

ABSTRACTS OF STUDIES RELATED TO SOFT-TISSUE INJURIES IN AUTOMOBILE ACCIDENTS

SUMMARY

1. Bioengineering

Study of Basic Physical Measurements related to Susceptibility to Cervical Hyperextension-Hyperflexion Injury; Synder, R.G., Chaffin, D.B., and Foust, D.R. Highway Safety Research Institute September 1975, Sponsored by Insurance Institute for Highway Safety.

This work studied the basic characteristics of the neck which may influence susceptibility to hyperextension-hyperflexion whiplash injury in rear-end automobile accidents:

- Aging and sexual differences in cervical mobility, reflex time, and muscle strength were all found to be important factors in injury susceptibility.
- Certain portions of population are more likely than others to sustain neck injuries in rear-end automobile accidents. Females suffer more whiplash injuries due to weaker neck muscles than men, on average.
- The elderly suffer the greatest risk of injury because of substantial degradation of reflex time, range of motion and muscle strength. Elderly females are at greatest risk during rear-end automobile accidents.

2. Scientific Automobile Accident Reconstruction treatise by Barzeley; Published by Mathew Bender 1984; Chapter 46:

- The simple fact remains: neck injuries do occur as a result of rear-end automobile accidents. 46-2
- Whiplash injuries may be present as a result of automobile accidents, even though no physical, radiological or other objective evidence of injury can be found. 46-3
- Usually the onset of symptoms occurs from 12 to 24 hours afterward. Sometimes there may be as much as weeks or even months delay between the automobile accident and the experience of symptoms. 46-5
- Most people just don't expect injuries to occur when the impact velocity has been low and damage to the vehicles has not been great. It is common sense to expect that the severity of the injuries should be in proportion to the severity of the collision. However, whiplash injuries most frequently result from relatively minor automobile accidents without major damage done to the vehicles. 46-6
- Rear-end collisions produce a sudden forceful hyperextension of the neck which is immediately followed by recoil into neck flexion. 46-8
- Probably most of the injuries result from the sudden traumatic snapping of the neck when the acceleration of the head suddenly shifts directions. 46-10

3. The Journal of Bone and Joint Surgery; Vol. 56-A, No. 8, December 1974; Mason Hohl, M.D.; "Soft Tissue Injuries of the Neck in Automobile Accidents-Factors Influencing Prognosis."

ABSTRACT: Five years or more after automobile accidents which caused soft tissue injuries of the neck in 146 patients who had no pre-existing degenerative changes, evaluation revealed statistically significant positive correlations between poor results and the following findings shortly after injury: numbness or pain in an upper extremity; sharp reversal of the cervical lordosis visible on x-rays; restricted motion at one interspace as shown

by flexion-extension x-rays; need for cervical collar for more than 12 weeks, or for home action; and need to resume physical therapy more than once because of the recurrence of symptoms. Symptomatic recovery occurred in 57% of the 146 patients, while degenerative changes developed after the injury in 39% of 743 patients seen in private orthopedic offices during the period of 1957-66, following automobile accidents causing neck injuries.

- 50% of patients were under orthopedic care by the fifth day after injury. 28% were not seen until 30 days or more following the automobile accident;
- Analysis of symptoms experienced during first month after injury from showed aching and stiff neck, 2/3 headaches, 1/3 shoulder pain;
- Positive physical finding included some degree of muscle spasm and restriction of movement in 72%.

Treatment followed no fixed routine and varied according to symptoms and findings:

- 46% Soft cervical collar, most using heat in some form
- 26% Heat only
- 66% Physical therapy including massage & traction
- 5% Home traction

Initial X-rays showed:

- 42% Lordotic cervical curve
- 35% Straight cervical spine
- 9% Reversed curve
- 15% Sharp reversal

4. While the incidence of disc degeneration increases with age, the data of Friedenberg found the incidence should not be more than 6% in uninjured asymptomatic people 30-40 years old; 25% for 50-60 years.

Friedenberg, Z.B., and Miller, W.T.: Degenerative Disc Disease of the Cervical Spine. A Comparative Study of Asymptomatic and Symptomatic Patients. J. Bone and Joint Surg., Vol. 45-A: 1171-1178, Sept. 1963. Please also see Friedenberg, Z.B., Broder, H.A., Edeiken, J.E., and Spencer, H.N.: Degenerative Disc Disease of the Cervical Spine Clinical and Roentgenographic Study. J. Am. Med. Assn., 174: 374-380, 1960. [In patients with no neck injury or symptoms i.e. asymptomatic]:

- The much higher incidence of these changes in the present series suggests that the trauma was probably a causative factor;
- 5 years or more following automobile accidents causing soft tissue neck injuries in patients with no pre-existing cervical degenerative changes, 39% of patients showed x-rays evidence of disc degeneration;
- 27% of the patients continued to have symptoms in the absence of degenerative changes, indicating that persistent neck symptoms did not necessarily mean that degenerative changes would develop or had developed;
- The older the patient the less likely they were to become asymptomatic;
- Property damage to vehicle: The duration of symptoms bore no relation to the amount of vehicle damage sustained in the automobile accident;
- Radiating pain or numbness, or both, in the upper extremities showed a significant positive correlation with a bad prognosis for symptomatic recovery. None of the various patterns of radiating pain was found to be specific for the location of the degenerative changes in an intervertebral disc;

