



Workplace Safety and Insurance  
Appeals Tribunal

Tribunal d'appel de la sécurité professionnelle  
et de l'assurance contre les accidents du travail

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# Neck and Arm Pain and Related Symptoms: Cervical Spine Disorders

Discussion paper prepared for

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This discussion paper was first published in 2002  
by the late Dr. J.F.R. Fleming, Professor Emeritus,  
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appraisal influences outcomes. He has collaborated with ICES on population based studies on metastatic disease and degenerative spinal conditions.

His clinical areas of interest are spinal trauma, metastatic disease to the spine and degenerative spinal conditions.

This medical discussion paper will be useful to those seeking general information about the medical issue involved. It is intended to provide a broad and general overview of a medical topic that is frequently considered in Tribunal appeals.

Each medical discussion paper is written by a recognized expert in the field, who has been recommended by the Tribunal's medical counsellors. Each author is asked to present a balanced view of the current medical knowledge on the topic. Discussion papers are not peer reviewed. They are written to be understood by lay individuals.

Discussion papers do not necessarily represent the views of the Tribunal. A vice-chair or panel may consider and rely on the medical information provided in the discussion paper, but the Tribunal is not bound by an opinion expressed in a discussion paper in any particular case.

Every Tribunal decision must be based on the facts of the particular appeal. Tribunal adjudicators recognize that it is always open to the parties to an appeal to rely on or to distinguish a medical discussion paper, and to challenge it with alternative evidence : see *Kamara v. Ontario (Workplace Safety and Insurance Appeals Tribunal)* [2009] O.J. No. 2080 (Ont Div Court). For more information about these papers, please consult the *WSIAT Guide to Medical Information and Medical Assessors*.

## Anatomical Considerations:

### i. Boney Anatomy

The cervical spine consists of 7 vertebrae however the upper cervical spine (Occiput to C2), is functionally different than the lower cervical spine, (C3 to C7). The upper cervical region is highly specialized to provide a large range of motion between the head and the torso. Approximately 50 percent of all motion occurs between the occiput and C2. Occiput to C1 is primarily for flexion/extension and between C1 and C2 for lateral rotation. The primary stabilizers in the upper cervical spine are the ligaments while stability in the lower cervical spine is more dependent on boney articulations involving the facet joints with their capsules posteriorly and the uncovertebral joints anteriorly on each side of the vertebral body.

