# Whiplash Injuries

## Diagnosis and Treatment

O. LEONARD HUDDLESTON, *M.D., Ph.D.*, Santa Monica

• **Whiplash injury may extend far beyond the neck, and may involve even the soft tissues of the pelvis. For permanent recovery, all the injuries must be evaluated and treated together.**

**When impact from the rear snaps the head back and then forward, posterior subluxations in the cervical spine cause anterior-posterior narrowing of the intervertebral foramina, which may result in injury to the cervical nerve roots. Impact at the front, causing hyperflexion followed by hyperextension, has a similar effect although usually not as severe. Resulting symptoms may not appear until two or three weeks later, when irritative lesions have developed because of hemorrhage or swelling. Mild or progressive degenerative changes may cause no symptoms but may predispose the affected area to injury following some slight trauma. Capsular ligaments of the lateral intervertebral joints are especially liable to whiplash injury which may give rise to scars and adhesions that compress spinal nerves. Sympathetic system involvement may cause reflex and referred pain.**

**Detailed neurologic, roentgen and electromyographic studies may be necessary for proper evaluation of injuries. Seemingly psychosomatic pain or disability is likely to have some physical basis in whiplash injuries.**

**In 33 patients with whiplash injury, some recently injured and some chronically disabled with persistent symptoms, good results were observed following hydromassage, hot packs, joint mobilization exercises and, in a few, cervical or pelvic traction.**

WHIPLASH INJURIES, according to Jackson,[1] usually result from traumatic sprains of the ligamentous and capsular structures of the cervical spine in an automobile collision. When an automobile is struck from the front, the rider's head, neck and trunk are flung forward and either bounce back after colliding with some object or recoil by action of the muscles. When the car is struck from the rear or the side, the inertia of the head and neck holds them stationary while the body is carried in the direction of impact; then, like a whiplash, the head and neck snap after the body and recoil, with stretching and distortion throughout the soft tissues of the neck.

This whipping stress, although its effect is most conspicuous in the neck, often involves ligaments, tendons, joint capsules and muscles of the torso including the pelvis. For lasting good results, all such disabilities should be treated.

The basic injuries resulting from whiplash stress are: Stretching, elongation, sometimes tearing of some soft tissues; inflammation causing varying degrees of swelling and acute inflammatory reactions; avulsion of ligaments, tendons and muscles; periosteal tears; joint effusions; abnormal mobility of joints; joint luxation—an abnormal relation of the articular surfaces.

The symptoms usually consist of pain, tenderness, impairment or loss of muscle power, limitation of motion, or forced movement or forced positions of the head and neck. In addition, cervical nerve irritation may cause weakness of shoulder or arm muscles, varying degrees of anesthesia and paresthesia or hyperesthesia, vascular changes such as blanching or reddening of the skin, drop in skin temperature (less often, a rise), muscle spasm, and localized tenderness or deeper areas of pain felt on palpation.

In chronic injuries muscle atrophy, resulting from either peripheral nerve injury or disuse, and persistent sensory and motor changes, as well as trophic changes, may persist in the involved structures of the neck and upper extremities. One must always keep in mind that injuries other than those of soft tissue strains and sprains may take place—fractures, dislocations, severe subluxations, severe root compression or injury to the spinal cord, brain or autonomic nervous system, or an aggravation of dormant abnormalities, such as cervical arthritis, spondylitis and subacute or chronic torticollis. These possible disorders should be either diagnosed or ruled out, for it is important to know when one is dealing simply with sprains and strains of the soft tissues. The refractoriness of sprains of the larger joints of the body, such as the ankle, knee, elbow, and wrist in healing completely is recognized fully by everyone who handles traumatic disabilities of the body. It is generally agreed that simple fractures not involving joints with their associated sprains and strains, heal much faster and have fewer sequelae of altered functional activities. It is also generally accepted that sprains without fractures are frequently more disabling than fractures and often

From the California Rehabilitation Center and the Department of Physical Medicine, University of Southern California School of Medicine.

