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## Whiplash Injuries of the Neck

Kenneth H. Abbott, M. D.\*

**T**HE TERM WHIPLASH INJURY OF THE NECK is commonly used to denote a type of injury in which the body of the individual has been jerked and the lagging, freely movable head has snapped, resulting in apparent minor injury of the neck. In addition, other injuries such as cerebral concussion and low back injury may be sustained by the individual subjected to this type of violence.

Most cases may be classified as minor injuries to the neck structures or sprain. The latter term is generally recognized to exist when ligaments, joint capsules, tendons, fascia and muscles have been stretched beyond their physiological limits. A more severe state of tissue injury exists when these tissues suffer complete rupture or dissolution of continuity. This may occur in whiplash injuries of the neck but is generally recognized as exceeding the usual limits of a simple sprain. However, minor tears in ligaments and muscles probably occur when tissues are stretched and, therefore, are compatible with this definition of the term "sprain."

Other injuries, such as fractures, nerve injuries and hemorrhages, may accompany this particular type of sprain of the neck structures and are included within the meaning of the general term—*whiplash injury of the neck*.

*Terminology.* The term "whiplash" is not as desirable a generic term as might be wished. It connotes extreme violence. When the old-fashioned bull whip was snapped with exceeding force, it caused the well-remembered and loud reverberating "crack." In most of these injuries, the snap is not violent. Davis applied the term *whiplash* to this syndrome because it so well portrayed the mechanism of the injury. It has since become well established in the American medical and legal literature. How-

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**ILLUSTRATIONS** appear at end of article.

ever, many medical authorities have seriously objected to the term. It erroneously connotes to the jury the idea of extreme violence. Other suggested terminology has been "minor cervical spine injuries," "minor neck injuries," "neck-lash sprain," "neck-lash injury," "extension-recoil neck injury" and "extension-flexion injuries of the neck."

Objections have been raised to most of these terms. "Minor neck injuries" is too vague and may not include the occasional more serious injury. Others (extension-recoil or flexion injury) seem to be too specific and may indicate only one movement of the head and neck. The term "neck-lash injury" has been the object of fewer criticisms. It should be used and popularized because it suggests the mechanism of the injury. It does not signify the direction of the movement of the head or structures damaged.

*Mechanism.* In the true neck-lash injury certain specific conditions are present to separate this injury from others. However, this type of injury is frequently complicated by other injuries occurring with it.

The uncomplicated mechanism is the result of sudden acceleration or deceleration of the trunk (Figure 1).<sup>1</sup> The freely movable head is jerked or snapped with this action. It commonly occurs when a vehicle is struck from behind by another vehicle. The victim in the front vehicle describes his head as being snapped. If he was facing forward he believes his head was snapped backward. If he was wearing a hat, the hat sometimes is found on the back seat. The secondary movement appears to be recoil into flexion (chin down). If this individual was sitting sideways, the thrust of the car forward against his body may have caused his head to snap from side to side.

Some objections have been raised, by such authorities as Gay, to this explanation of these mechanisms.<sup>2</sup> He suggested that the thrust of the seat is against the back. The flexing muscles of the neck, pulling the head forward and chin down, come into almost instantaneous action, and overstretch the muscles of the back of the neck. These posterior neck muscles come into violent contraction a fraction of a second after the impact. A similar type of response may occur when the head and trunk are in the side or oblique positions.

<sup>1</sup> Abbott, K. H.: Whiplash Injuries, 162 J. A. M. A., 917 (Oct. 27, 1956).

<sup>2</sup> Gay, J. R. (personal communication).

One cannot experimentally determine which mechanism is in force from the study of dummies, since the neuromuscular responses are not in action. No experimental work on humans is of sufficient value to clarify these details.

*Injuries Sustained.* Most students of this problem agree that the type of injury sustained is essentially a "sprain" of the neck. However, this definition of the injury is an oversimplification in that other injuries and reactions also may be present.<sup>3</sup> As already indicated, the injury is one in which the ligaments, between the spinous processes of the neck vertebrae, and those around the joints of the neck vertebrae (capsular and other ligaments) as well as the fascia and muscle fibers of the neck are stretched beyond their normal physiologic limits. In addition, small blood vessels are frequently ruptured, causing extravasations of blood into the surrounding tissues. Less commonly, fractures of various parts of the vertebrae occur (i.e., transverse process and spinous process, chip fractures of the body of a vertebra, etc.). Rotational subluxation of the first cervical vertebra on the second cervical vertebra (so-called "slipped facet") may occur. (Rare.) Contusions or minor crushing of nerves (cervical spinal roots) and/or hemorrhages into them may also occur (Figures 2, 3, 4, 5a, b, c).

In more severe injuries, it is believed that actual tears (stress lacerations) occur in ligaments, fascia and muscles. Hemorrhages have been noted on the tissues in front of the bodies of the middle and upper neck vertebrae. These were noted by the victim, as "a painful lump in the throat on swallowing." In lateral (side) X-ray views of the neck, a soft tissue-like swelling was seen in front of the neck vertebra, and behind the back of the throat and upper esophagus (Compere).<sup>4</sup>

Other injuries occurring at the moment of the impact have been mild concussion of the brain and mild concussion of the spinal cord.<sup>5</sup> Various degrees of damage to the intervertebral disc (the pad of gristle between the bodies of the vertebrae) is

<sup>3</sup> See notes 2, 18, 5, 12; and Kulowski, J. (Editor) *Motorists injuries and motorists safety. Clinical Aspects (Part 1). Acute motorists' injuries of the spine.* 7 *Clinical Orthopaedics* 308-310, J. P. Lippincott Company, Philadelphia and Montreal, Depalma, A. F. (Editor), 1956. *Symposium on Whiplash Injuries, Intnatl. Rec. Med. and G. P. Clin.*, pp. 1-30 (Jan. 1956).