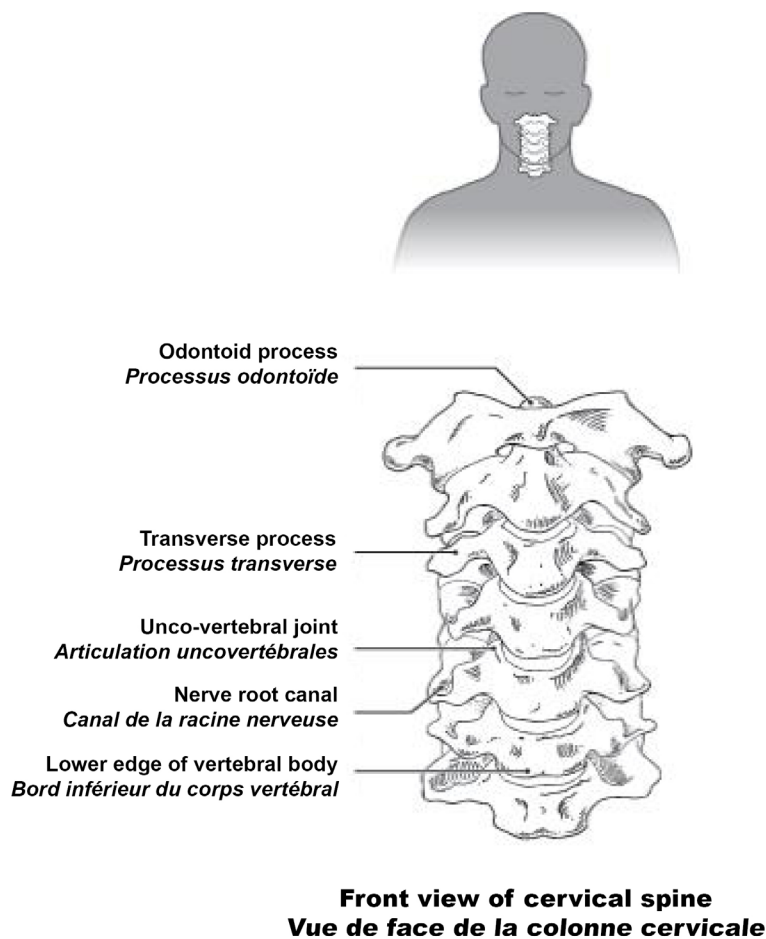


Figure 1: Front view of cervical spine

