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## *Physician's View of Whiplash Injuries of the Neck*

*Paul A. Nelson, M. D.\**

**W**HIPLASH INJURIES OF THE NECK as the result of automobile accidents have attracted increased attention in recent years from both the medical and legal professions. The incidence of such injuries has risen steadily, paralleling the increases in the number of automobiles and in the number of accidents on our highways. Unfortunately, effective safety measures or changes in automobile design that might prevent or minimize these injuries have not yet been introduced. Because most whiplash injuries involve compensation and many entail litigation, the correct management of such cases both medically and legally is of considerable economic importance.

The term "whiplash," which was first introduced by Davis<sup>1</sup> in 1945, now is widely used in describing strains or sprains of the neck not resulting from direct blows to the head or neck. Unfortunately, the term connotes sudden violence and grave consequences. Although the effects of whiplash injuries often are negligible, the layman generally regards them indiscriminately as being very serious. A more accurate and less colorful term, such as "neck strains or sprains," is preferable; however, since "whiplash injury" is so widely used, there is little to be gained in avoiding its use in this discussion.

Gay and Abbott<sup>2</sup> found that 45 (90 per cent) of 50 persons with whiplash injuries had sustained those injuries when the car in which they were riding had stopped at an intersection or had

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<sup>1</sup> Davis, A. G., Injuries of the Cervical Spine. 127 *J. A. M. A.* 149-156 (January 20, 1945); correction 936 (April 7, 1945).

<sup>2</sup> Gay, J. R., and Abbott, K. H., Common Whiplash Injuries of the Neck. 152 *J. A. M. A.* 1698-1704 (August 29, 1953). And see Dr. Abbott's paper on Whiplash in this issue of *Cleveland-Marshall Law Review*.

**ILLUSTRATIONS** appear at end of article.

slowed down unexpectedly and had then been struck from the rear by another vehicle. To study the effects of such accidents, Severy, Mathewson, and Bechtol<sup>3</sup> conducted a series of experimental collisions in which the rear-end of a stationary car was struck by another car moving at speeds ranging from 7 to 20 miles per hour. Human subjects were used in both cars for the collisions at the low speeds, and a specially constructed, lifelike dummy in the stationary car for the higher speed impacts. Instruments measured the accelerations produced, and high-speed cameras photographed the collisions so that micromotion analyses could be made of the subjects and of the vehicles. These investigators found that before the head and shoulders of the occupant of the stationary car had achieved significant acceleration from the impact, the car itself and the rest of the occupant's body had achieved maximal acceleration. They attributed this lag in acceleration of the head and shoulders to inertia, which resulted in the head's being snapped backwards into a position of extreme hyperextension of the neck. Subsequently, the springs of the carseat and the elasticity of structures in the neck pitched the head forward, sharply flexing the neck. Finally the head returned to normal, erect position. Severy and associates interpreted this sequence of movements as experimental confirmation of the "whiplash" action upon the head and neck of an occupant of a stationary car that is hit from behind.

### Functional Anatomy of the Neck

An understanding of the anatomy of the cervical spine is basic to a consideration of whiplash injuries. The cervical spine is a column with a slightly convex, forward curvature which is specially adapted to support the skull and to afford maximal protection to the spinal cord (Figures 1 and 2, left). The cervical spine consists of seven bones called "vertebrae," the main portions of which—the bodies—are separated from one another by resilient, cartilaginous intervertebral disks. The transverse processes extend laterally from the vertebral bodies (Figures 1 and 2, bottom right), enclose the vertebral artery, vein and sympathetic nerves on each side, and articulate with adjacent vertebrae. Pos-

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<sup>3</sup> Severy, D. M., Mathewson, J. H., and Bechtol, C. O., *Controlled Automobile Rear-End Collisions, An Investigation of Related Engineering and Medical Phenomena*, p. 152-184. In Elliott, H. (Editor), *Medical Aspects of Traffic Accidents. Proceedings of the Montreal Conference*. Montreal, Canada, The Traffic Accident Foundation for Medical Research, Sun Life Assurance Company of Canada, 1955, 519 p.

teriorly, bony extensions form the thin laminar arch, which protects the spinal cord in the spinal canal, and the elongated mid-line spinous processes. The spinal nerves leave the spinal canal through the intervertebral foramina, which are openings formed by grooves in the transverse processes of adjacent vertebrae. The two highest cervical vertebrae, called the "atlas" and the "axis" (Figure 2), are structurally different from the other cervical vertebrae. The atlas, which articulates with the skull, does not have a vertebral body as do the other cervical vertebrae, and is shaped somewhat like a ring. The axis, which is designed to permit rotation of the neck, possesses a toothlike process, the odontoid, which projects upward into the ring of the atlas to articulate with the anterior arch.