<sup>4</sup> Compere, E. L. (personal communication); and see, Davis, A. G.: *Injuries of the cervical spine.* 127 *J. A. M. A.*, 149-156 (1944).

<sup>5</sup> Gay, J. R. and Abbott, K. H.: *Common whiplash injuries of the neck,* 152 *J. A. M. A.*, 1698-1704 (Aug. 29, 1953).

known to occur both in the neck region and in the lower back (usually between lumbar 4 and 5).<sup>6</sup>

More serious injuries to the head and neck may occur with the neck-lash mechanism if the head strikes a relatively immobile object; i.e., the back of the seat, a door, windows, etc. (Figures 13a & b). Cerebral concussion, contusions and various types of intracranial bleeding may mask the damage done to the neck structures. Similarly, more serious neck injuries may be present, including vertebral fractures, ruptured intervertebral discs, and bruising or even crushing of the spinal cord or its cervical spinal roots (Figures 7 & 8). These more extensive injuries are not primarily within the scope of this discussion, since, as noted above, they are caused by additional mechanisms. It is to be recognized, however, that the neck-lashing injury does not necessarily occur alone. If the head subsequently strikes an object, or is struck by flying objects, additional injury is thus incurred. The problem then is one of determining the various mechanisms which were present and the injuries consequent thereto.

*Symptoms and Clinical Findings.* The symptoms and findings consequent to such a mechanism of injury under discussion have varied widely from very minor and transitory aches and pains in the neck with or without headache, to protracted aches, pains, muscles spasm, radicular pains, limitation of motion of neck and creaking noises. There have also appeared transitory signs and symptoms of spinal cord involvement (numbness and/or weakness from the neck down) and lumbar muscle, ligament and disc injury (low back pain and sciatica). Any more serious involvement of the spinal cord (fracture dislocation with weakness or paralysis of the legs and/or upper extremities) does not appear to belong to this group. On closer scrutiny, they are evidence that the head has struck an object or that the neck has received a direct violent blow.

*Immediate and Early Symptoms.* In most victims of minor cervical injury, the immediate symptoms are those of "feeling stunned," or "dazed for a moment." They may have only felt their neck "snap" or "jerk" or "bob," with or without a pain in the back of the neck. A few patients have been unconscious either momentarily or for several minutes immediately after the

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<sup>6</sup> See notes 18, 5; and Spurling and Segerberg, *Lateral Intervertebral Disc Lesions in the Lower Cervical Region*, 151 J. A. M. A., 354 (1953).

impact, giving evidence of a mild cerebral concussion. Later, not a few of these have displayed rather typical postconcussion symptoms of headache, dizziness,<sup>7</sup> nervousness, intolerance to heat, etc. If pain is experienced at the moment of the sudden oscillation of the head and neck, it may or may not persist. Frequently it is momentary, only to return a few hours later.

There is, commonly, a short period of an hour or more following the accident, in which the patient has only vague feelings of discomfort in the neck, shoulders and head. This may be only nervousness. In this period, few if any objective signs may be discovered by the examining physician. Because of this, a therapeutic program is seldom prescribed. In a few hours, or perhaps in the morning following the accident, stiffness, aches and pains occur in the muscles on the back of the head, in the neck, and in the shoulders. These symptoms may be associated with muscle spasm and limitation of motion of the neck. Only a few cases will show more. These suboccipital and posterior cervical aches, pain, tenderness and limitation of motion of the neck and head frequently persist.

Other symptoms arising out of injury may appear immediately or may be delayed for hours, days or even longer. Some patients experience definite radicular pain (pain along the course and in the distribution of a cervical nerve root) (Figure 6) which may be anatomic in its distribution. This radicular pain usually involves one or more cervical roots (usually C2, 3 and C6, 7) as evidenced by sensory changes (hyperesthesia—increased sensation or hypesthesia—decreased sensation)<sup>8</sup> (Figures 9, 10).<sup>9</sup> A few will show tendon reflex changes (biceps, triceps or pronator) and less frequently, muscular weakness may be detected. The presence of palpable muscle spasm has been mentioned and this should be emphasized, for not a few find this difficult to evaluate.

<sup>7</sup> Ryan, G. N. S.: Cervical vertigo, 2 *Lancet* 1355-1358 (Dec. 31, 1955); and Fulton (ed.), *Textbook of Physiology*, Sanders & Co., Phila., 17th ed., 1955, pp. 219-229 (Tonic Neck and labyrinthine reflexes; and Watts, J. S. (personal communications).

<sup>8</sup> Occipital tenderness, aches, pains, with hyperesthesia and hyperalgesia is common (over 50%). This may be due to the peculiar position and course of the second cervical root. As it leaves the spinal canal and its dural sac, it rests on the midportion of the medial margin of the atlanto-axial articulation. The nerve then follows the margins of this joint laterally and slightly downward and lies beneath the posterior arch of the atlas until it turns posteriorly within the upper neck muscles. Its close proximity to the lateral joint and the posterior arch makes it potentially vulnerable to irritation or compression. (Figure 8).

<sup>9</sup> Keegan, J. J.: Dermatone hypalgesia with posterolateral herniation of lower cervical intervertebral disc. 4 *J. Neurosurgery* 115-139 (1947).

(The writer has found it advantageous to have the patient lie in a supine position with the examiner's hand behind the head; then it is possible to relax the neck muscles. Time is taken to assure him that there will not be any sudden movements or snapping of his neck and that if any pain appears, movement of the head will be stopped immediately. Thus gaining his confidence, it is usually possible to differentiate between the organic muscle spasm and that which is due to "neuromuscular tension," hysteria or malingering. One should be fair in this evaluation, for some individuals may have some soreness and pain and yet not show true muscular spasm or limitation of motion.)