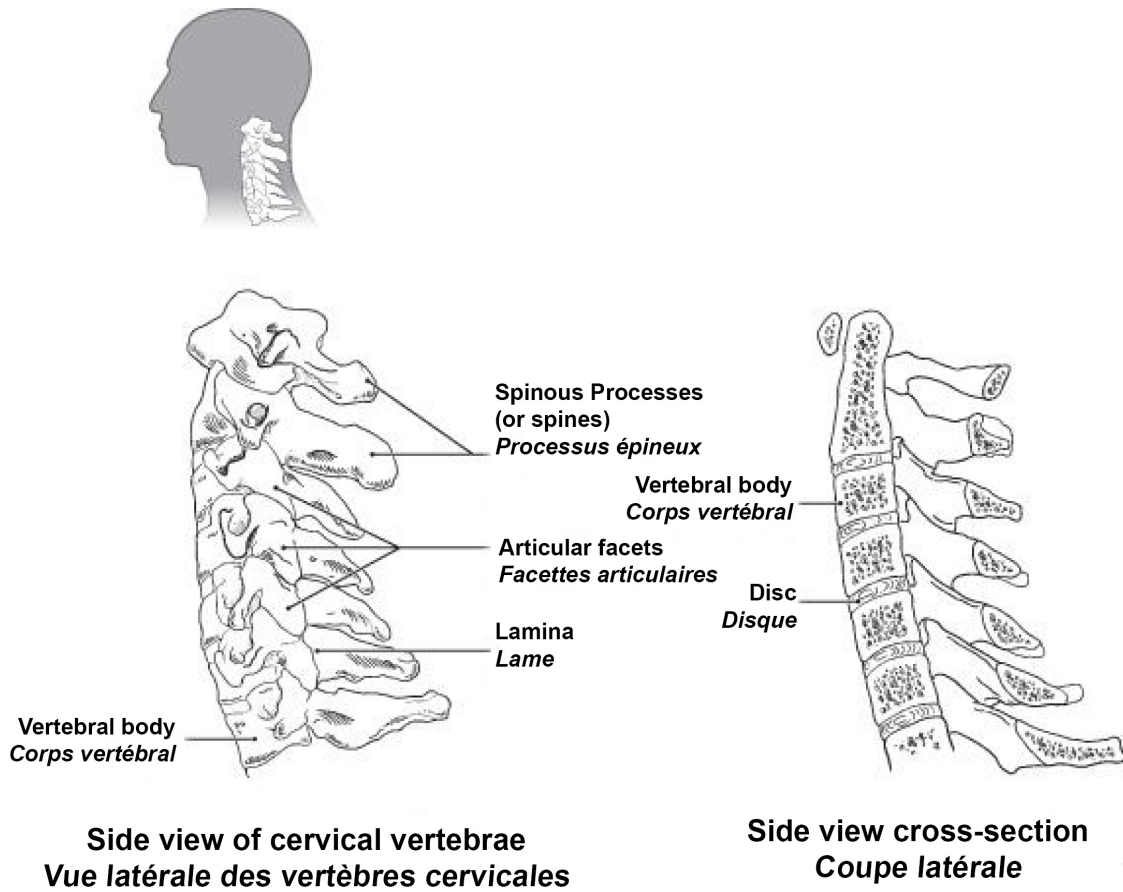
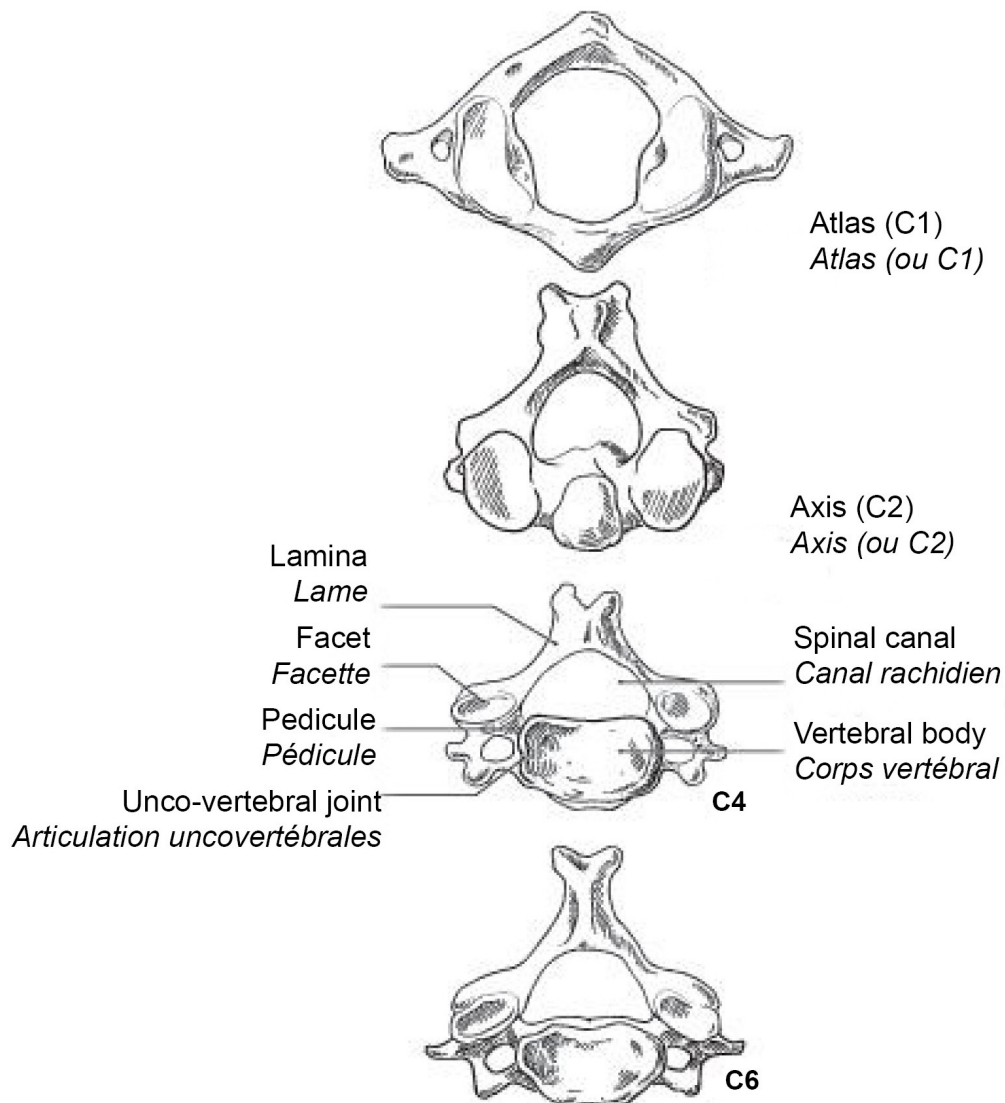