The stability of the cervical spine and its articulation with the skull is dependent upon ligaments, which are tough fibrous bands of connective tissue binding together the bony structures, and upon the cervical muscles. Information concerning the anatomy and function of these intricate systems together with excellent illustrations is available in the books by Netter<sup>4</sup> and by Hollinshead.<sup>5</sup>

The cervical spine possesses surprising freedom of motion. The head can be bent forward and backward (flexion and extension), turned to either side (rotation), bent sideways to either side (lateral flexion), and moved forward and backward (protraction and retraction). In attaining such flexibility, the cervical spine has sacrificed some structural stability, with the result that the neck is more vulnerable to stresses and strains than is a rigid structure. The maximal strains occur at levels where there is the most bending or angulation. In whiplash injuries, the intervertebral disks most frequently damaged are those between the fourth and fifth and between the fifth and sixth cervical vertebrae, because at these levels greatest angulation occurs in marked hyperextension and in extreme flexion, respectively.

### Diagnostic Considerations

Frequently, whiplash injuries are minor, involving only slight muscular and ligamentous strain; the patient will have

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<sup>4</sup> Netter, F. H., *The Ciba Collection of Medical Illustration*. Vol. 1. *The Nervous System*. Summit, N. J., Ciba Pharmaceutical Products, Inc., 1953, 143 p.

<sup>5</sup> Hollinshead, W. H., *Functional Anatomy of the Limbs and Back*. Philadelphia and London, W. B. Saunders Co., 1951, 341 p.

minimal symptoms and there will be few objective findings on physical examination. A person who has sustained such a whiplash injury usually notices no appreciable symptoms immediately after the accident. He appears to be uninjured, is able to get out of his car, inspect the damage, and discuss the accident. However, 12 to 24 hours later, pain may develop in the back of his neck, with soreness and stiffness of the neck muscles. On physical examination, the physician may find no abnormality other than slight tenderness on palpation of the neck, occasional muscular spasm, and limitation of motion of the head. Roentgenograms of the cervical spine may be normal. However, a patient having a sprain, which is a more serious injury to the muscles and ligaments than a strain, may experience considerable pain immediately following the accident; in such a case, bleeding and swelling of the deep tissues may occur, resulting in marked splinting of the cervical muscles.

Occasionally, whiplash injuries damage structures other than the muscles and ligaments of the neck. The brain may receive a mild concussion. A nerve may be stretched at the time of the accident or subsequently compressed by swollen tissue, by an osteophyte, or by a protruded cervical disk; when a cervical nerve root is involved, this condition is called "cervical radiculitis." The spinal column may be damaged, causing compression and protrusion of a cervical intervertebral disk, fracture of a lamina or a spinous process, or subluxation (i.e. a sliding forward of one vertebra upon another).

Serious complications, such as crushing of the spinal cord from a compression fracture or dislocation of a vertebra, probably do not result from whiplash injuries. To my knowledge no authenticated report of such serious complications has appeared in the medical literature.

The responsibility of evaluating the patient's injury rests on the physician. He must obtain an accurate and complete history and perform a careful physical examination, giving particular attention to the neck, back, and upper extremities. He should record the patient's recollection of the accident and the injuries received, the symptoms and the time of onset, the location and radiation of any pain, with its severity and duration, aggravating factors, and measures providing relief. The physician must inquire into the patient's past medical history, noting any previous injuries to the head and neck and any symptoms existing before the accident.

The physical examination should include inspection and palpation of the neck, back, and upper extremities; testing of deep-tendon reflexes, of sensation, of muscle strength, and of range of joint motion; and observations of balance and muscular co-ordination. Testing of the effects of downward pressure applied to the top of the head and of upward traction applied under the chin and occiput and of the outlet maneuvers (checking the effect of certain movements of the arms upon the circulation and nerve supply) may give important information. Roentgenograms of the cervical spine, including anteroposterior, lateral and oblique views, also should be obtained.