*Clinical Course:* The post-traumatic course of these patients is most varied and depends on (1) the severity of the injury, (2) the association or pre-existing state of the neck structures (osteoarthritis, disc degeneration, etc.), and (3) the emotional reaction of the patient to the injury and its subsequent legal developments. These are discussed seriatim.

(1) *Severity of the Injury. (Group 1 (Mild Injury)).* It is apparent that the most of these patients get along very well with only transitory neck aches and pains and headache. These are the ones who may not see a physician at all. The injury is only a mild strain or sprain of the soft tissues of the neck and it heals rapidly—within from a few days to a few weeks.

*Group 2 (Moderate Injury).* Another group has a somewhat more severe sprain and suffers considerable distress with or without some emotional disorder accompanying the organic element. These we consider may have had, in addition to the sprain, hemorrhages and tears in ligaments and possibly in muscles of the neck, both anterior and posterior to the spinal column. In those with oblique or lateral projection with oscillation of the head, the lateral muscles and ligaments are affected. Serious involvement of nerve root is usually not encountered, but transitory radicular pains do occur. If appropriate therapy is instituted and if emotional factors do not complicate the picture, these symptoms disappear in a few weeks, but may last for six months.

*Group 3 (More Severely Injured and/or Those with Prolonged Symptoms).* In this group, more serious injuries occur: fractures, nerve root compression, herniation of a cervical disc, cerebral concussion, low back injuries, etc. These symptoms may be protracted for many months or years. These patients require close, frequent and prolonged medical attention.

*Group 4 (Chronic Phase).* This group consists of patients from any of the first three groups whose symptoms persist for months to several years. These symptoms, referable to the neck and head, consist of soreness, stiffness, limitation of motion, neck cracking or grating, pains radiating into one or both upper extremities and/or shoulder blades. They may or may not be accompanied by objective evidences of structural changes (organic disease) such as true limitation of motion in the neck, tendon reflex changes (increased or decreased biceps, triceps or brachioradialis tendon reflexes) and sensory changes.<sup>10</sup> It is in this chronic group that the delayed, progressive bony changes may be followed by X-rays. (Figures 14 a & b). Degenerative changes of focal osteoarthritis about the edges of the vertebral bodies and the intervertebral foramina (where the spinal nerves leave the spinal canal), thinning and narrowing of the intervertebral discs, mild subluxation of the cervical vertebra (from relaxation of the capsular ligaments about the joints of the Luschka<sup>11</sup> and other ligaments) (Figure 7) as well as other less prominent X-ray changes are to be noted.<sup>12</sup> It is, therefore, of considerable value to have, for the record, a series of X-rays of the neck. These pictures accurately chronicle this objective evidence and guide the patient's therapy.

Several students<sup>13</sup> of this problem have shown the effect of trauma and degenerative processes (either primary or consequent to trauma) upon the "capsular" joints. (Luschka joints—located on the posterolateral back and side aspects of the lower 5 cervical vertebrae). When these joints become deranged they may affect the nearby nerve roots, nerves and sympathetic nerves (Figure 8). Symptoms may appear when only the lining of the joints (synovial membrane) is involved, and under these circumstances they are not apparent by X-ray. Later (many months to years) hypertrophic spurs along the vertebral margins may protrude into the nerve root canals (foramina, where the nerve roots leave the spinal canal) and give rise to pain along the course of the irritated nerve root. (Figures 8 & 9). If the cap-

<sup>10</sup> Jackson, Ruth: The mechanism of cervical nerve root irritation. 38 Dallas M. J., 71-72 (June, 1952).

<sup>11</sup> Boreadis, A. G., and Gershon-Cohen: Luschka joints of the cervical spine. 66 Radiology, 181-187 (1956); Von Luschka, Die Halbergelanke des Menschen Korpers, G. Reimer (1858).

<sup>12</sup> Jackson, Ruth: The cervical syndrome. Charles C. Thomas, Publisher, Springfield, Ill., 1956.

<sup>13</sup> See notes 11, 18, 12, 10.



sular and other ligaments become relaxed this will allow a slight degree of sliding forward and backward of one vertebra on the other (subluxation) and irritate the nerve root, giving rise to nerve root (radicular) pain. Symptoms not unlike the so-called neck-shoulder-hand syndrome may thus develop in which condition sympathetic fibers probably are irritated.<sup>14</sup>

The chronic symptoms which persist in varying intensities for months and years are further affected by changes in weather and in the patient's emotions, thus giving rise in part to the exacerbations and remissions of symptoms.

(2) *Effect of Pre-existing Pathological Conditions.* If the injury occurs to a patient who has pre-existing osteoarthritic changes (bone-like ridging along the edges of the opposing surfaces of the bodies of the vertebrae) or other forms of arthritis and degenerative changes (absorption of the intervertebral discs, osteoporosis, etc.) the symptoms are prone to be more severe and of longer duration. It should be emphasized that such individuals may not have had any distress or physical signs of these changes previous to the insult to the neck.

It is of interest that Neufeld<sup>15</sup> has noted that individuals who have shown allergic reactions (hay fever, hives and skin reactions, asthma, etc.), or patients who were subject to growing pains in childhood are far more susceptible after trauma (and particularly following the neck sprain injury), to manifest myalgias (muscle pains), fibrositis (fibrous contractions in muscles and fascia) or collagen-like disease syndromes.

(3) *Emotional Factors.* Other symptoms which may appear immediately, or may be delayed for a few hours to a day, are those of "nervousness," "tremulousness," "tenseness" or inability to relax. Some of this is the reaction to the injury itself; that is, it may be a part of the symptoms following a mild cerebral concussion. Another common cause for this nervous reaction appears to be fear in relation to the accident itself and anxiety over the possible implications of a neck injury (fear of paralysis). Another emotional reaction in this traumatic experience is the extreme hostility toward the driver of the other car. This is a common emotional reaction. Added to this is the anxiety, tension and hostility developed over the official investigation of the acci-

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<sup>14</sup> See note 11.