Figure 2: Side view of cervical vertebrae with side view cross section



**Cervical vertebrae from above**  
**Vue supérieure de la vertèbre cervicale**

Figure 3: Cervical vertebrae from above

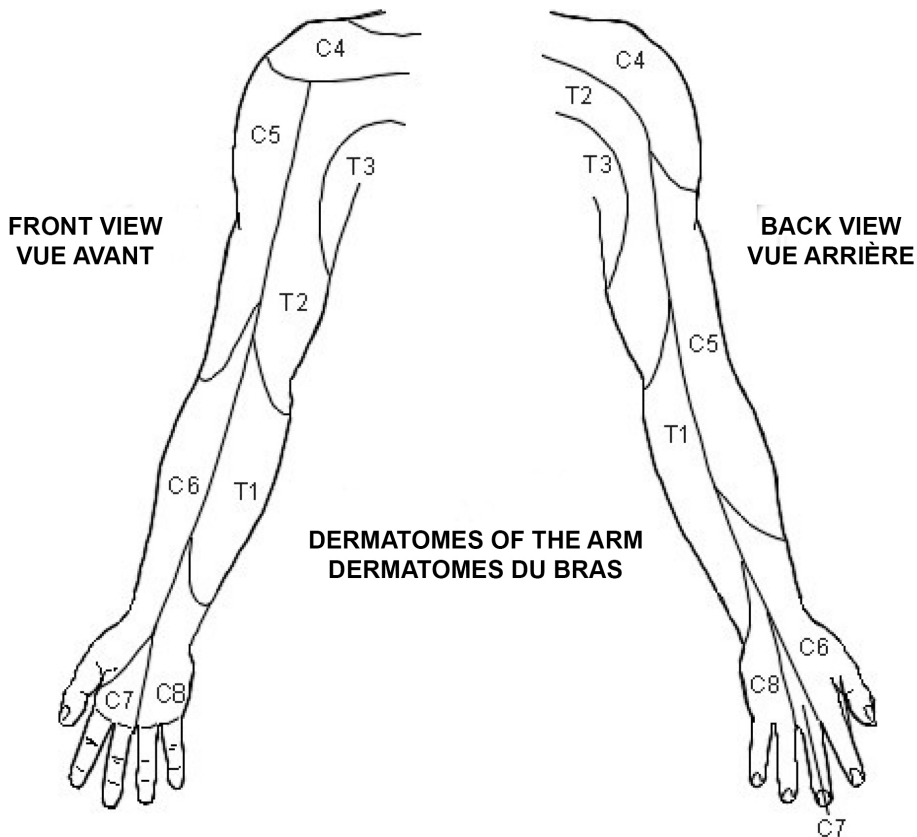
ii. **Discs and Nerves:**

The upper cervical spine has no discs while intervertebral discs are present in the lower cervical spine. These discs consist of an outer fibrous membrane called the “annulus fibrosus” and a semisolid core “nucleus pulposus” in its centre. The intervertebral disc is able to transmit compressive loads throughout a range of motion and prevent excessive stress concentration from occurring.

Herniations of the cervical nucleus pulposus tend to occur posterolaterally where the rate of curvature of the annulus fibrosus is the greatest. This leads to stress concentration and fiber breakdown which weaken the annulus. It is at this site at which the nerve root is most closely approximated and can create a clinical problem of cervical radiculopathy from either disc herniation or osteophyte formation

Radiculopathy is characterized by motor and/or sensory changes in the neck and arms, which results from extrinsic pressure on the nerve root. True radicular pain follows dermatomal patterns and is unilateral. This point is critical to recognize by the clinician as symptoms that are reported in a vague nonspecific pattern of distribution in the arm is not radicular and hence not emanating from the cervical spine. It is important to rule out other causes of nerve compression such as brachial plexopathy, thoracic outlet syndrome, peripheral compressive neuropathies i.e. carpal tunnel syndrome or neurologic conditions such as diabetic neuropathy.

Pain that originates in the shoulder from an intrinsic shoulder problem may also be described as arm pain and neck pain. These other diagnoses will be discussed later.



**Figure 4. Dermatomes of the upper extremities**

At each vertebral level a pair of spinal nerves (right and left “nerve roots”) exits from the spinal column through openings called foramina; these nerves supply sensation to the skin and power to the muscles of the arms and hands in defined patterns of innervation as depicted in Figure 4. The C1 nerve roots exit between the occiput and C1 vertebra, C2 nerve roots exit between the C2 and C3 vertebra; this pattern carries down to the C7 nerve roots which exits between the C6 and C7 vertebra. The C8 nerve roots exit between the C7 and T1 vertebra. The spinal cord itself carries the motor and sensory nerve pathways to the trunk and legs, including nerves that control bowel, bladder and sexual function. The spinal cord and nerve roots are enclosed in a tough membrane called the dura, inside of which is a flimsy membrane called the arachnoid, containing the clear colourless spinal fluid which bathes the spinal cord and nerves.

### iii. Muscle anatomy

Large strong muscles run the length of the cervical spine, in front, beside and behind the vertebral column, maintaining and controlling head position and neck movement. Muscle bulk in the back of the spine is more massive than in the front. This is related to the position of the head which is anterior to the center of gravity of the spinal column and thus requiring a larger lever arm to maintain the upright or neutral position of the head. The posterior musculature requires a constant degree of tonicity or contraction to counteract the effect of gravity on the head, and is the most significant group of muscles when considering soft tissue cervical spine injury.

The posterior muscles of the cervical spine can be divided into superficial, middle and deep layers. The most superficial of the cervical muscles are muscles of the shoulder girdle - upper trapezius, rhomboids and the levator scapulae. The middle layer is the splenius capitis and cervicis. The deep layer is collectively known as the erector spinae muscles which are made up from medial to lateral of the spinalis and semispinalis capitis and colli, longissimus capitis and colli.

