those reported in the general population in other countries.

IMAGING

30 Pettersson K, Hildingsson C, Toolana G, Fagerlund M, Bjornebrink J. MRI and neurology in acute whiplash trauma. Acta Orthopedic Scandinavia 1994; 65(5):525–528.

This article is apropos in context to the present climate of today's health care environment concerning cost and utilization of diagnostic tests. The authors provide the reader with a prospective study of 39 individuals who had been involved in a whiplash injury and shortly thereafter (mean of 11 days) were clinically evaluated as well as receiving MRI evaluation of their necks. The evaluation and the MRI read were performed in a blinded manner. The results of the study were that despite many findings on MRI the authors found no relationship between these lesions and the neurological deficit in the acute phase.

31 Dvorak J. Soft tissue injury to the cervical spine. New possibilities of diagnosis with computed tomography. Journal of Manual Medicine 1989; 4:17–21.

This article addresses the evaluation of the patient who has cervical spine complaints especially with apparent soft tissue injury. The author provides the reader with a review of the possible planes of instability that can occur at the level of the cervical spine as well as the most appropriate study to accurately evaluate each pathological movement. The article states that the more commonly thought of planes of instability i.e. ... flexion/extension and lateral flexion can be assessed with conventional functional radiography but that rotational instabilities may require computed tomographic functional studies. A stepwise diagnostic sequence for evaluation is offered when posttraumatic hypermobility or hypomobility of the cervical spine is suspected.

TREATMENT/MANAGEMENT

32 Fitz-Ritson D. The chiropractic management and rehabilitation of cervical trauma. Journal of Manipulative and Physiological Therapeutics 1990; 13(1):17–25.

This article addresses the need for a well defined and rational approach to the treatment of cervical spine trauma. The author provides the reader with a treatment protocol which is outlined into stages with each stage defined by its operational end-point. In essence, the author feels that an aggressive yet conservative approach with more involvement of the patient in the care i.e. ... active care, is needed to generate the greatest potential for restoration of optimum structure and function of the traumatized area.

33 Mealy K, Brennan H, Fenelon GCC. Early mobilization of acute whiplash injuries. British Medical Journal 1986; 292:656–657.

The authors of this article feel that the majority of studies to date concerning whiplash injury have concentrated on prognosis due to its medicolegal importance and not on treatment efficacy. This prospective randomized trial was carried out to compare a standard treatment of rest and immobilization for whiplash injury with an alternative regimen of early active mobilization (Maitland technique). The results of their study confirmed their expecta-

tions that initial immobility after whiplash injuries gives rise to prolonged symptoms whereas a more rapid improvement can be achieved by early active management without any consequent increase in discomfort.

34 McKinney LA. Early mobilization and outcome in acute sprains of the neck. British Medical Journal 1989; 299:1006–1008.

This single blinded randomized study looked at the long term effect of early mobilization exercises versus analgesia and a cervical collar in patients with acute sprains of the cervical spine following a road traffic accident. The results of the study support early mobilization with the reliance on a home patient program and not in-office care.

35 Greenman PE. Manual and manipulative therapy in whiplash. Spine: State of the Art Reviews 1993; 7(3):517–530.

This article provides an excellent review on whiplash injury including the potential role of manual therapy in treatment as well as the biomechanical dynamics of the cervical spine. A comprehensive examination following whiplash injury with emphasis on structural diagnosis is felt by the author to be of utmost importance and can lead to a rational well thought out and focused approach to management of this type of injury. The article lists what actually constitutes manual medicine techniques and what they involve, as well as indications and contraindications for their use. The role of adjunctive therapies in treatment of whiplash injuries is also presented.

36 Teasell RW, Shapiro AP, Malis A. Medical management of whiplash injuries. Spine: State of the Art. 1993; 7(3):481–499.

This paper presents a thorough review of the management of whiplash injuries including an important but many times lightly taken issue of patient-clinician relationship. The basic treatments are summarized including education, rest, cervical collars, postural factors, exercise, manipulation and medications. Psychological intervention is addressed in light of what is known about chronic pain and suffering on behavior. As well, the authors feel that vocational adjustments and retraining are important issues where applicable.

37 Simons DG, Hong CZ. Response to treatment for pectoralis minor myofascial pain syndrome after whiplash. Journal of Musculoskeletal Pain 1993; 1(1):89–131.

