

Whiplash and cervical spine injury

See also the separate [Spinal Cord Compression](#) article.

An acute whiplash injury follows sudden or excessive hyperextension, hyperflexion or rotation of the neck and causes neck pain and other symptoms^[1]. Whiplash injury is common in road traffic accidents and may also be caused by sports injuries, falls or assaults. Most cases of whiplash injury occur as the result of rear-end vehicle collisions at speeds of less than 14 miles per hour. Patients present with neck pain and stiffness, occipital headache, thoracic back pain and/or lumbar back pain and upper-limb pain and paraesthesia^[2].

There are two types of injury:

- Typical cervical hyperextension injuries occur in drivers/passengers of a stationary or slow-moving vehicle that is struck from behind. The person's body is thrown forwards but the head lags, resulting in hyperextension of the neck. When the head and neck have reached maximum extension, the neck then snaps into flexion.
- A rapid deceleration injury throws the head forwards and flexes the cervical spine. The chin limits forward flexion but the forward movement may be sufficient to cause longitudinal distraction and neurological damage. Hyperextension may occur in the subsequent recoil.

Whiplash-associated disorders (WAD) can be classified by the severity of signs and symptoms^[3]:

- Grade 0: no complaints or physical signs.
- Grade 1: indicates neck complaints but no physical signs.
- Grade 2: indicates neck complaints and musculoskeletal signs.
- Grade 3: neck complaints and neurological signs.

- Grade 4: neck complaints and fracture/dislocation:
 - Most cervical spine fractures occur predominantly at two levels – at the level of C2 or at C6 or C7.
 - Most fatal cervical spine injuries occur in upper cervical levels, either at the cranio-cervical junction C1, or at C2.

Epidemiology

- Trauma and sports injuries are more common in young adults.
- Rates of whiplash are higher in persons using a seatbelt with shoulder restraint than with no restraint but seatbelts often prevent more serious injuries.
- Poor posture.
- Poorly-fitted head restraints.
- Women sustain higher rates of whiplash, probably because their neck muscles are less well developed than men's.
- Narrowing of the cervical spinal canal due to acquired or congenital disorders predisposes to spinal cord damage with these types of injuries.

Risk factors for severe injury

The Canadian cervical spine rule for risk of skeletal injury^[4]:

- The Canadian cervical spine rule applies to trauma patients who are alert (Glasgow Coma Scale of 15) and stable.
- It has been shown to be safe and reliable, missing only one unstable injury in a series of over 16,000 cases.

High-risk factors

- Age 65 years or over.
- Paraesthesia in extremities.

- Dangerous mechanism of injury, which is considered to be:
 - A fall from a height of at least a metre or five stairs.
 - An axial load to the head - eg, during diving.
 - A motor vehicle collision at high speed (>100 km/h) or with rollover or ejection.
 - A collision involving a motorised recreational vehicle.
 - A bicycle collision.

Low-risk factors

- Simple rear-end motor vehicle collision (excludes being pushed into oncoming traffic, being hit by a bus or a large truck, a rollover, and being hit by a high-speed vehicle).
- Able to sit rather than lie down in the emergency department.
- Ambulatory at any time.
- Delayed (not immediate) onset of neck pain.
- Absence of midline cervical spine tenderness.

Presentation^[1]

See also the separate [Examination of the Spine](#) article.

The clinical symptoms of whiplash injury may not develop until 6-12 hours after the injury, or even after a few days. These include:

- Neck pain, jaw pain, paraspinal muscle tightness and spasm. Neck pain usually develops shortly after the accident and may worsen and peak 1-2 days after the event. Neck pain may refer to the shoulder or arm.
- Interscapular and low back pain.
- Muscle spasm.
- Reduced range of movements and neck tenderness.

- Headache, fatigue, dizziness, vertigo, blurring of vision, nausea.
- Numbness in shoulders and arms. Paraesthesia and weakness in the arms and legs – depending on presence and site of any cord contusion.
- There may be retropharyngeal swelling and dysphagia.
- Insomnia, anxiety (general anxiety and/or travel anxiety when in a car) or depression.
- Leg weakness, hyperactive tendon reflexes in the legs, upgoing plantar response, and/or sphincter disturbance, suggest damage to the spinal cord.
- Arm weakness or numbness suggests injury or entrapment to the nerve roots of the cervical spine.
- Symptoms may be severe but investigations often do not demonstrate any abnormality.

Risk factors for serious injury

These include:

- Immediate onset of neck pain following the event.
- Age 65 years or older.
- Dangerous mechanism of injury (a fall greater than 1 metre) or a side impact collision.
- Unable to walk about or sit following the injury.

Neck movement examination

Do not examine neck movements until you have excluded:

- Features of a serious head or neck injury including:
 - An altered level of consciousness.
 - A focal neurological deficit or paraesthesia in the extremities.
 - Midline cervical tenderness.

