

**Chronic whiplash and whiplash-associated disorders:  
An evidence-based approach**

**Journal of the American Academy of Orthopedic Surgeons  
October 2007;15(10):596-606**

Schofferman J, Bogduk N, Slosar P.  
FROM ABSTRACT:

Whiplash is neck pain experienced as a result of a motor vehicle collision or similar trauma.

Following a motor vehicle collision, 15% to 40% of patients with acute neck pain develop chronic neck pain.

The cervical facet joint is the most common source of chronic neck pain after whiplash injury, followed by disk pain. Some patients experience pain from both structures.

Initial management recommendations need not be directed toward an exact structural cause, but treatment includes advising the patient to remain active and providing advice regarding the generally favorable outcome.

When neck pain persists, the physician should recommend medial branch blocks of the dorsal rami of the spinal nerves that supply the putative painful facet joint or joints; this is done to determine whether the facet joints are the cause of pain.

When significant relief occurs on two occasions, radiofrequency neurotomy typically provides substantial relief for approximately 8 to 12 months and can be repeated indefinitely as needed.

Occasionally, long-term treatment with medication may be indicated.

Anterior cervical discectomy and fusion is necessary on rare occasions.

THESE AUTHORS ALSO NOTE:

“In a typical rear-end MVC, the injury is caused by the abnormal biomechanics of neck motion resulting from the forward and upward motion of the torso while the head lags behind as the result of inertia.”

“Whiplash injury is any structural damage sustained because of the whiplash forces.”

“Clinical studies have shown that 15% to 40% of patients with acute neck pain after MVC develop chronic pain.”

“5% to 7% of patients become permanently partially or totally disabled.”

## Mechanism and Biomechanics of Whiplash Injury

“The whiplash event lasts well under 500 ms.”

“The forward acceleration of the torso deforms the cervical spine into a nonphysiologic S-shaped curve, with extension developing between the lower segments and flexion developing between the uppermost segments. Most of the whiplash injury occurs during this deformation phase.” **[Important]**

“The forces and resultant motion that cause the whiplash injury are related to neither the total range of motion of the neck nor the amount of extension or flexion—the so-called whip. Instead, it is the abnormal motion that occurs within and between individual motion segments that has the potential to injure facets, disks, and ligaments.”

“The facet joints undergo a nonphysiologic pinching motion, with compression posteriorly and distraction anteriorly, usually coupled with shear.”

“The annulus fibrosis of the disk and longitudinal ligaments can be disrupted by the same abnormal motion.”

Facet injuries include:

- 1) Capsular tears and strain
- 2) Bony impingement
- 3) Synovial fold pinching
- 4) Contusion with intra-articular hemorrhage
- 5) Damage to subchondral bone

Disk injuries include:

- 1) Strain or avulsion of the anterior annulus
- 2) Tearing of the posterior annulus
- 3) Disk herniation

“Any of these structural injuries [facet / disk] has the potential to cause acute and chronic neck pain.”

“Severity of property damage is not a reliable predictor of injury or outcome in low-speed collisions. Crash characteristics and human factors are much more relevant.” **[Very Important]**      Crash factors include:

- 1) Size, weight and speeds of the vehicles
- 2) Type and position of the seat and head restraint
- 3) The ability of the vehicles to absorb or transmit energy

Human factors include:

- 1) Size, weight and sex of the occupant
- 2) Awareness of impending collision
- 3) Direction occupant is facing at impact
- 4) Individual tissue tolerance

## Natural History of Neck Pain After Whiplash Injury

“Those who experience acute neck pain immediately following the MVC are three times more likely to report chronic neck pain 7 years later than are patients involved in MVCs who had no acute neck pain and patients not involved in a prior MVC,”

In 80% of whiplash patients, their pain begins the day of the collision.

20% of patients who develop chronic pain experience a delay in time between the collision and the onset of pain.

Up to 40% of whiplash-injured patients develop chronic pain.

5% to 12% of whiplash-injured patients experience chronic moderate to severe pain.

5% to 10% of whiplash-injured patients have permanent partial or total disability.

### Prognostic Factors

Cited recovery rates for acute whiplash injuries show:

- 1) 44% are not recovered at 3 months.
- 2) 30% are not recovered at 6 months.
- 3) 24% are not recovered at 12 months.
- 4) 18% are not recovered at 24 months.

“The strongest predictor of poor outcome is high initial intensity of pain.”