This retrospective study on 37 subjects was designed to investigate the role of myofascial trigger points of the pectoralis minor muscle in producing symptoms following whiplash injury. Following inclusion and exclusion criteria selection, as well as history and physical examination, the subjects were rendered treatment consisting of standard physical therapy as well as spray and stretch techniques. Some of the subjects also received trigger point injections. The rate of progress was assessed via pain and function. The results from the study lead the authors to conclude that the pectoralis minor myofascial syndrome not infrequently occurs in association with whiplash injury and is easily misdiagnosed as cervical radiculopathy.

38 Fricton JR. Myofascial pain and whiplash. Spine: State of the Art Reviews 1993; 7(3):403–422.

This paper provides the reader with an in-depth look at myofascial pain and whiplash injury. The section on pathophysiology includes a chart of the most commonly involved muscles of the head and neck and their associated referral patterns in a post-whiplash patient. The article defines more specifically what constitutes a trigger point as well as local and referred pain, ancillary findings, the relationship to other pain disorders and contributing factors all of which are presented in table form for the reader. Treatment of myofascial pain through exercise, stretching and trigger point therapy is covered. The author addresses the control of the contributing factors as well as a need for a team approach to management.

39 Bisbee LA, Hartsell HD. Physiotherapy management of whiplash injuries. Spine: State of the Art Reviews 1993; 7(3):501–516.

This article reviews the literature describing current norms of clinical practice in the physiotherapy management of the patient with cervical spine whiplash injury. The authors feel that there is considerable evidence in the literature to support the organic basis for the symptoms described by the patients after injury but no concrete evidence indicating that any particular treatment is more beneficial than another. They also feel that evidence is

lacking at this time as to when exactly, following the onset of the symptoms, treatment intervention should be introduced. The article initially deals with physiotherapy assessment with specific emphasis on assessment of cervical spine instability. The authors take an objective look at cervical collars before moving on to actual treatment via physiotherapy. Treatments assessed include patient education, standard therapies such as ice and heat etc. as well as traction and manual therapy.

40 Weinberger LM. Trauma or treatment? The role of intermittent traction in the treatment of cervical soft tissue injuries. The Journal of Trauma 1976; 16(5):377–382.

This article addresses the rationale behind the use of intermittent traction following soft tissue injuries to the cervical spine. The author believes that the potential harm is as likely as is any potential benefit due to the lack of understanding of what is actually occurring anatomically and physiologically with traction.

41 McKinney LA, Dornan JO, Ryan M. The role of physiotherapy in the management of acute neck sprains following road-traffic accidents. Archives of Emergency Medicine 1989; 6:27–33.

In this single blinded randomized study of whiplash victims, 71 subjects receiving outpatient physiotherapy (including mobilization), 33 subjects receiving analgesics and a cervical collar and 66 subjects receiving only advice on comprehensive home mobilization therapy were compared. The results of the study showed a significant improvement for the outpatient physiotherapy subjects as compared to the analgesic/collar group but no significant differences in outcome between the outpatient physiotherapy subjects and the home therapy group. This is an interesting article in that the same author, later that same year in another study, found that there were significant improvements in the home physiotherapy group versus the outpatient physiotherapy group.

42 Croft AC. Treatment paradigm for cervical acceleration/deceleration injuries (whiplash). ACA Journal of Chiropractic 1993: 41–45.

The author provides the reader with the legal and socioeconomical problems inherent in dealing with a whiplash injury patient in the context of a health care environment that is currently demanding accountability and standards of care. The article provides not only the multifaceted problems entrenched in dealing with whiplash injuries but solutions as well. The author offers a proposed new classification for cervical acceleration/deceleration injuries, details complicating factors related to whiplash injuries and offers treatment frequency and duration guidelines that together can be used to determine when the patient has reached maximum medical improvement.

43 Provincialli L, Baroni M, Illiminati L, Ceravalo MG. Multi modal treatment to prevent the late whiplash syndrome. Scandinavian Journal of Rehabilitative Medicine 1996; 28:105–111.