<sup>15</sup> Neufeld, A. J. (personal communication).

dent. Further frustration and hostility are engendered by the victim experiencing a series of negative medical examinations done with an apparent lack of interest on the part of the physician, and by being told, "There is nothing wrong." At this time the sufferer is experiencing distress. This situational reaction has been ably described by Gay, who summarizes the effects upon the individual as follows:

"With this combination of emotional turmoil, painful and unusual symptoms and apparent failure of others to take their conditions seriously, it is natural that their symptoms become protracted and that they are vulnerable to develop severe psychoneurotic reactions."

The usual result of this is the feeling of the need for revenge or recompense; it is, therefore, to be expected that such traumatized individuals do show improvement after a financial settlement has been established, as has been emphasized by Gotten.<sup>16</sup>

Another phase of the emotional reaction is worthy of mention: the patient's emotional reaction to the litigation involved in the accident. Some have a genuine fear of court proceedings, bringing about further neuro-muscular tension and adding to the painful state of the neck muscles. When encountered with feelings of hostility and need for recompense, it creates a difficult and conflicting emotional situation, thus aggravating the chronic anxiety tension state of the victim and more deeply ingraining the psychoneurotic reaction pattern. Undoubtedly one of the more common factors which prolongates or perpetuates the symptoms the longest is the emotional reaction.

*Injuries to Lumbar Spine.* Gay and Abbott<sup>17</sup> called attention to the injuries to the lumbar spine, muscles and intervertebral discs which may accompany a neck-sprain injury. In each instance, it has occurred at the fourth lumbar disc and occasionally has necessitated surgical intervention. Low backache and muscle spasm occur rather frequently with these injuries. These may be

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<sup>16</sup> Gotten, Nicholas: Survey of one hundred cases of whiplash injury after settlement of litigation. 162 J. A. M. A., 865-867 (Oct. 27, 1956).

In our opinion, Gotten's report is not without its serious flaws and may be untenable on two counts. First, he used a medical student to evaluate the data; second, by the time the litigation had been completed, two to three years had elapsed. This period corresponds to the time when most whiplash cases have recovered, or nearly recovered. It is unscientific to compare these cases before settlement, when the injury is at its zenith, with cases after settlement, when the injury is in its decline.

<sup>17</sup> See note 8.

very troublesome if associated with arthritic changes. Attention to such injuries is fully as important as caring for the neck and head complaints.

*X-ray Examination.* It is of importance that this examination be made by a competent and experienced radiologist and not by just anyone, doctor or otherwise, with an X-ray machine. The X-ray examination is most important even though the majority of examinations fail to show any changes. If the examiner chooses to rely upon the X-ray findings, he will be disappointed, for seldom are there any bony changes. It must be emphasized that this is a soft tissue injury. An occasional X-ray will show reversal or straightening of the cervical spinal curve in the side (lateral view (Figure 11a, b, c)). This is caused by spasm of the neck muscle. In one instance there was a slipped facet (C1 on C2) (Figure 11c). Loss of symmetrical relationships of the facets to each other (of C1 and 2) and of their relationship to the odontoid process may indicate torn ligaments about these two vertebrae as shown in Figure 12 (also see Figure 3). The possibility of a fracture in this area is not to be overlooked. Reversal of the cervical spinal curve and subluxation (slipping of one vertebral body upon the other) may be shown by taking lateral views with the head in three positions; neutral, flexion and extension. Occasionally slight subluxation of one cervical vertebra over the other is seen in case of several months to years after injury. Less commonly a minor fracture of a process or chip fracture of the body of the vertebra may be seen (Figure 13b).

Since most of the patients have been in the 30-to-50 year age group, a fair number have had mild or extensive osteoarthritic changes in the bodies of the cervical and lumbar vertebrae (Figure 14). X-ray films made in the right and left oblique views are of value in determining the degree of encroachment on to the foramina by osteoarthritic changes if and when present. A series of films taken over a period of months to years will record the progress of these degenerative processes. This is particularly useful in the patient whose symptoms become chronic and who subsequently develops these changes which may be precipitated or aggravated by the injury (Figure 15a & b).

When the individual is examined some months after the injury and has had protracted radicular symptoms (pain and numbness) which have not responded to appropriate therapy, a pantopaque myelographic study of the cervical-spinal canal is justified.

In the writer's experience, a ruptured intervertebral disc is only very occasionally found in the cervical region (Figure 16). It is also to be noted that such a lesion has occurred in the lower back (lumbar 4 and 5) as a result of this same injury mechanism.

A myelogram involves the injection of the radio opaque substance Pantopaque or Lipiodol into the cerebrospinal fluid surrounding the spinal cord and its nerve roots (subarachnoid space). The test may not be without its own complications. In occasional instances it causes an irritation in the nerve roots and the spinal arachnoid membrane. Thus it is not justifiable to expose the patient to the risks of myelography in whiplash cases unless surgery is seriously being considered.

*Therapy.* Therapy should begin immediately after the injury. It should include a *careful attentive examination* by the physician, followed by a definite plan of treatment. In the hands of many physicians, Gay's outline<sup>18</sup> of therapy has proven of much value in alleviating symptoms and shortening the time of recovery. I quote it here because of its completeness and conciseness:

"Treatment by the physician begins with his examination. If he takes an interest in obtaining an adequate account of the accident and thoroughly interrogates the patient, his suspicion of a spinal injury is likely to be aroused. A thorough physical examination including several routine neurological procedures will usually reveal some abnormal findings to support his suspicion. It is especially reassuring to a patient with discomfort in the spine when his physician obtains roentgenograms of the affected part.