The significance of abnormal conditions revealed by roentgenograms must be cautiously evaluated. Some conditions that have been attributed to whiplash injury, such as osteoarthritis of the cervical spine, loss of the normal cervical curvature, and narrowing of a cervical intervertebral disk, are relatively common and may actually have been present for many years before the accident without causing symptoms. On the other hand, it is possible that such an accident could aggravate a pre-existing pathologic condition.

*Osteoarthritis* is not a true arthritis (i.e. inflammation of the joints), but the end-result of stresses and strains sustained by the body over the years. Osteoarthritis of the cervical spine is especially common because the mobility of the neck makes it susceptible to injury. As might be expected, osteoarthritis occurs most frequently in elderly persons.

*Loss of the normal cervical curvature* fairly often occurs in patients who give no history of neck injury; for this reason, many radiologists attribute little significance to this finding. However, it may be indicative of spasm in the anterior cervical muscles.

*Narrowing of a cervical intervertebral disk* probably results from injury to the neck, but not necessarily from the injury most recently sustained.

In the interpretation of the significance of any of these abnormal findings on the basis of one set of roentgenograms of the cervical spine, the *post hoc, ergo propter hoc* fallacy must be avoided. The possibility that such abnormalities were present prior to the accident must be considered. Whenever possible, the post-accident roentgenograms should be compared with roentgenograms obtained before the accident.

The incidence of whiplash damage to structures other than the ligaments and muscles of the neck is difficult to ascertain. Most physicians who have had wide experience believe that it is fairly low. On the other hand, Gay and Abbott<sup>2</sup> in their group of 50 patients with whiplash injuries reported 35 persons with cervical radiculitis, 31 with concussion of the brain, 13 with protruded cervical disks, 5 with osteoarthritis, 1 with fracture of a lamina, and 1 with subluxation of a vertebra. These figures are open to some question since 38 (76 per cent) of these patients were not examined by those authors until one month to two years after the accident, when the patients were referred to them presumably because of persistent complaints. The complications were evidently diagnosed on the basis of the referring physician's summary or of the patient's own recollection.

The symptoms of whiplash injury of course depend upon which structures are damaged. With *involvement of the cervical nerve roots (cervical radiculitis)*, the patient experiences severe, sharp, intermittent pains, usually on one side of the neck, which are aggravated by coughing, straining and movement of the head and which may radiate up to the occiput, to the jaw, or down into the shoulder and upper extremity, depending upon the specific nerve roots involved. Frequently, there is spasm in the neck muscles. If the patient became unconscious as a result of the accident, he most likely sustained a *concussion of the brain*. Subsequently, the patient may have intractable headache, insomnia, nervousness, difficulty in concentrating, forgetfulness, sweating of the hands, or personality changes. Damage to the spine may result in *protrusion of an intervertebral disk* and compression of a cervical nerve root. In such cases, the symptoms are similar to those in acute cervical radiculitis—severe pain, marked limitation of motion in the neck, and paresthesias (tingling sensations), absent deep-tendon reflexes, impaired sensation, and muscular weakness in the upper extremities.

### Psychologic Factors

In few conditions do psychologic factors play a more important part in determining a patient's symptoms, his response to treatment, or the duration of the disability, than in whiplash injuries. Gay and Abbott<sup>2</sup> have accurately summarized a patient's reaction to this type of injury:

“The accident involved a sudden, violent, and unexpected jolt that was a disturbing experience. Since the victim was

seldom incapacitated immediately after the accident, there was opportunity for development of considerable hostility toward the offending motorist. A tedious investigation usually followed the accident at a time when the patient was bewildered, emotionally disturbed, and uncomfortable. If an examination was conducted in a hospital emergency room or a physician's office, very little injury was found and the patient was usually sent home equipped with a vague program of rest and recovery. It was usually several hours later or during the next day that frightening symptoms began, such as pain in the neck and head, radiating pain and paresthesias in the limbs, or aching in the lower back. Most of these sensations had never been experienced before. Lacking understanding of the variety, extent and nature of their injuries and ill-prepared to alleviate their discomfort, these patients were prone to the development of apprehension, anxiety, and neuromuscular tension."

It was to this sequence of events that Gay and Abbott attributed the high incidence (52 per cent) of persistent psychoneurotic reactions in their series of 50 patients having whiplash injuries. They also noted that 33 persons (66 per cent) were involved in legal actions of some type as the result of their injury. Psychoneurotic reactions and lawsuits pending settlement may prolong the duration of a patient's symptoms, reduce the effectiveness of treatment, and unduly delay recovery.