This controlled, randomized single-blinded study on 60 consecutive patients suffering from a cervical acceleration-deceleration injury following an automobile accident included a group that received multi modal treatment including active and passive care such as postural training, relaxation techniques and manual treatment and another group that received passive treatment in the form of electrical muscle stimulation and ultrasound. Each patient received ten one hour treatment sessions over a two week period. A blinded physician performed assessment pre and post treatment up to six months following completion of care. Outcomes assessed were cervical spine range of motion, pain level, self-rating efficacy and return to work delay. Analysis of the data showed greater improvement in all outcomes except for range of motion in the group receiving active and passive care when compared to the group receiving just passive care.

44 Coulter ID, Hurwitz EL, Adams AH, Meeker WC, Hansen DT, Mootz RD, Aker PD, Genovese BJ, Shekelle PG. The appropriateness of manipulation and mobilization of the cervical spine. Santa Monica: RAND, 1996.

This document is a collaborative project between the Consortium for Chiropractic Research, the Los Angeles College of Chiropractic, the Palmer College of Chiropractic (West), and RAND. The objective of this report was to establish through the literature the suitability of manipulation and or mobilization for various conditions such as neck pain, headache, shoulder/arm/hand pain, carpal tunnel syndrome, temporal mandibular joint dysfunction and

other variables related to the cervical spine such as intersegmental motion and curve alignment. Complications following cervical spine manipulation were addressed in the report. A nine member panel of content experts from the disciplines of chiropractic and allopathic medicine were selected to review and then rate possible indications as to their degree of appropriateness concerning manipulation and mobilization. The initial literature review and rating process was done individually by each panel member but culminated with the panel members being brought together to generate a consensus opinion as to the condition related appropriateness of manipulation and or mobilization of the cervical spine. This document that clarifies the present state of scientific knowledge concerning manipulation/mobilization and the cervical spine.

45 Aker PD, Gross AR, Goldsmith CH, Peloso P. Conservative management of mechanical neck pain: systematic overview and meta-analysis. British Medical Journal 1996; 313:1291–1296.

This article may be considered as a summary paper of a more comprehensive document entitled Conservative Management of Mechanical Neck Disorders which can be found in The Cochrane Database of Systematic Reviews/ The Cochrane Collaboration (Issue 2): Musculoskeletal module. The authors of this paper performed a systematic overview and meta-analysis of the healthcare literature on the subject of conservative management of mechanical neck pain. The inclusion criteria for the articles were that they be randomized clinical trials (RCT) on adult populations with conservative treatments and have reported pain outcomes. The objective of the paper was to determine the present level or state of evidence concerning various standard conservative treatments utilized routinely in the management of mechanical neck pain. The conservative therapies analyzed and presented separately in the paper included manual treatments (manipulation/mobilization/ massage), physical medicine methods (spray and stretch/ laser/infrared/acupuncture/exercise, etc.), drug treatments and patient education. Key messages noted by the authors were that neck pain is a common problem, systematic literature searching finds a limited number of clinical trials, there is early evidence to support the use of manual treatments in combination with other treatments for short term pain relief and that further clinical trials are needed to determine optimal treatment approaches. In conclusion, the authors felt that in general, no treatments have been studied in enough detail to assess either efficacy or effectiveness adequately.

PROGNOSIS

46 Miles KA, Maimaris C, Finaly D, Barnes MR. The incidence and prognostic significance of radiological abnormalities in soft tissue injuries to the cervical spine. Skeletal Radiology 1988; 17:493–496.

The aim of this study was to determine the incidence of radiological abnormalities in 71 patients who had sustained trauma to the cervical spine without bony injury in vehicle collisions and to correlate these with the mode of injury and the clinical outcome at 2 years. The radiographs were assessed by a radiologist for evidence of prevertebral soft tissue swelling, degenerative changes and angular deformity between two adjacent vertebral bodies. The results of this study conclude that the only radiological feature associated with poor prognosis is the presence of degenerative changes.

47 Bannister G, Gargan M. Prognosis of whiplash injuries. Spine: State of the Art Reviews 1993; 7(3):557–569.

After reviewing the signs and symptoms of whiplash injury patients, including back pain, this article examines the issue of prognostic factors in whiplash injuries taking into account chronicity of symptoms and other factors. A table is presented in this article that lists prognostic factors associated with poor outcomes as well as the authors of recent literature on each factor. Imaging findings and their potential for significance as prognostic factors are also addressed. Litigation and psychological effects are addressed as well as the effect of prevention and therapy on whiplash injuries. An interesting look at the natural history of neck pain is offered.