"It is useful to provide hospital care if the injured individual is disturbed or in case the symptoms and signs are severe. The period of hospitalization need not be long, however, it is an excellent opportunity to survey the extent of the problem, reassure the patient and train him in simple measures that may be employed in the home environment.

"If the patient is sent home after the initial examination, it is imperative that a program of treatment be outlined and that the patient be encouraged to report to a physician for regular supervision during his convalescence.

"The patient is advised to rest in a firm bed for at least twenty-four hours. Analgesics and sedatives should be prescribed at regular intervals for at least five days. When symptoms are severe it is advisable to arrange for a light

<sup>18</sup> Gay, J. R.: Minor injuries of the spinal column caused by traffic accidents. 12 *Canad. Serv. Med. J.*, 131-135 (Feb., 1956).

(4 to 7 pounds) intermittent cervical or lumbar traction for seven to twenty-one days. (Traction applied to the head by means of a halter, rope, pulley device and weights—or applied to legs or pelvis). The length of time spent in traction is proportional to the severity and persistence of symptoms. When out of traction an improvised cervical collar or low back support should be worn (in certain cases only). It must be emphasized that the use of traction and wearing of a mechanical support should be intermittent to prevent atrophy of muscles and to avoid increasing and unfavorable psychological reaction through over-efficient immobilization. Gentle warmth applied to the site of injury usually makes a patient more comfortable.\* General neuromuscular tension may be lessened through the regular use of warm tub baths. Even if the patient is very uncomfortable, it is important to recommend some physical activity, either in the form of manual hobbies or easily-accomplished household responsibilities. After the symptoms have partially subsided, the patient is encouraged to resume his regular personal and occupational activities. It is necessary for the physician to maintain an optimistic therapeutic attitude, frequently reassure the injured and educate the patient regarding the nature of his affliction and what he can do about it.”

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\* Hot fomentations (packs) if given early and frequent in the course of a planned therapy, commonly are more helpful than analgesics. When moist heat is not available, an electric heating pad is useful.

*Prevention.* Since nearly 100 per cent of these accidents are preventable, it would seem that a program of education might be helpful in reducing their frequency. Unfortunately, no such program has been of much help to reduce any vehicular accidents in this country, where higher-powered vehicles appear each year. Possibly “an increased effort should be made in driver-training programs, driving manuals and through public education (television and radio, billboards, etc.), to call passenger and driver alike to be alert to the activity of the car coming in the rear.

“Since intoxication of the offending driver is rarely observed, responsibility for rear-end collisions rests in the average driver who is unprepared for a sudden change in traffic conditions ahead and behind. This fact makes it important to encourage motorists to make liberal use of hand signals to make sure the driver behind is aware of a stop or turn. Additional education is necessary to insure that drivers keep a safe stopping distance behind the car ahead.”<sup>19</sup> This still leaves for further thought what should

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<sup>19</sup> *Ibid.*, n. 18.

be done to the daydreaming driver and the hand-talking driver, who must frequently turn and look at his passenger to whom he is talking. Both of these types contribute to the fundamental etiology of these injuries occurring in ever-increasing numbers on our streets and highways.

*Qualifications of Medical Examiner, Time for Settlement of Claim, and Special Miscellaneous Suggestions.* The persons best suited to examine a whiplash injury are qualified neurologists, neurosurgeons, and orthopedic surgeons who have an appreciation of neurologic problems as well as of physical medicine, and who have acquired an understanding of this particular problem. Whenever possible such a specialist should be employed to evaluate the problem and recommend treatment and disposition. In some instances it may be necessary to discover by trial and error which specialists understand and take an active interest in this special problem. Whenever practical, the specialist should be consulted *as soon as possible after the accident.*

All cases should be studied and a recommendation made by *the examining physician* as to the *optimum time* for settling the legal aspects of the case. Such recommendation is useful to the lawyer in making his plans for his client, and useful to the doctor in obtaining the best possible solution of the medical problem. *Mild injuries* require a thorough examination, simple therapeutic measures and much education and reassurance. These individuals usually recover quickly—in days to a few weeks. In such instances legal settlement may be *effected at once.* *Moderate injuries* require the same painstaking examination, but need more regular medical supervision and more extensive therapy. Most of these cases may be released for legal settlement in *about three to six months.* Severe injuries need prolonged supervision, even extending beyond the incident of settlement. In severe cases, and in those who develop symptoms of a chronic nature, the optimum time of settlement is *after the first year following the accident and no later than the second anniversary of the accident.* It is unfair to all concerned, the injured, the lawyer, the doctor and the defendant to prolong legal settlement *beyond two years.* In such delayed instances (over two years), the details of the accident have faded, much unnecessary anxiety has occurred (plaintiff and defendant), the patient has often shopped around or employed do-it-yourself medicine, and the injured tends to become a legal-neurotic derelict.

There is no question about the unfavorable effect of sus-

pending legal action on all parties concerned. However, the fact that there is a neurotic factor in persons with remote injuries, does not detract from the fact they have suffered real and demonstrable injuries.

A suggested procedure is to ask the treating physician to permit a specialist examination. It is best if the treating physician refers the injured directly to the specialist. This overcomes embarrassment of having patients referred directly by the lawyer and avoids a charge that the specialist is just examining for purpose of a trial or settlement action. Such a procedure means that all correspondence and medical recommendations are made doctor to doctor, with the lawyer receiving a copy of such reports as an interested bystander. The specialist should never be expected to testify at a jury trial without having first examined the patient in his own private medical office. It is much more effective to have a physician testify from actual knowledge of the case than on hypothetical grounds.

Every effort should be made by the lawyer to cooperate with the physician in getting the neck-lashed person back to work as soon as possible. The emotional factors at play in this particular type of injury have been outlined; among them is the adverse effect of idleness which may permanently destroy him psychologically. These cannot be too strongly emphasized.