For all patients presenting with acute whiplash injury^[1]

- Exclude spinal cord compression; if this is suspected, admit immediately.
- If a fracture or subluxation of the cervical vertebrae is suspected, refer immediately to an Accident and Emergency Department.
- Consider risk factors for severe trauma or skeletal injury, which include a history of neck surgery, and risk factors for osteoporosis (eg, premature menopause, use of systemic steroids), as minor trauma may fracture the spine in people with osteoporosis.
- Always consider and assess for other injuries, including head injury.
- Consider other serious causes of neck pain. See the separate **Neck pain (cervicalgia) and torticollis** article.
- Assess the presence of associated stress, anxiety, or depression and poor concentration; look for 'yellow flags' that indicate psychosocial barriers to recovery and that suggest that the acute injury could progress to become a chronic problem. Yellow flags that may indicate long-term chronicity and disability include:
 - A negative attitude that pain is harmful or potentially severely disabling.
 - Fear avoidance behaviour and reduced activity levels.
 - An expectation that passive rather than active treatment will be beneficial.
 - A tendency to depression, low morale and social withdrawal.
 - Social or financial problems.

Differential diagnosis

It is essential to consider serious injury in the immediate period following injury. Other possible causes of acute neck pain and stiffness include:

- [Spinal fracture.](#)
- [Cervical disc herniation.](#)

- [Subarachnoid haemorrhage](#) (may precede or occur at the time of a road traffic accident).
- [Meningitis](#) or meningism due to systemic infection.

It is also essential to consider other causes of symptoms – eg, a person in a road traffic accident may have severe chest pain due to restraint from the seatbelt; however, the possibility of [acute myocardial infarction](#), especially in the elderly, must be considered.

- If the neck symptoms persist then it is also very important to consider other causes of chronic neck pain, even though soft tissue 'whiplash' injuries may cause long-term symptoms.
- Other possible causes of persistent neck pain and stiffness include:
 - [Cervical spondylosis](#): this results from narrowing of the canal around the spinal cord, with or without the formation of bony osteophytes.
 - Tumours: [brain tumours](#), [bone tumours](#).

Investigations

The National Institute for Health and Care Excellence (NICE) recommends using an adapted version of the Canadian cervical spine rules that incorporates some aspects of the NEXUS rule to identify patients who need imaging of the cervical spine^[5].

Cervical spine X-rays

- A standard series of X-rays of the cervical spine consists of three views: anteroposterior, lateral and anteroposterior odontoid peg views.
- The lateral view must show the top of the T1 vertebral body; the odontoid peg view should show the lateral masses of the atlanto-axial articulation.
- In children aged <10, use anterior/posterior and lateral radiographs without an anterior/posterior peg view; use CT imaging to clarify abnormalities or uncertainties.

The following patients should have plain radiography (three views) of the cervical spine^[6]:

- Patients with neck pain or midline tenderness if aged ≥ 65 years, or any age if there was a dangerous mechanism of injury (see 'Risk factors for serious injury', above).
- Any patients where it is considered unsafe to assess movement. Safe assessment can be carried out if the patient:
 - Was involved in a simple rear-end motor vehicle collision.
 - Is comfortable in a sitting position in the emergency department.
 - Has been ambulatory at any time since injury with no midline cervical spine tenderness.
 - Has delayed onset of neck pain.
- Patients initially considered safe to have neck movement assessment still need cervical spine X-rays if on assessment they cannot actively rotate the neck 45° to the left and right.

Cervical spine CT scanning^[5] ^[6]

- CT scan is indicated immediately if:
 - The patient had a Glasgow Coma Scale < 13 on initial assessment.
 - The patient has been intubated, or is being scanned for multi-region trauma.
 - A definitive diagnosis of cervical spine injury is needed urgently for a patient (eg, before surgery).

- CT is also indicated:
 - If plain films are deemed inadequate, suspicious, or definitely abnormal.
 - If clinical suspicion of injury continues despite a normal radiograph.

CT is superior to plain radiography, with a reported sensitivity of 100% and specificity of 99%.

Cervical spine MRI scanning

- The technique depicts soft tissue structures well, with reported sensitivities for intervertebral disc injury of 93%, posterior longitudinal ligament injury of 93% and interspinous ligament injury of 100%^[5].
- MRI is indicated for patients with neurological signs, even if plain films are negative.
- MRI has a role in the assessment of ligamentous and disc injuries suggested by X-ray, CT or clinical findings^[6].
- MRI can distinguish haematoma from oedema, which can have prognostic importance.

CT myelography

This is indicated if MRI is not available, the patient cannot tolerate MRI or MRI is contra-indicated.

Management

For serious neck injuries, see also the separate [Spinal Cord Compression](#) article.

Provide the following advice and reassurance for the majority of patients who have not suffered a severe injury^[1]:

- Reassurance that whiplash-associated disorder is usually benign and self-limiting.

- Encouragement of early return to usual activities and early mobilisation. Explain that usual activities may initially be painful but this is not harmful and not indicative of ongoing damage.
- Discouragement of rest, immobilisation and the use of soft collars.