A number of referenced studies make the following prognostic points:

- 1) Compensation or litigation is not associated with an adverse prognosis.
- 2) Older age, female sex, radicular symptoms, multiple areas of pain, and being unprepared for impact are associated with a worse prognosis.
- 3) “There is no pre-injury personality that renders individuals more likely to develop chronic pain after whiplash.”
- 4) There are no psychosocial factors that are useful predictors of whiplash injury chronicity.
- 5) There is no correlation between initial psychological testing and whiplash chronicity.
- 6) In most instances, psychological problems are a “consequence rather than a cause of pain.”
- 7) “There was no difference in the prevalence of pre-injury psychological illness in those who did or did not return to work.”
- 8) “The strongest predictor of prolonged disability [after whiplash injury] was intensity of [initial] symptoms.”
- 9) Differences in speed between vehicles is not predictive of whiplash symptom chronicity. **[Important]**

- 10) "Multiple studies have demonstrated that personal injury litigation does not adversely affect the outcome of whiplash injury."
- 11) Patients with more pain and more objective findings are more likely to file litigation claims. **[Important]**
- 12) There is no evidence for symptom improvement after litigation is settled.

### **Clinical Symptoms**

Chronic pain is defined as pain that persists after the resolution of structural injury, defined by these authors as pain that persists beyond 6 months.

The predominant whiplash symptoms are neck pain, trapezius pain, shoulder pain, interscapular pain, arm pain and occasionally face pain.

Arm pain is common in chronic whiplash.

If arm pain is more severe than neck pain, it usually means neural compression radiculopathy.

Arm pain can occur in the absence of neural compression, referred from the disc or from a facet joint.

"Facet joint-mediated arm pain is usually in the shoulder or uppermost arm."

Median nerve injury from the steering wheel or dashboard can cause carpal tunnel syndrome.

After neck pain, headache is the most common symptom of whiplash.

Post whiplash cervicogenic headache is usually unilateral and begins at the base of the skull and can radiate to the crown of the head and frontal regions. The documented sources for chronic cervicogenic headache are:

- 1) Discogenic, C2-C3 and C3-C4
- 2) Upper cervical facet joint
- 3) Atlanto-occipital joint

Whiplash injury can also cause:

- 1) Low back pain
- 2) Visual disturbances
- 3) Dizziness
- 4) Tinnitus
- 5) Weakness
- 6) Fatigue
- 7) Poor concentration
- 8) Poor memory
- 9) Difficulty sleeping
- 10) Psychological changes, such as depression

Large studies show that initially, 55% of whiplash patients report low back pain. This pain remains chronic in 30% to 42% of patients at 6 months.

The tissue sources for chronic low back pain from whiplash are injury to the sacroiliac joints, low back facet joint injury, and low back discogenic pain.

Studies show that post-whiplash psychological disorders are secondary to pain and impairment.

### **Structural Etiology of Chronic Neck Pain Caused by Whiplash**

“The facet joints are the most common source [more than half of the cases] of chronic neck pain after whiplash injury.”

“Some patients have pain that arises from a disk, and some have a combination of facet joint pain and discogenic pain.”

Associated muscle and ligament injuries heal in 6 to 8 weeks, and these injuries do not cause chronic neck pain.

Facet joint pain can only be diagnosed by anesthetizing the joint with a medial branch block of the posterior primary rami. Because of the high false positive rate, this procedure must be done twice on separate occasions and the pain must be relieved each time.

The C2-C3 facet joint is the cause of post-whiplash cervicogenic headache 53% of the time.

The cervical disc is innervated and can be injured during whiplash.

To diagnose disc pain, discography is helpful, but should be reserved for patients who are surgical candidates.

The alar and transverse ligaments may be damaged in whiplash and are potential sources for cervicogenic headaches.

### **Treatment**

Treatments for acute neck pain by these authors include remaining active despite ongoing pain, performance of prescribed exercises, and possible inclusion of spinal manipulation, which can improve outcomes over exercise alone.

In the treatment of chronic neck pain, “exercise alone is rarely curative” but exercise is helpful, and should be prescribed. The exercise should be directed to strengthen the weak muscle groups, usually the anterior, posterior, and interscapular muscle groups. Strength training is superior to stretching exercises, and intense exercise is superior to light exercise.

Radiofrequency neurotomy is the coagulation of the medial branches of the posterior primary rami that innervate the facet joints. It will give pain relief for 270 to 400 days in patients who are suffering from facet pain only, which must be proved with two controlled anesthetic blocks.

“Intra-articular injections of corticosteroid do not provide long-term relief.”