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much more difficult to heal completely. Whiplash injuries of the cervical spine fall into the category of acute sprains and strains and understandably give rise to persistent subjective and objective symptoms, pain, headache, and abnormal changes in mobility of the neck because they are extremely difficult to treat.

## ANATOMICAL CONSIDERATIONS

There are eight cervical vertebrae joined by six intervertebral discs (no disc between the first and second vertebrae). The discs are thicker anteriorly than posteriorly. Additional lateral intervertebral synovial joints are located on each side of each intervertebral disc (joints of von Luschka). These joints are quite prominent between the first and second cervical vertebrae and at the atlanto-occipital joint where they serve both as swivel and as weight support for the head and the atlas. Since the atlas and axis have no pedicles or lamina, the nerve roots of the first and second cervical joints have no bony covering and no intervertebral foramina. (In the lower joints the nerve root is located between the posterior articulation and the lateral portion of the vertebral body within the foramen.) The apophyseal joints on each side are superiorly and inferiorly placed from the pedicle and lamina of adjacent vertebrae. Each has a true joint capsule reinforced by ligaments, tendons and muscular attachments. The ligaments include the anterior and posterior longitudinal, the ligamentum flavum, the interspinal, the supraspinous, the annular ligaments around the intervertebral discs and some poorly developed ligaments between the transverse processes. Between the atlas and the axis there are five joints: The intervertebral, two articular or apophyseal joints, and two lateral intervertebral synovial joints.

This arrangement of ligaments and joints gives the cervical region three significant characteristics: (1) It provides wide mobility in three directions—front to back, side to side, and in rotation; (2) it prevents excessive movement of the joints, which are limited by the check ligaments; (3) it protects against rupture of the intervertebral discs by the cupping, beveling, lipping and contouring together of the vertebral bodies, by the relative slightness of the discs, by the bordering secondary joints and lateral synovial joints, and by the construction of the longitudinal and capsular ligaments.

### Nerve Root Compression

Whiplash injuries which occur when a car is struck from the rear are brought about by primary hyperextension, followed by hyperflexion, and generally result in posterior subluxations. This brings about an anterior-posterior narrowing of the intervertebral foramina. The spinal nerve is compressed anteriorly and posteriorly, and the vertical diameter of the intervertebral foramen also is decreased. Thus a nerve may become compressed in the vertical diameter as well as in the horizontal.

Neck injuries resulting from head-on collisions produce primary hyperflexion of the neck, followed by recoil hyperextension. These whiplash forces usually result in anterior subluxations that likewise narrow the anterior-posterior diameter of the foramina (although usually not as severely as in posterior subluxation) and compress the nerve in a pincer-like catch. Since the vertical diameter, however, does not become narrowed and may actually be increased, vertical compression as a rule does not occur.

The spinal structure tends to throw the greatest stress between the fourth and fifth vertebrae in hyperextension, but between the fifth and sixth in hyperflexion. These joints are most often affected, but others may be also.

Nerve compression and symptoms may not occur immediately after neck injury but may result later from irritative lesions due to hemorrhage or to swelling of surrounding structures. Therefore the physician must be cautious about assuring patients or their counselors that no damage has occurred to soft tissues. Guarded judgment and prognosis should certainly be observed for two to three weeks.

Another possibility to remember is that of mild or progressive degenerative changes that may result in chronic inflammation, predisposing the affected area to disabling injury as the result of even mild and normally harmless stresses. Change in posture, unaccustomed effort or sudden movement of the head may be sufficient to stir up an acute irritative reaction and bring on delayed pain and associated disabilities.