48 Norris SH, Watt I. The prognosis of neck injuries resulting from rear-end vehicle collisions. Journal of Bone and Joint Surgery 1983; 65(5):608–611.

This article addresses 61 patients who had previously sustained whiplash injury in a rear-end collision. A thorough history and examination including x-ray was performed

on each subject immediately following their injury. The purpose of this study was to design a classification system based upon presenting symptoms and physical signs to be used as a reliable basis for formulating a prognosis for whiplash patients. The subjects were clinically re-evaluated at a mean follow-up time of approximately two years post injury. The results of this analysis lead the authors to conclude that poor prognostic symptoms and signs were stiffness of the neck, neurological signs, muscle spasm and pre-existing degenerative changes.

49 Gargan MF, Bannister GC. Long-term prognosis of soft-tissue injuries of the neck. Journal of Bone and Joint Surgery 1990; 72(5):901–903.

This article is a continuum of the initial and two year analysis of 61 post-whiplash injury subjects by Norris and Watt. The authors interviewed and clinically evaluated 43 of the original 61 subjects at a mean of 10.8 years post-whiplash injury for any residual symptoms, rate of recovery and any litigation in order to potentially identify long-term prognosis in whiplash injuries. The authors concluded that it is not possible at this time to reliably predict the long-term outcome based on symptoms and that after two years, symptoms in their study subjects did not alter with further passage of time.

50 Squires B, Gargan MF, Bannister GC. Soft-tissue injuries of the cervical spine. Journal of Bone and Joint Surgery 1996; 78-B:955–957.

The authors of this study interviewed and clinically re-evaluated, at approximately fifteen years post-whiplash injury, 40 of 61 post-whiplash injury subjects from the previous work by Norris & Watt and Gargan & Bannister. These same subjects had previously been evaluated at two and ten years by the same authors. Evaluation involved an interview as to the subjects present symptoms followed by placement of each subject into one of four symptom/function classifications designed by the authors and based on increasing pain and dysfunction. A pain questionaire and pain map as well as three psychometric assessments were administered to each subject. The results of this study were that 70% of the subjects remained symptomatic at fifteen years post-whiplash injury. Eighteen percent of these symptomatic subjects showed improvement over the last five years but 28% had deteriorated. Women and older patients were more likely to experience symptoms. Radiating pain was associated with more severe disability. Evidence of psychological disturbance was seen in 52% of the subjects with symptoms.

OUTCOMES

51 Jonsson H, Cesarini K, Sahlstedt B, Rauschning W. Findings and outcomes in whiplash-type neck disorders. Spine 1994; 119(24):2733–2743.

The authors of this article assessed the clinical findings, imaging findings and late outcomes in 50 patients with whiplash-type neck disorders. Repeated clinical and radiographic examination and contrast magnetic resonance imaging were performed after 1 year and 5 years by a neurologist who functioned as an independent observer. The results lead the authors to conclude that a high incidence of disco ligamentous injury was found in whiplash-type neck disorders and five years after the accident, mobility had decreased in most spines but there was no progression of degenerative changes or instability.

52 Hildingsson C, Toolanen G. Outcome after soft-tissue injury of the cervical spine. Acta Orthopedia Scandinavia 1990; 61(4):357–359.

This article details a prospective study of 93 subjects who had been involved in a car accident and incurred soft-tissue injury to the cervical spine. The subjects were initially examined and then followed up 2 years later. The results at 2 years showed similar symptom complexes as initial evaluation but in a smaller number of subjects. The authors also looked at factors such as acute symptoms, age, sex, and radiographs but did not reveal any factor of prognostic importance in contrast to previous literature.

53 Osterbauer PJ, Derickson KL, Peles JD, DeBoer KF, Fuhr AW, Winters JM. Three-dimensional head kinematics and clinical outcome of patients with neck injury treated with spinal manipulative therapy: a pilot study. Journal of Manipulative and Physiological Therapeutics 1992; 15(8):501–511.