Cervical epidural corticosteroid injections do not work well, especially for traumatically induced radicular pain.

Spinal manipulation is one of the most popular treatments for chronic neck pain, and it can be beneficial. Serious complications from spinal manipulation are “quite low.”

Cervical collars are of “no value in the patient with acute whiplash injury.”

Anterior cervical disc fusion should only be performed on chronic patients who are proven not to have facet pain and who have a positive discogram.

#### KEY POINTS FROM DAN MURPHY

- 1) “Following a motor vehicle collision, 15% to 40% of patients with acute neck pain develop chronic neck pain.”
- 2) Cervical collars are of “no value in the patient with acute whiplash injury.”
- 3) “The cervical facet joint is the most common source of chronic neck pain after whiplash injury, followed by disk pain. Some patients experience pain from both structures.”
- 4) “When neck pain persists, the physician should recommend medial branch blocks of the dorsal rami of the spinal nerves that supply the putative painful facet joint or joints.”
- 5) “In a typical rear-end MVC, the injury is caused by the abnormal biomechanics of neck motion resulting from the forward and upward motion of the torso while the head lags behind as the result of inertia.”
- 6) “The whiplash event lasts well under 500 ms.”
- 7) “The forward acceleration of the torso deforms the cervical spine into a nonphysiologic S-shaped curve, with extension developing between the lower segments and flexion developing between the uppermost segments. Most of the whiplash injury occurs during this deformation phase.” **[Important]**
- 8) “The forces and resultant motion that cause the whiplash injury are related to neither the total range of motion of the neck nor the amount of extension or

flexion—the so-called whip. Instead, it is the abnormal motion that occurs within and between individual motion segments that has the potential to injure facets, disks, and ligaments.”

9) “The facet joints undergo a nonphysiologic pinching motion, with compression posteriorly and distraction anteriorly, usually coupled with shear.” Facet injuries include:

- A)) Capsular tears and strain
- B)) Bony impingement
- C)) Synovial fold pinching
- D)) Contusion with intra-articular hemorrhage
- E)) Damage to subchondral bone

10) “The annulus fibrosis of the disk and longitudinal ligaments can be disrupted by the same abnormal motion.”

Disk injuries include:

- A)) Strain or avulsion of the anterior annulus
- B)) Tearing of the posterior annulus
- C)) Disk herniation

11) “Any of these structural [facet / disk] injuries has the potential to cause acute and chronic neck pain.”

12) “Severity of property damage is not a reliable predictor of injury or outcome in low-speed collisions. Crash characteristics and human factors are much more relevant.” **[Very Important]**

Crash factors include:

- A)) Size, weight and speeds of the vehicles
- B)) Type and position of the seat and head restraint
- C)) The ability of the vehicles to absorb or transmit energy

Human factors include:

- A)) Size, weight and sex of the occupant
- B)) Awareness of impending collision
- C)) Direction occupant is facing at impact
- D)) Individual tissue tolerance

13) “Those who experience acute neck pain immediately following the MVC are three times more likely to report chronic neck pain 7 years later than are patients involved in MVCs who had no acute neck pain and patients not involved in a prior MVC.”

14) In 80% of whiplash patients, their pain begins the day of the collision.

15) 20% of patients who develop chronic pain experience a delay in time between the collision and the onset of pain.

16) Up to 40% of whiplash-injured patients develop chronic pain.

- 17) 5% to 12% of whiplash-injured patients experience chronic moderate to severe pain.
- 18) 5% to 10% of whiplash-injured patients have permanent partial or total disability.
- 19) Cited recovery rates for acute whiplash injuries show:
- A)) 44% are not recovered at 3 months.
  - B)) 30% are not recovered at 6 months.
  - C)) 24% are not recovered at 12 months.
  - D)) 18% are not recovered at 24 months.
- 20) "The strongest predictor of poor outcome is high initial intensity of pain."
- 21) A number of referenced studies make the following prognostic points:
- A)) Compensation or litigation is not associated with an adverse prognosis.
  - B)) Older age, female sex, radicular symptoms, multiple areas of pain, and being unprepared for impact are associated with a worse prognosis.
  - C)) "There is no pre-injury personality that renders individuals more likely to develop chronic pain after whiplash."
  - D)) There are no psychosocial factors that are useful predictors of whiplash injury chronicity.
  - E)) There is no correlation between initial psychological testing and whiplash chronicity.
  - F)) In most instances, psychological problems are a "consequence rather than a cause of pain."
  - G)) "There was no difference in the prevalence of pre-injury psychological illness in those who did or did not return to work."
  - H)) "The strongest predictor of prolonged disability [after whiplash injury] was intensity of [initial] symptoms."
  - I)) Differences in speed between vehicles is not predictive of whiplash symptom chronicity. **[Important]**
  - J)) "Multiple studies have demonstrated that personal injury litigation does not adversely affect the outcome of whiplash injury."
  - K)) Patients with more pain and more objective findings are more likely to file litigation claims. **[Important]**
  - L)) There is no evidence for symptom improvement after litigation is settled.
- 22) Chronic pain is defined as pain that persists after the resolution of structural injury, defined by these authors as pain that persists beyond 6 months.
- 23) The predominant whiplash symptoms are neck pain, trapezius pain, shoulder pain, interscapular pain, arm pain and occasionally face pain.
- 24) Arm pain is common in chronic whiplash. If arm pain is more severe than neck pain, it usually means neural compression radiculopathy.