Since this type of injury is difficult to delineate in words, medical witnesses are advised to use visual aids—models, skeletons, drawings and other medical illustrations, during their hour in court, so as to properly inform the judge and the jury concerning the anatomy and pathology of this type of injury.

### Summary

The nomenclature, mechanics, pathology and symptomatology of the minor injuries to the neck incurred in the so-called whiplash injury have been reviewed. The common mechanism of this injury is shown to be hyperextension with recoil into hyperflexion, causing a sprain, of the soft tissues of the neck. In the more seriously injured, there may occur tearing and even avulsion of capsular and ligamentous structures of the neck. With injury to nerves and blood vessels, associated head and lower back injuries may also occur. Less commonly bony fractures of the neck vertebrae may be found. Attention is given to the delayed symptoms as well as to their perpetuation by various types of structural changes and by adverse psychologic emotional factors.

Early and adequate treatment by an interested physician is imperative.

Particular attention has been given to the time to settle the claim from the medical standpoint in relation to mild, moderate, and severe injuries. The proper ethical relationship between the patient, specialist physician and lawyer is briefly outlined.

[A leading Cleveland attorney, on reading the above paper, made the following comments:]

*Contained in this authoritative statement on the "whiplash" injury is everything necessary to a basic understanding of this popular generic term for neck injuries, undoubtedly the most common injuries sustained in automobile accidents. Compliments are due Dr. Kenneth Abbott for succinctly covering every important phase and rendering the whole understandable. The pictures and diagrams, which are related to the text, are of great assistance.*

*Dr. Abbott has explicitly covered the mechanics of the injury, symptoms, grades of severity, course of healing, and treatment. His explanation of the major complicating factors and the mental and emotional reaction to this type of injury should be thoroughly read. Special note should be made of the section on X-rays—their value—and their limitations.*

*Dr. Abbott's recommendation that the injured party be examined by qualified medical specialists is heartily endorsed. Too often unattended and misattended injuries are complicated and the presentation of such a case is made more difficult. The suggested times for settlement under ideal conditions do offer some guide posts heretofore lacking.*

*As a legal measure to prevent this type of accident, it would possibly be advisable to place a greater burden of responsibility and penalty on the driver making a hazardous or improper stop. Perhaps we have gone too far under the "Assured Safe Clear Stopping Distance" law.*

*For the fundamentals to follow the physician's findings in the particular case, to distinguish a client's complaints, to know what to look and watch for, and how to advise a client, this is a most excellent summary.*

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(See Illustrations on next page et seq.)





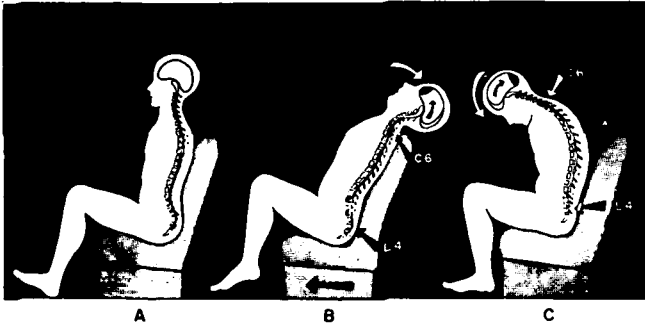


Figure 1

Diagram representing direction of head when vehicle is struck from behind and head is originally directed directly forward. Primary snap of head with greatest force is posteriorly (87% of over 200 patients surveyed). Secondary movement is forward. Primary movement usually carries greatest force. However, if the vehicle hit is forced into an object in front at the right time, the secondary movement may be quite violent. It will be noted there is also force applied in the lower lumbar region. In several instances damage to intervertebral disks at the fourth lumbar level has occurred.

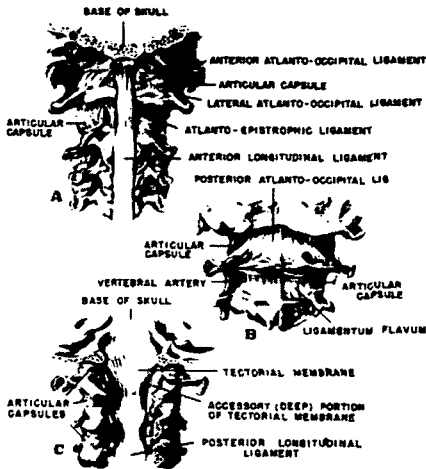


Figure 2

Ligament of upper portion of cervical vertebrae. A. Base of skull and upper cervical vertebrae and ligaments. Front view. B. Base of skull and upper cervical vertebrae and ligaments. Back view. C. Upper portion of spinal canal after removal of vertebral arches to expose posterior longitudinal ligament. (Redrawn from the Ciba Collection of Medical Illustrations by Frank H. Netter, M.D. Copyright CIBA Pharmaceutical Products Inc.) By permission from Spurling, R. Glen, Lesions of the Cervical Intervertebral Disc. Charles C. Thomas, Publisher, Springfield, Ill., 1956.

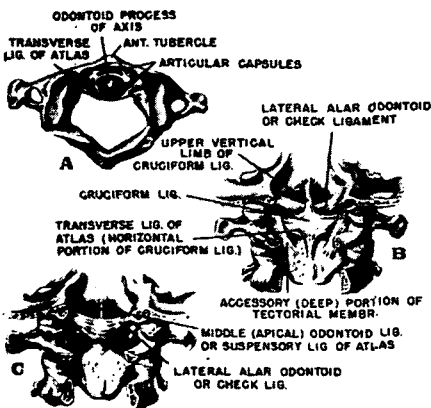


Figure 3

Ligaments of axis and atlas. A. Atlanto-odontoid articulation viewed from above. B. Deeper cruciform ligaments shown after removal of principal portion of tectorial membrane. C. Deepest ligaments shown after removal of cruciform ligaments. (Redrawn from the Ciba Collection of Medical Illustrations by Frank H. Netter, M.D. Copyright CIBA Pharmaceutical Products Inc.) By permission from Spurling, R. Glen, Lesions of the Cervical Intervertebral Disc. Charles C. Thomas, Publisher, Springfield, Ill., 1956.