Especially liable to sprains are the capsular ligaments of the lateral intervertebral joints, which are short and taut and may tear, undergo acute inflammatory reaction, and subsequently form scars and adhesions that may compress spinal nerves. Reflex and referred pain may also be produced through involvement of the sympathetic nervous system. Postganglionic sympathetic fibers may be compressed at the level of the intervertebral foramen. From the branch of the sympathetic nerve which supplies the posterior longitudinal ligament and the capsule of the lateral intervertebral joints, pain may be referred through the spinal meningeal branches to areas served by the cervical nerves.

## DIAGNOSIS

In addition to history-taking and general physical examination, a special orthopedic examination is needed for diagnosis. Besides this, the soft tissues in the involved area should be minutely inspected for signs of localized muscle tightness or tenderness.

Alignment of joints and bony processes should be studied and range of joint motion should be measured. Strength of muscles of the neck, extremities and trunk should be evaluated. A detailed neurologic examination should be made for sensory or motor changes involving the cranial and spinal nerves, and lastly, the torso and pelvis should be examined in detail for evidence of strains and sprains, luxations or fractures of the bones and joints of the spinal column and pelvis.

Roentgen studies of the spine and pelvis, with special views of the neck, should include lateral views with the patient sitting and the head faced directly forward, as well as with the neck hyperflexed and hyperextended. The straight lateral view shows alignment of the vertebrae and the cervical curvature. Flexion and extension disclose anterior and posterior subluxations, respectively. In addition, right and left oblique views show the size and shape of the intervertebral foramina. Anteroposterior views may be useful in determining variations in the width of the intervertebral spaces, the dimensions and contour of the lateral intervertebral joints, and the presence or absence of hypertrophic changes or compression fractures. All the cervical films should be scanned for evidence of fractures, faulty alignment, degenerative or hypertrophic change, and narrowing or widening of the joint spaces.

Patients with persistent or chronic symptoms may need further study by electromyography or myelography. Electromyography may help to diagnose or rule out lower motor neuron lesions associated with nerve compression or spinal cord injury, and may indicate the level of the injury. Myelography, useful in study of space-occupying lesions, is indicated only when there is a question of fracture, disc rupture, tumor, hemorrhage or any condition that does not respond to apparently adequate non-surgical treatment.

#### DIFFERENTIAL DIAGNOSIS

The cause of presenting symptoms, such as pain, weakness, headache, limitation of joint motion, and vascular and trophic changes should be determined. If pain seems organic in origin, does it result from local inflammation or from nerve compression or irritation? Is it segmental, referred, or associated with disorders of somatic or visceral structures? Is it related to some abnormality of the brain or the spinal cord? Or can it be ascribed to psychosomatic origin by ruling out all these other possibilities? The author believes that in most cases where psychologic components are important, they are somatopsychic rather than psychosomatic in origin. It is in these cases that the greatest danger exists of inadequate recognition and improper or inadequate treatment.

#### TREATMENT

Seventy per cent of patients with "cervical disc syndrome" responded to conservative treatment, according to Spurling and Segerberg,[5] who reported in 1953 on 110 cases in which "unequivocal clinical diagnosis of root compression in the lower cervical region was made." The other 30 per cent were surgically treated. The conservative regimen consisted of bed rest with cervical traction for seven to ten days, using six to twelve pounds of traction, two hours of stretch and one hour of rest, and no traction at night. The following year Martin and Corbin (1954)[3] reported their observations upon conservative treatment of similar patients, on an ambulatory basis. This consisted of daily treatments in the physical medicine department for a period of one day to three weeks, with an average of eight treatments for each patient—application of heat and massage to the neck and shoulders, followed by cervical traction at 30 to 100 pounds, with an average pull of 60 pounds applied from one to three minutes twice daily. During traction, the patient was instructed to shrug his shoulders and then relax. Rotation of the head through a maximum range to the right and to the left was carried out two or three times, either by the patient or with the assistance of the physician giving the traction. Following the initial improvement, the patient was instructed in home treatment of application of radiant heat to the neck, followed by cervical traction, using home traction equipment consisting of a simple felt head-sling which could be fastened or suspended from the door frame, and traction applied by the patient himself by slightly bending his knees. Observations were made on 61 patients treated with this procedure; 67 per cent had definite improvement during the initial period, 77 per cent were definitely improved in six months to five years later, 3.2 per cent showed no change, and 20 per cent required operation.