The interconnection between the shoulder and cervical spine musculature helps explain why neck and shoulder pain complaints are often described together by the patient. Special tests for the shoulder are needed to exclude an intrinsic shoulder injury and confirm that the patient’s pain report is due to a cervical spine cause.

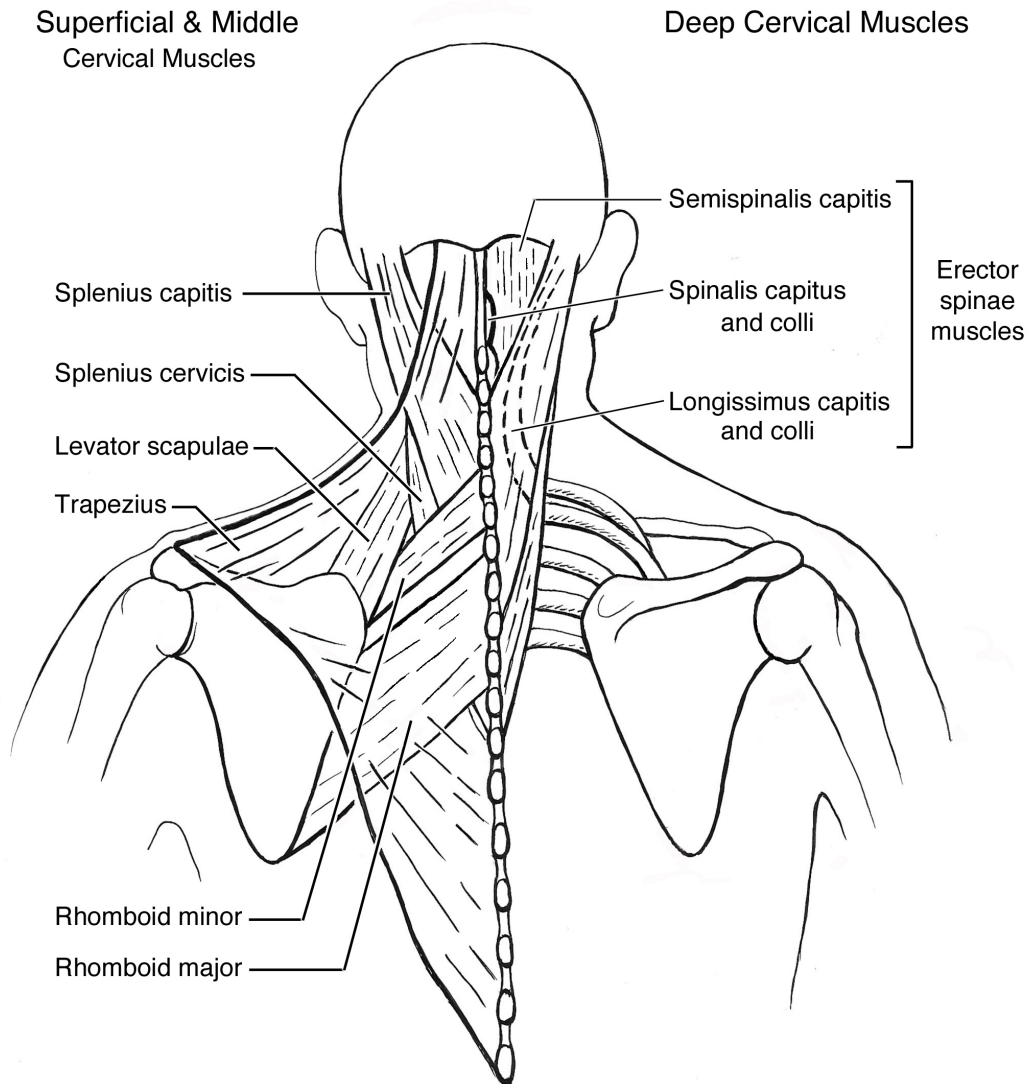


Figure 5. View of dorsal cervical spine demonstrating paraspinal musculature

## Degenerative or Aging Changes

Progressive degenerative changes (aging changes) occur in the cervical spine of all adults. The nucleus portion of the discs gradually dry out and become thinner, allowing the adjacent vertebrae to become closer together. As a result, the annulus portion of the discs tends to “bulge”. Because the vertebral bodies come to lie closer together, there is increased wear and tear on the joints of the vertebral column, especially the unco-vertebral joints, the facet joints and disc margins, resulting in the gradual formation of bony overgrowths (“spurs”, “osteophytes”, “osteoarthritis”, “bone hypertrophy” - all synonyms in this context) at the disc margins, at the unco-vertebral joints and at the facet joints. This process is the normal aging process, and it begins in middle life. It is