An interesting study was conducted by Gotten<sup>6</sup> in Memphis, Tennessee, of 100 persons with whiplash injuries who had settled their litigation or compensation claims. His purpose was to determine the true chronicity of symptoms and the amount of persistent disability. Gotten found that of the 100 persons, 54 no longer had any appreciable symptoms; 34 had only minor complaints; and 12 continued to have distressing symptoms which necessitated wearing a Thomas collar, sleeping in traction, receiving physical therapy, or visiting their physicians on occasion. Delayed recovery was noted in persons more than 60 years of age. After settlement of claims, only 7 persons lost as long as 3 months from work; whereas, before settlement, 41 had lost that much time from work. In a number of cases, Gotten was forced to conclude that the injury had consciously or unconsciously been used by the patient as a lever for personal gain.

Because of similarities in symptoms, it is difficult to differentiate patients having concussion of the brain from those having

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<sup>6</sup> Gotten, N., Survey of One Hundred Cases of Whiplash Injury after Settlement of Litigation. 162 J. A. M. A. 865-867 (October 27, 1956).



anxiety tension reactions as a result of whiplash injuries. However, symptoms of concussion usually begin immediately after the accident and continue unremittingly for a long time, whereas, symptoms related to increased nervous tension typically begin after a mental "incubation period" and continue somewhat intermittently with frequent "ups and downs."

Some people confuse pain due to excessive nervous tension with intentional malingering. This is unfair and inaccurate. Persons who are anxious and tense—and this includes all of us on occasion—often exhibit sustained contraction and tightness in some muscles, particularly those of the upper back and neck. When tension of this sort is maintained in a muscle for a prolonged period, there is interference with circulation and nourishment of the muscle fibers, which results in ischemic pain, edema, and the formation of adhesions between the muscle fibers, and prevents the muscle from relaxing to its normal length. Pain resulting from excessive nervous tension is very common; it is a dull, pressure-like discomfort, rarely more than moderately severe in intensity, often more pronounced late in the day, and aggravated by fatigue, emotional stress, and unpleasant weather. Undoubtedly, many patients with whiplash injury develop this type of pain. Tension in posterior cervical muscles will tend to aggravate symptoms resulting from pressure of osteophytes, from swollen tissues, or from a protruding intervertebral disk. With increased pain, the patient becomes more apprehensive and contracts his posterior neck muscles even more tightly, thus setting up a vicious cycle.

### Treatment

Treatment of a person with whiplash injury begins with the physician's initial examination. This first contact between the patient and the physician often determines the extent of the patient's confidence in the physician's diagnostic ability and judgment. It is most important that the physician explain his findings in some detail to the patient, describing the injury and the symptoms that might be expected in the future. Reassurance at this time is the best insurance against the subsequent development of a persistent anxiety tension state in the patient.

Understandably upset by a whiplash injury, the patient often is beset by many fears—of paralysis, invalidism, loss of memory, or unemployment because of disability. If the patient is greatly disturbed, rest in bed for a few days is advisable, either at home

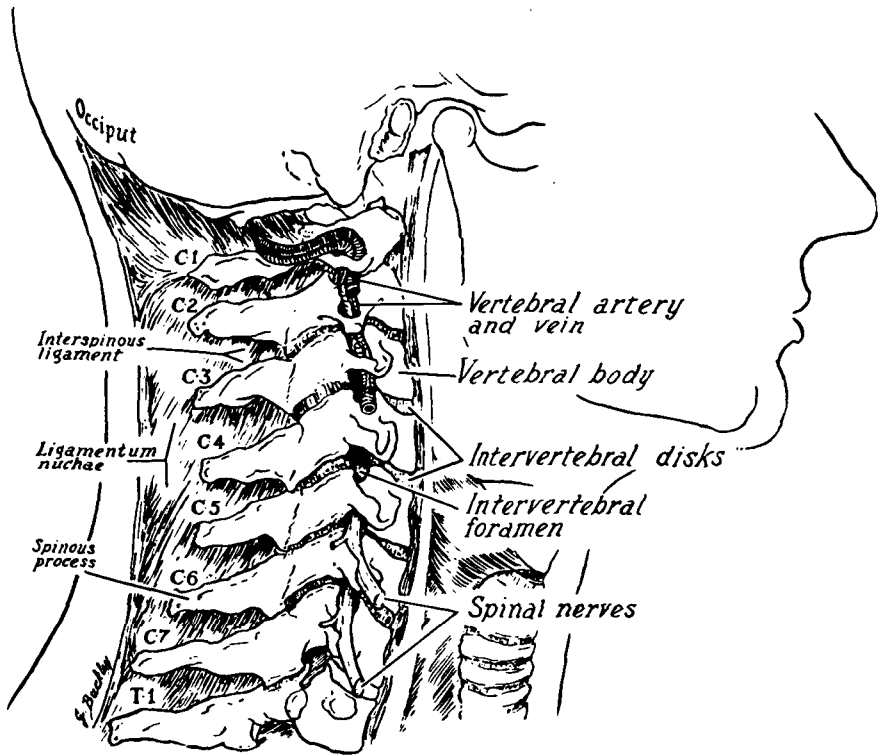
or in the hospital. Medication should be prescribed for relief of pain, release of nervous tension, and adequate sleep. Some physicians recommend that the patient wear a Thomas collar, which limits neck motion to some extent. When this device is used, it is advisable that the patient remove it several times daily, so that he does not become too dependent upon it.