- 25) Arm pain can occur in the absence of neural compression, referred from the disc or from a facet joint.
- 26) "Facet joint-mediated arm pain is usually in the shoulder or uppermost arm."
- 27) Median nerve injury from the steering wheel or dashboard can cause carpal tunnel syndrome.
- 28) After neck pain, headache is the most common symptom of whiplash.
- 29) Post whiplash cervicogenic headache is usually unilateral and begins at the base of the skull and can radiate to the crown of the head and frontal regions. The documented sources for chronic cervicogenic headache are:
- A)) Discogenic, C2-C3 and C3-C4
  - B)) Upper cervical facet joint
  - C)) Atlanto-occipital joint
- 30) Whiplash injury can also cause:
- A)) Low back pain
  - B)) Visual disturbances
  - C)) Dizziness
  - D)) Tinnitus
  - E)) Weakness
  - F)) Fatigue
  - G)) Poor concentration
  - H)) Poor memory
  - I)) Difficulty sleeping
  - J)) Psychological changes, such as depression
- 31) Initially, 55% of whiplash patients report low back pain. This pain remains chronic in 30% to 42% of patients at 6 months.
- 32) The tissue sources for chronic low back pain from whiplash are injury to the sacroiliac joints, low back facet joint injury, and low back discogenic pain.
- 33) Studies show that post-whiplash psychological disorders are secondary to pain and impairment.
- 34) "The facet joints are the most common source [more than half of the cases] of chronic neck pain after whiplash injury."
- 35) "Some patients have pain that arises from a disk, and some have a combination of facet joint pain and discogenic pain."
- 36) Associated muscle and ligament injuries heal in 6 to 8 weeks, and these injuries do not cause chronic neck pain.

- 37) Facet joint pain can only be diagnosed by anesthetizing the joint with a medial branch block of the posterior primary rami. Because of the high false positive rate, this procedure must be done twice on separate occasions and the pain must be relieved each time.
- 38) The C2-C3 facet joint is the cause of post-whiplash cervicogenic headache 53% of the time.
- 39) The cervical disc is innervated and can be injured during whiplash.
- 40) To diagnose disc pain, discography is helpful, but should be reserved for patients who are surgical candidates.
- 41) The alar and transverse ligaments may be damaged in whiplash and are potential sources for cervicogenic headaches.
- 42) Treatments for acute neck pain by these authors include remaining active despite ongoing pain, performance of prescribed exercises, and possible inclusion of spinal manipulation, which can improve outcomes over exercise alone.
- 43) In the treatment of chronic neck pain, "exercise alone is rarely curative" but exercise is helpful, and should be prescribed. The exercise should be directed to strengthen the weak muscle groups, usually the anterior, posterior, and interscapular muscle groups. Strength training is superior to stretching exercises, and intense exercise is superior to light exercise.
- 44) Radiofrequency neurotomy is the coagulation of the medial branches of the posterior primary rami that innervate the facet joints. It will give pain relief for 270 to 400 days in patients who are suffering only from facet pain, which must be proved with two controlled anesthetic blocks.
- 45) "Intra-articular injections of corticosteroid do not provide long-term relief."
- 46) Cervical epidural corticosteroid injections do not work well, especially for traumatically induced radicular pain.
- 47) Spinal manipulation is one of the most popular treatments for chronic neck pain, and it can be beneficial. Serious complications from spinal manipulation are "quite low."
- 48) Anterior cervical disc fusion should only be performed on chronic patients who are proven not to have facet pain and who have a positive discogram.