- Symptoms lasted for an average of twenty months in patients with no late degenerative changes and for an average of thirty months for in those in whom degenerative changes did develop;
- There was a significantly higher incidence of degenerative changes in the twenty who had a sharp reversal of the normal cervical curve;
- Patients with early flexion extension x-rays showing restricted motion at one intervertebral level tended to have a poorer symptomatic recovery and a considerably increased ($p < 0.01$) incidence of degenerative changes;
- These findings indicated a significant positive correlation ($p < 0.05$) between persistence of symptoms and the development of degenerative changes.

5. The 43% incidence of residual symptoms in this series was within the 20% to 46% reported in other series. Braaf, M.M., and Rosner, Samuel: Symptomatology and Treatment of Injuries of the Neck. New York State J. Med., Vol. 55, 237-242, 1955; Gotten, Nicholas: Survey of One Hundred Cases of Whiplash Injury after Settlement of Litigation. J. Am. Med. Assn., Vol. 162: 865-867, 1956. MacNab, I.: Acceleration Injuries of the Cervical Spine. J. Bone and Joint Surg., Vol. 46-A: 1797-1799, December 1964.

- Numbness and pain in the upper extremity were associated with a significantly higher incidence of residual symptoms 9 ($p < 0.05$);
- The above study summarizes disputes in literature regarding alterations of normal cervical curve: Borden: Studied 180 volunteers of all ages without prior neck injury or symptoms finding 13 with loss of cervical lordosis. Most of the 11 were >50 years. Braf & Rosner : Concluded loss was related to muscle spasm in the cervical region. Davis: concluded loss was indicative of mechanical derangement or posterior intervertebral discs. Fineman & Borelli: Reported that a straight curve may occur normally and does not necessarily indicate muscle spasm. Rechtman: Measured cervical lordosis in randomly selected population concluding it was an important finding, that it is an antalgic position, and that it is a protective mechanism to avoid further soft tissue damage. Juhl: Found straightened or reversed curves frequently in 116 subjects 17-37 years; Reversed and angled less frequently;
- The findings in this series support the concept that deeply lordotic, shallow lordotic and flat cervical curves are normal variations. A sharp reversal of the curve after injury, however, is a harbinger of degenerative changes in 60% of patients;
- This study also corroborated the well known fact that intervertebral disc degeneration often occurs without associated clinical symptoms.

6. Study of car accident victims at British Hospital, 1982-83:

- 22% of patients felt neck pain in 12 hours, or more, post collision.
- 35% experienced persistent neck pain at six months.
- 26% experienced persistent neck pain at one year.

Confirming that neck pain occurs after impact from all directions but is disproportionately more common after automobile collisions in which the impact is from the rear, the incidence of pain after this type of impact (84%) being similar to the 78% reported by Thomas et al.

[Thomas C., Faverjon G., Hartemann F., Tattiere C., Patel A., Got C. The Enigma of Whiplash Injuries. In: Proceedings of the 13th 1969. Michigan: Highway Safety Research Unit of University of Michigan, 1970:83-108.]

7. Study of rear-end automobile accident victims 1977-80 at the Bristol Royal Infirmary:

- 22% experienced delayed onset of pain in 3 to 24 hours post accident;

- Pre-existing degenerative changes in the cervical spine, no matter how slight, do appear to affect the prognosis adversely. Secondly, abnormal curves in the cervical spine, presumably reflecting spasm of the neck muscles, are more common in patients with a poor outcome.

Norris S.H., Watt .I: The prognosis of neck injuries resulting from rear end vehicle collisions. Journal of Bone & Joint Surgery 65B(5):608-611, 1983.

8. Severy D.M., Mathewson J.H., Bechtol C.P.: Controlled Automobile Rear-End Collisions, An Investigation of Related Engineering and Medical Phenomena. Canadian Services Medical Journal 11: 727, 1955:

Unlike most types of collisions, the rear-end automobile accident frequently results in minor car damage with major bodily injury.

Objective:

To facilitate a keener discernment of the medical phenomena associated with the neck injuries common to this type of impact.

Findings and Conclusions:

(1) The Whiplash injury pattern can be significantly influenced by any or all of the following factors:

(a) Speed of contact of the two vehicles in the automobile accident.

(b) Type of cars: mass and collapse characteristics of the contacting sections.

(c) Height and Strength of the seat-back.

(d) Human body variations including height, weight and age as well a posture of the individual during the automobile accident.