Similar observations on 80 cases of cervical syndrome were reported in 1955 by Krusen and Leyden-Krusen.[2] The treatment consisted of the application of heat, usually short-wave or microtherm diathermy, massage, vertical traction starting with 30 pounds and gradually increasing to tolerance, active exercises of the neck muscles consisting primarily of rotation and lateral bending, and in some cases electrical stimulation of the neck muscles. The average treatment time was three to four weeks. Among 328 patients having a history of injury, 40 per cent showed decided improvement, 47 per cent moderate improvement, 13 per cent no improvement. Among 472 without a history of injury, 42 per cent had good improvement, 38 per cent moderate improvement and 20 per cent none. Cervical syndrome due to acute fibrositis responded very satisfactorily to

conservative treatment, with good improvement in 91 per cent, moderate in 7 per cent, none in 2 per cent.

### Customary Conservative Treatment

Conservative, nonsurgical treatment of cervical disc syndrome, or whiplash injuries usually consists of a selected combination of the following therapeutic procedures: The use of some form of heat, massage, traction, immobilization with a cervical collar during the day and a contour pillow at night, injection of local anesthetic, drugs—usually some type of sedative or anodyne—correction of posture, therapeutic exercises, mobilization therapy and/or the application of ultrasound to selected areas. The traction may be applied manually; intermittently with a Sayer head-sling, which may be either manual or motorized; or continuously during the day or at night or both, usually with the patient recumbent.

## PERSONAL OBSERVATIONS

At the California Rehabilitation Center in the past two years we have treated 33 patients with whiplash injury. Thirteen began treatment at the center soon after injury; results, without exception, have been satisfactory after three to twelve treatments over periods ranging from a few days to three weeks. The other 20 patients, whose symptoms had persisted after extensive treatment elsewhere with little or only partial relief, required as a rule more intensive and prolonged therapy.

In all these cases the disability usually extended beyond whiplash strain of the soft tissues of the cervical vertebrae. There were usually multiple injuries of the back; ligaments, tendons, joint capsules and muscles of the torso and pelvis were involved in multiple subluxations extending from the base of the skull to the tip of the spine. Similar injuries were often present in the sacroiliac and lumbosacral regions and the symphysis pubis. For lasting improvement, it was necessary to treat all the disabilities and their symptoms—muscle soreness, tenderness, pain and limitation of motion, fatigability, headache, backache, torticollis, difficulty in sleeping and vocational disabilities.

Treatment for most patients consisted of hydrosubmersion with hydromassage, Kenny or chemical hot packs applied to the neck and back, and mobilization. Tissue mobilization was achieved by flexibility exercises, stretching and mechanical percussion massage with the Percussomotor.* Joint mobilization was obtained with Mennell's maneuvers.[4] In some cases, extensive fascial stretching and resistive exercises were added. Only five of the 33 patients received cervical or pelvic traction, which was applied intermittently (either by hand or by manually or motor-operated sling) or continuously with sling, pulley, and five to eight pounds of weight. The latter treatment was applied at home during the night and sometimes during the day. Only three patients wore a supportive collar between treatments.

Among the 20 patients treated for chronic symptoms, and except for three still under treatment, all were discharged as greatly improved and essentially symptom-free. In the 13 treated soon after injury the symptoms were completely abolished without recurrence to date.

1 Pico Boulevard, Santa Monica.

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*A small, electrically controlled vibrator of percussion type, fitted with various sizes and shapes of rubber applicators to transmit mechanical energy of selected frequency and intensity to various soft tissues of the body.