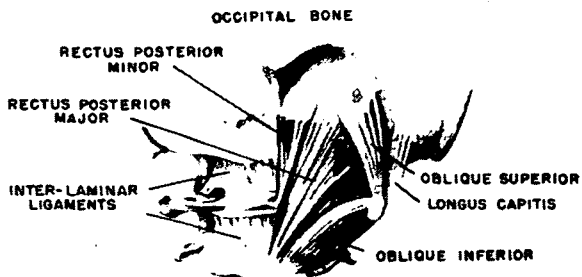


Figure 4

Diagrammatic representation of muscle supply of base of skull and two upper cervical vertebrae. The short muscles which connect these structures are shown in the right of the drawing. On the left side, the muscles have been removed to show the modified inter-laminar ligaments in the upper cervical region. By permission from Spurling, R. Glen, Lesions of the Cervical Intervertebral Disc. Charles C. Thomas, Publisher, Springfield, Ill., 1956.

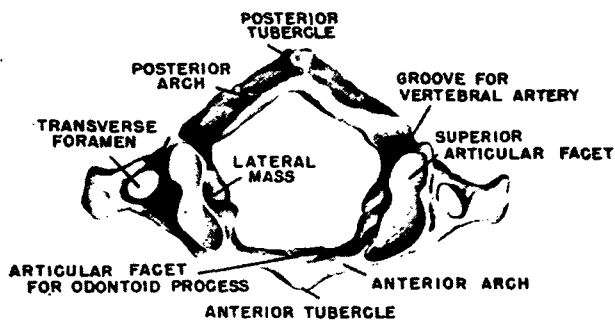


Figure 5(a)

Atlas viewed from above. (Redrawn from the Ciba Collection of Medical Illustrations by Frank H. Netter, M.D. Copyright CIBA Pharmaceutical Products Inc.) By permission from Spurling, R. Glen, Lesions of the Cervical Intervertebral Disc. Charles C. Thomas, Publisher, Springfield, Ill., 1956.

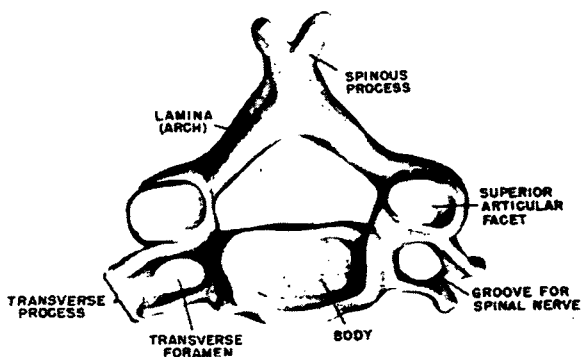


Figure 5(b)

Typical vertebra in the mid cervical region, viewed from above. By permission from Spurling, R. Glen, Lesions of the Cervical Intervertebral Disc. Charles C. Thomas, Publisher, Springfield, Ill., 1956.



Figure 5(c)

Second to seventh cervical vertebrae inclusive, viewed from the side and above. By permission from Spurling, R. Glen, *Lesions of the Cervical Intervertebral Disc*. Charles C. Thomas, Publisher, Springfield, Ill., 1956.

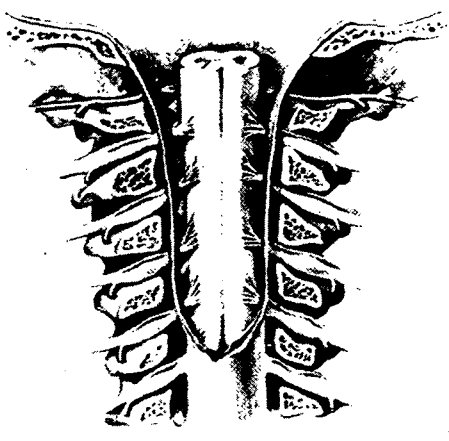


Figure 6

Semidiagrammatic representation of cervical spinal cord and nerve roots exposed from rear. By permission from Spurling, R. Glen, *Lesions of the Cervical Intervertebral Disc*. Charles C. Thomas, Publisher, Springfield, Ill., 1956.

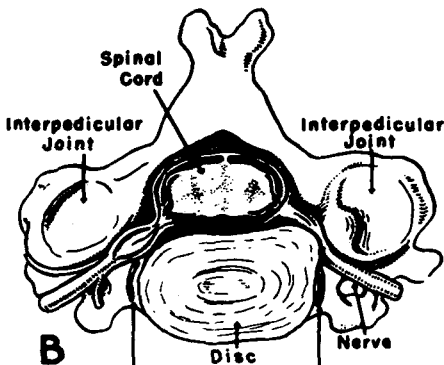


Figure 7

Diagrammatic representation showing normal relation between intervertebral disc, bony structures and neural elements in lower cervical region. By permission from Spurling, R. Glen, *Lesions of the Cervical Intervertebral Disc*. Charles C. Thomas, Publisher, Springfield, Ill., 1956.