The objective of this study was to correlate 3D head kinematic data with clinical outcome in an uncontrolled

group of 10 patients with a diagnosis of whiplash syndrome following a course of spinal manipulative therapy (SMT). Following clinical evaluation and biomechanical analysis, treatment was rendered for 6 weeks. Principal outcome measures were neck pain and range of motion as well as a follow-up questionnaire. The results of the study lead the authors to conclude that their 3D analysis system for obtaining the critical finite helical axis parameters (FHAP) and related parameters appears to be a promising tool with which to accumulate the state of function of the cervical spine. In addition, it appears that treating patients with whiplash syndrome conservatively for even fairly short periods of time may be useful.

54 Vernon H, Mior S. The neck disability index: a study of reliability and validity. Journal of Manipulative and Physiological Therapeutics 1991; 14(7):409–415.

This article describes the process of the development of a questionnaire entitled Neck Disability Index (NDI). The NDI, a revised form of the Oswestry Low Back Pain Index, can be used as a self-reporting instrument for the assessment of activities of daily living (ADL) of sufferers of disabling neck pain, particularly from whiplash-type injuries. The NDI has been shown to demonstrate a high degree of test-retest reliability and internal consistency, to be applicable to a wide age range, is unaffected by gender, and has an acceptable level of validity being sensitive to severity levels and to changes in severity over time.

55 Radnov BP, Sturzenbegger M, Di Stefano G. Long-term outcome after whiplash injury/a two year follow-up considering features of injury mechanism and somatic, radiologic, and psychological findings. Medicine 1995; 74(5):281–297.

The authors designed this study to assess the significance of injury mechanisms and of early somatic, radiographic, and psychological variables on the outcome assessed 2 years after the trauma in a nonselected sample of patients with whiplash. As well, the authors also looked at the course of cognitive and psychological variables, the proportion of disability, and the factors upon which the responsible physicians assessed these variables. This is a very thorough study that attempts to clarify aspects of whiplash that are commonly disagreed upon within healthcare today. The results of the study support the view that a poor outcome in the long term after whiplash injury is primarily related to the initial severity of injury. Further, the authors concluded that symptom persistence but not disability can be predicted based on early initial examination and that the criteria on which physicians certified disability were difficult to establish.

LITIGATION

56 Shapiro AP, Roth RS. The effect of litigation on recovery from whiplash. Spine: State of the Art Reviews 1993; 7(3):531–556.

This is an excellent paper that addresses a very controversial and at times hotly debated issue concerning whiplash injuries; chronic symptoms and litigation. The authors provide both retrospective and prospective studies on the effect of litigation and the resolution of symptoms as well as offering their conclusions on this matter. The article also deals with the understanding of "psychogenic accusation," the tendency to view chronic pain secondary to whiplash as psychogenic in origin. A model of chronic pain is offered and its role or interaction with litigation is looked at. Litigation and its relationship to employment, family, society and treatment is dealt with as well.

57 Parmar HV, Raymakers R. Neck injuries from rear impact road traffic accidents: prognosis in persons seeking compensation. Injury: The British Journal of Accident and Surgery 1993; 24(2):76–78.

The authors of this article studied the natural history and prognostic factors of 100 subjects who had been involved in a rear impact road traffic accident in whom neck injury was predominant. All subjects in the study were followed for up to 3 years. The results of the study were that the front seat position, pain within 12 hours of injury, past history of neck pain and degenerative changes on radiographs were associated with a longer duration of significant pain. Early onset of pain was also associated with a worse level of pain at follow-up. The timing of compensation was not associated with improvement in symptoms and the injury has not accelerated the development of degenerative changes.

58 Schofferman J, Wasserman S. Successful treatment of low back pain and neck pain after a motor vehicle accident despite litigation. Spine 1994; 19(9):1007–1010.

This prospective study evaluated 39 subjects with low back or neck pain resulting from a motor vehicle accident who also had litigation pending. All the subjects were initially evaluated in a comprehensive manner and then treated with an array of therapies ranging from physical therapy to oral medication and injection therapy. Upon release from care, a final analysis of pain and function was performed. The results of the study were that the subjects showed statistically significant improvement with treatment despite ongoing litigation.

References

1 Spitzer WO. Whiplash-Associated Disorders(WAD)/ Redefining "Whiplash" and it's Management. Quebec Task Force on Whiplash-Associated Disorders, 1995:2.
2 Croft AC. Whiplash Advanced Topics. In: Whiplash: The Masters' Certification Program, 1996:6.