(e) Defensive action, if any, taken by motorist when forewarned of imminent collision. (3) A relaxed motorist, such as one waiting for a traffic signal to change, not forewarned of an impending rear-end collision could have his head subjected to loadings in excess of one hundred pounds for a collision under 15mph. (7) The neck is able to withstand very considerable acceleration and sustain only minor soft tissue injuries. These injuries produced symptoms which last for an unusually long time. (10) Unlike most injury producing accidents there is generally no visible sign of injury for the rear end collision victim. Frequently, he is not immediately aware that he has suffered a disabling injury. (14) The body posture and state of preparedness of the motorist at the time of impact appears to have an influence on the acceleration pattern of the body components, and hence the injury potential of a given collision. (23) Most of the collapsing of car structures that occur during a collision is not evident following the automobile accident.

9. The April 1993 issue of Clinical Chiropractic contains an article by Dr. Daniel J. Murphy, DC, FACO, entitled "Soft Tissue Research: Recovery Time for the Whiplash Injury." Dr. Murphy analyzed his own data regarding 15 years of clinical chiropractic treatment of whiplash injured patients (cervical soft-tissue spine injury). Dr. Murphy noted the number of patient visits and the length of time these injuries required to achieve maximum improvement. He found that his average case achieved maximum improvement in approximately 32 visits over a period of 5 months. He also found, however, that 10% of cases would require more than 100 patient visits of treatment lasting between 12-18 months and that 2% of these cases would require in excess of 200 visits lasting a period greater than 2 years. Dr. Murphy summarized recent studies reiterating the probability of chronicity:

1. Hodgson in 1989 states, 62% of the people injured in a whiplash soft tissue trauma will have continued complaints between 10 and 15 years after the date of the accident; and that of this subjective group, 62.5% had to modify their leisure activities, and 44% had to change permanently to lighter work.

Hodgson, S.P., Whiplash Injuries: Their Long-Term Prognosis and Its Relationship to Compensation, *Neuro-Orthopedics* 7, 1989.

2. Nunn in 1990 states that follow-up studies on whiplash indicate with standard treatment, up to half the patients have significant pain at five years. Nunn, P.J., Whiplash Syndrome – A Transformational Approach, *Pain* 9 (supplement 5), 1990.
3. Gargan in 1990 followed for ten years patients who had sustained soft tissue injuries of the neck. Of those, only 12% had recovered completely. Residual symptoms were intrusive in 28% and severe in 12%. After two years, symptoms did not appear to alter with the passage of time. Gargan, M.F., Long – Term Prognosis of Soft – Tissue Injuries of the Neck, *The Journal of Bone and Joint Surgery*, Sept. 1990.
4. Watkinson in 1991 also followed patients for over ten years following soft tissue injuries of the cervical spine. He noted that symptoms persisted in 86% of the patients and were intrusive or worse in 23%.

The findings of 2 recent studies regarding the timing of recovery were also reviewed:

1. Mild injuries may develop immediately or more slowly after injury, will heal rapidly, with minimal work loss and symptom free status about six months post injury. This type of injury and timing for healing is classified by the author as being uncomplicated.
2. Whiplash victims with moderate injury [complicated] may develop symptoms over 24 hours. These people will experience serious problems with substantial work loss of weeks or months but will recover a normal lifestyle within six months to two years. Valid complicated symptoms often include severe headache, paresthesia and significant early spinal range restrictions.
3. Within one year, about 50% of patients in the moderate category will have recovered to a level of functional recovery. Although functional, often these persons will have intermittent symptoms in damp or cold weather and intolerance of prolonged neck position or of extreme turning or extension.
4. After 18-24 months, almost all patients will have reached functional recovery although some report recovery up to five years later.
5. About 10-15% of motor vehicle related cervical injuries fail to achieve a functional recovery even after the passage of 2-3 years.
6. From 40-70% of such patients retain some degree of intermittent, unpleasant, unnatural but not serious symptoms in the injured tissues. These symptoms may be periodically distracting, but the patient retains the ability to perform daily activities.

Amesis, Arthur, *Cervical Whiplash: Considerations in the Rehabilitation of Cervical Myofascial Injury* Canadian Family Physician, Vol. 32, Sept. 1986.

Further findings made by Teasell were outlined:

1. If, at the end of six weeks, the patient has continuous pain, he or she can be expected to have intermittent symptoms for an additional 6-12 months.
2. 50% of patients will have made a functional recovery at the end of the first year.
3. A further 25% may recover during the next six months.
4. Patients will not be able to return to full time work or enjoy leisure activities after 18 months have a poor prognosis with less than 25% chance of recovery.

Teasell, R. W., *Clinical Spectrum and Management of Whiplash Injuries, Painful Cervical Trauma*, Williams & Wilkins, 1992, p. 306-307.

10. More recent studies support finding referred to above and address further the question of how much force is required to cause injury: Freeman MD, Croft AC, Nicodemus CN, Centeno CJ, Elkins WL. *Significant spinal injury resulting from low-level accelerations: a case series of roller coaster injuries*. Archives of Physical Medicine & Rehabilitation 2005;86:2126-2130. This study examined 19 months of various records, including emergency medical reports related to a roller coaster in Texas.

See also Siegmund GP, King DJ, Lawrence JM, Wheeler JP, Brault JR, Smith TA. Head/Neck kinematic response of human subjects in low-speed rear-end collisions. SAE 1997, 973341.