Physical therapy is of particular benefit to the patient with whiplash injury. If the patient is hospitalized, it should be given daily. On an out-patient basis, treatment usually is given three times weekly at the hospital, supplemented by measures the patient has been instructed to carry out at home. Although physical therapy is individually prescribed, the treatment typically consists of the application of some form of heat (infrared radiation, diathermy, or hot packs), sedative massage, exercises to improve posture and to strengthen trunk musculature, exercises to improve relaxation and range of motion in the neck and shoulder, and cervical traction with Sayre's apparatus. The length of time during which physical therapy should be given varies according to the individual patient, but rarely is it necessary for him to receive therapy from a physical therapist for longer than two months.

With many other physicians, I strongly believe that there should be no undue delay in making final settlements of compensation claims or of legal action in cases that involve a person who has sustained a whiplash injury. Such delay greatly increases the likelihood of the patient's developing a fixed compensation neurosis and a warped personality. I believe that one year is a reasonable period of time in which to complete all such settlement. Within that period, all symptoms resulting from whiplash injury should be fully apparent; and there is no reason to fear a "hidden" injury that might appear years after the accident to disable the patient further.

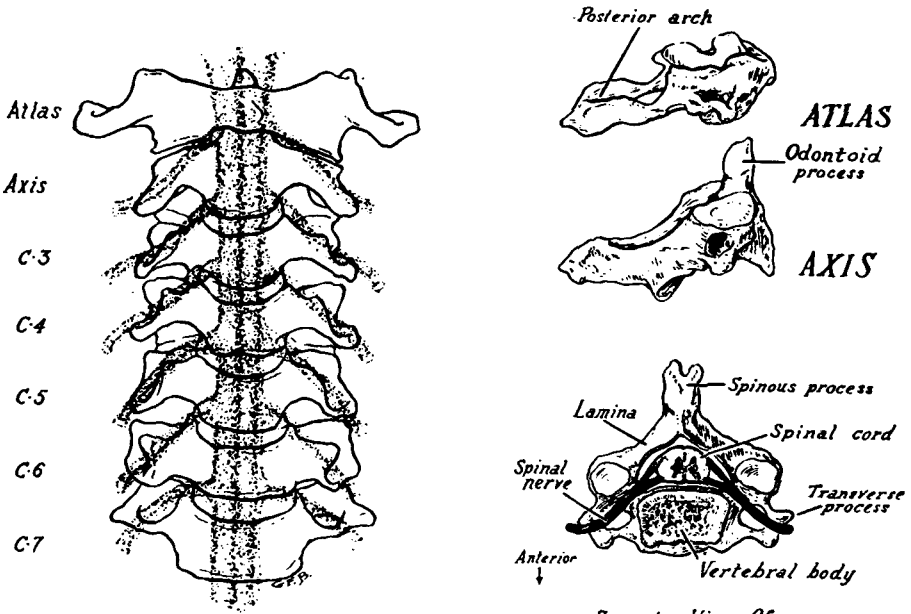
*(Illustrations follow on the next page.)*





*Lateral View Of Structures In The Neck*

**FIGURE 1**



*Anterior View Of Cervical Vertebrae  
Showing Position Of Spinal Cord And Nerves*

**FIGURE 2**