For patients with acute whiplash, there has been a trend towards active treatments to reduce pain and stiffness but the evidence remains conflicting. There is insufficient evidence to indicate the most effective treatments for patients with whiplash-related problems that have lasted for longer than six months^[7]. A Cochrane review found^[8]:

- Moderate evidence for the benefit of intravenous methylprednisolone given within 8 hours of acute whiplash.
- Lidocaine injection into myofascial trigger points appeared effective (in 2 trials).
- Moderate evidence that Botulinum toxin A is not superior to saline injection for chronic MND.
- Muscle relaxants, analgesics and NSAIDs had limited evidence and unclear benefits.

However, the following are considered to be appropriate management:

- Recovery and return to full function is best aided by sympathy and encouraging the patient to take an active role in dealing with the symptoms.
- Provision of adequate analgesia.
- There is now good evidence that the use of collars in whiplash injury does not shorten neck pain in the 1st 2 weeks, and prolongs the recovery of the patient. Patients should be advised about neck mobilisation and encouraged to remain as active as possible^[9].
- Exercises:
 - Patients should receive instruction about exercises.
 - Specific strengthening exercises of the neck, scapulothoracic region and shoulder are beneficial for chronic neck pain and chronic cervicogenic headache^[10].

- Physiotherapy:
 - A study comparing education by GPs compared to physiotherapists found no significant differences in overall outcome; treatments by GPs and physiotherapists were of similar effectiveness^[11]:
 - The long-term effects of GP care seemed to be better compared to physiotherapy – for functional recovery, coping and physical functioning.
 - Physiotherapy was found to be more effective than GP care on cervical range of motion at short-term follow-up.
 - Patients with particularly severe symptoms or symptoms that are not resolving may benefit from referral to physiotherapy but physiotherapy treatment is most effective if started soon after the injury occurs.
- Manipulation and mobilisation^[12]:
 - Manipulation and mobilisation have been shown to have benefits for MND with or without headache.
 - Although support can be found for use of thoracic manipulation versus control for neck pain, function and quality of life, results for cervical manipulation and mobilisation versus control are few and diverse.
 - Findings suggest that manipulation and mobilisation present similar results for every outcome at immediate/short/intermediate-term follow-up.
 - Multiple cervical manipulation sessions may provide better pain relief and functional improvement than certain medications at immediate/intermediate/long-term follow-up.
 - There is a risk of very rare but serious adverse events for manipulation – eg, arterial dissection, myelopathy, vertebral disc extrusion and epidural haematoma^[13].
- Evidence suggests that acupuncture has only a small benefit for patients with chronic neck pain^[14].

When 'yellow flags' (indicators of psychosocial barriers to recovery) are identified, early intervention is important and may include^[1]:

- Simple education and reassurance to correct erroneous beliefs.
- Referral for a short course of cognitive behavioural therapy.
- Referral to a psychologist or pain clinic.

Surgery may be required for a fracture or spinal cord injury. See also the [Spinal Cord Compression](#) article.

Complications

- May cause variable difficulties and restrictions with employment, leisure activities and domestic and personal care.
- This may lead to financial as well as psychological difficulties.

Prognosis

- The prognosis of whiplash injury is variable and obviously depends on the severity and grade of the whiplash injury.
- There is great debate as to the expected prognosis which is only further confused by possible influence of compensation-seeking behaviour.
- Many studies have only included small numbers of affected people and have had basic flaws with study design, only serving to increase debate.
- A review found that of all patients experiencing a whiplash injury as a result of a road traffic accident, over 66% make a full recovery and 2% are permanently disabled^[2].

Some studies have shown that the strongest prognostic indicators are factors that are present before impact. Lankester et al found that the factors that showed significant association with poor outcome on both physical and psychological outcome scales were pre-injury back pain, high frequency of GP attendance, evidence of pre-injury depression or anxiety symptoms, front position in the vehicle and pain radiating away from the neck after injury^[15].

Prevention

- Prevention of accidents: personal responsibility when driving, safe roads, avoiding alcohol before driving.
- Headrests which are properly fitted play a major role in preventing or reducing the severity of whiplash injuries.
- Laser-initiated braking systems can prevent collisions; intelligent seat design can halve the rate of neck injury if an accident occurs [2].
- Prevention of sports injuries, particularly contact sports.
- Prevention of falls in the elderly.

Further reading

- [Sarrami P, Armstrong E, Naylor JM, et al](#); Factors predicting outcome in whiplash injury: a systematic meta-review of prognostic factors. *J Orthop Traumatol*. 2017 Mar;18(1):9-16. doi: 10.1007/s10195-016-0431-x. Epub 2016 Oct 13.
- [Nikles J, Yelland M, Bayram C, et al](#); Management of Whiplash Associated Disorders in Australian general practice. *BMC Musculoskelet Disord*. 2017 Dec 29;18(1):551. doi: 10.1186/s12891-017-1899-0.

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Last updated by: Dr Colin Tidy, MRCP 17/02/2021	
Peer reviewed by: Dr Laurence Knott 17/02/2021	Next review date: 16/02/2026

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