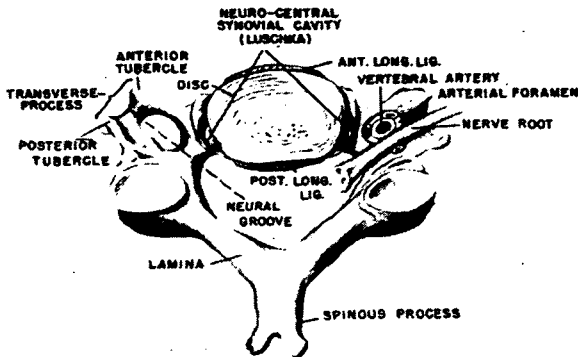


Figure 8

Semidiagrammatic representation of vertebra in mid cervical region, viewed from above, showing relations of joints of Luschka to intervertebral foramen, spinal nerve roots, vertebral arteries, and other bony and cartilaginous structures. By permission from Spurling, R. Glen, *Lesions of the Cervical Intervertebral Disc*. Charles C. Thomas, Publisher, Springfield, Ill., 1956.

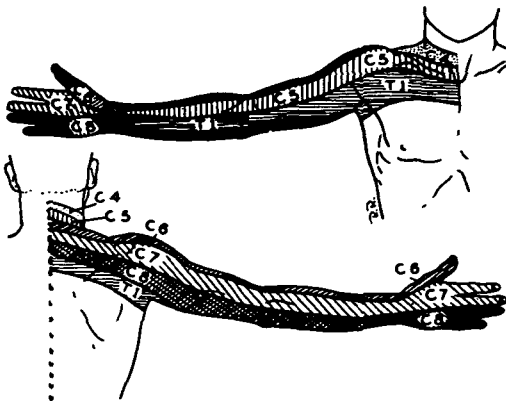


Figure 9

Ventral and dorsal views of cervical and first thoracic dermatomes. By permission Keegan: *J. Neurosurg.*, 4:115, 1947.

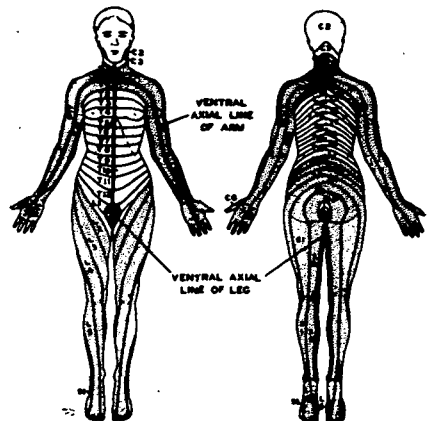


Figure 10

Complete dermatome chart of the human body. By permission from Keegan: *J. Neurosurg.*, 4:115, 1947.

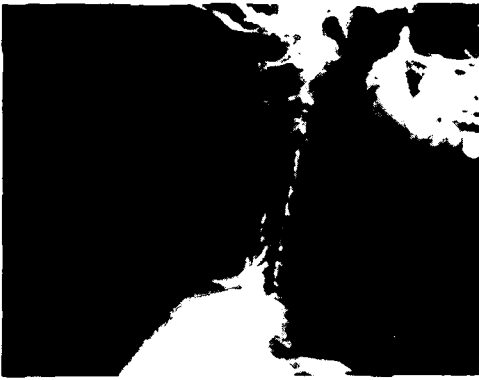


Figure 11(a)

X-ray side view of a neck as an example of "straightening" of the cervical vertebral curve due to muscle spasm.



Figure 11(b)

X-ray view of same cervical spine as Figure (a) after disappearance of muscle spasm; note the normal curve of the neck vertebrae.



Figure 11(c)

Same cervical spine as Figure (a) taken at same time in the front to back (anteroposterior) view and disclosing the typical list of the spine and opposite tilt of the head due to a "slipped facet," C1 on 2.

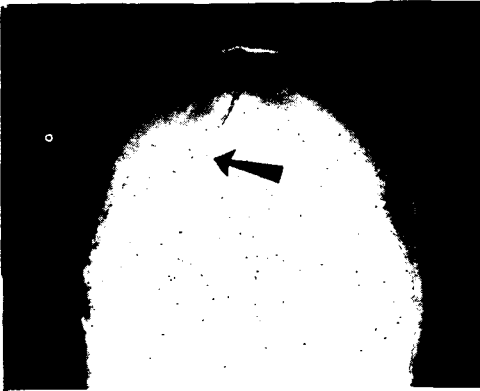


Figure 12

An "open mouth" x-ray view of cervical vertebrae 1 and 2 emphasizing the odontoid process and the facets. Note the unequal position of the facets in relation to themselves and to the odontoid process. This proved to be due to torn ligaments and a possible fracture (whiplash neck injury).

**Figures 13(a) and 13(b)**

Unusual head and neck injury from the extension-recoil mechanism in which the head struck the back of the seat when the vehicle was hit from behind by a car traveling about 70 m.p.h.



**Figure 13(a)**

(X-ray-occipital view)

Linear fracture in occipital bone. There were associated contusions of the cerebellum.



**Figure 13(b)**

(X-ray-lateral cervical view)

Fracture and separation of tip of spinous process of C6.



**Figure 14**

Pre-existing extensive osteoarthritis and degenerative disc changes (absorption) mostly involving the 4th to 7th cervical vertebrae. There is an associated fracture dislocation of the 6th cervical vertebra on the 7th (arrow) occurring in an elderly female.



Figure 15(a)



Figure 15(b)

Progressive degenerative changes between the 6th and 7th cervical vertebrae (arrows) as seen by x-rays taken 2 years apart. Figure (a) 1955, lateral cervical view. Figure (b) 1957, lateral cervical view. In this x-ray note the bony "lipping" on the front (anterior) side of the bodies of the vertebrae ("anterior vertebral osteoarthritic lipping"). Similar bony spurring was noted projecting into the intervertebral foraminae at this site in other films.



Figure 16

A myelogram of the cervical spinal canal (white column) disclosing a defect between C6-7 on the right side (to the reader's left) due to a ruptured intervertebral disc.