sometimes called “spondylosis”, and is present to a greater or lesser degree in all adults. The vast majority of individuals with these aging changes, even though the changes are quite advanced, are free of pain or any other symptoms. Various aging or degenerative changes such as bulging, degenerated or protruding discs, bony spurs or overgrowths, and facet joint hypertrophy are seen in X-rays, CT scans or MR scans of the cervical spine in over half the adult population. (Okada et al. 2009)

Another common radiographic finding is straightening of the cervical spine or loss of cervical lordosis. This may be due to neck pain and spasm but is commonly seen in normal individuals. Muscle spasm is determined clinically by tenderness, increased tonicity in the muscles of the neck and decreased mobility. In this context, the x-ray may show cervical straightening. In the normal population almost half of all adults with no neck pain or any injury demonstrate straightening of the cervical spine on plain x-rays. This can also be a manifestation of disc degeneration and can cause the head to tilt forward. The posterior muscles have to work harder to maintain the head upright and can be more prone to fatigue and pain with prolonged forward neck posturing. The radiological interpretation of cervical straightening is in itself not a sign of injury.

## Progression in Cervical Spondylosis

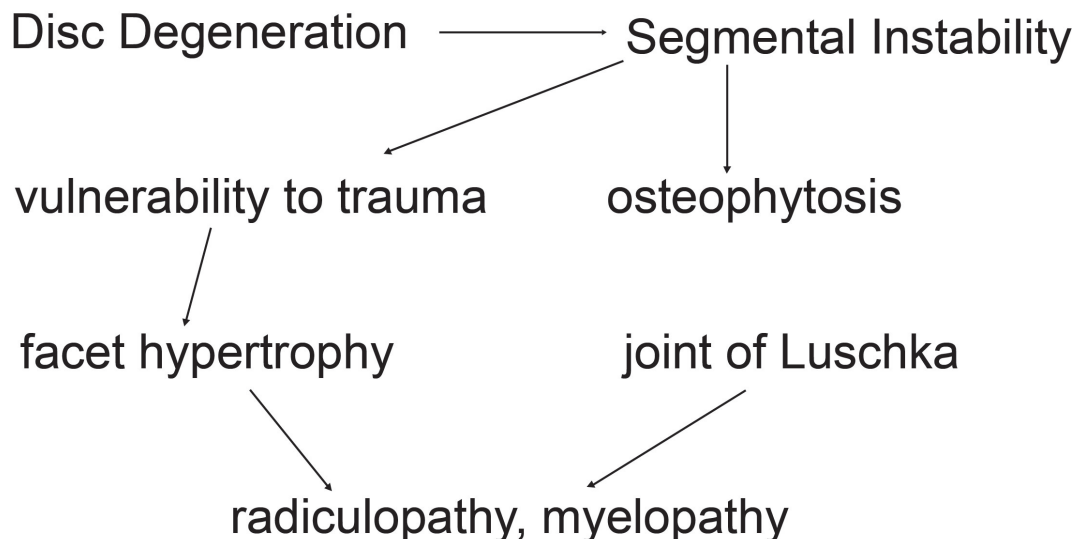


Figure 6. Pathomechanism of degeneration

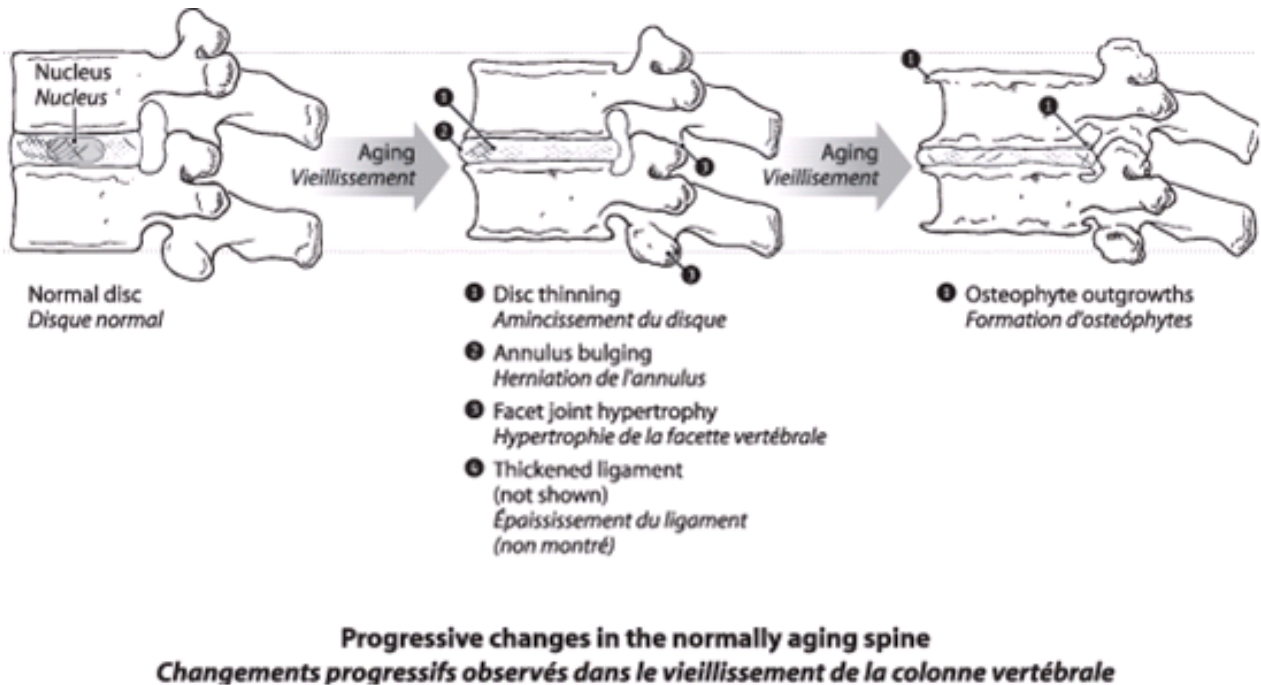


Figure 7. Natural history of cervical spondylosis

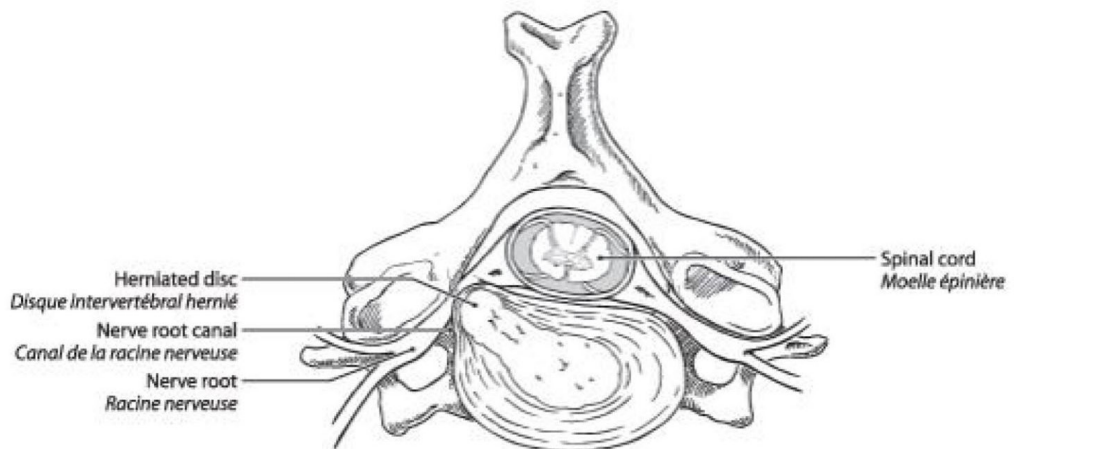
## Cervical nerve root pain

When a cervical nerve root is severely irritated or compressed, this can cause pain, numbness or weakness down the arm and into the forearm and hand. The specific nerve root affected can be determined by the affected dermatomal distribution of the symptoms. There may also be pain around the shoulder blades. Symptoms can be aggravated by neck movement or use of the arm.

A nerve root may be irritated or compressed by: (a) bone spurs or osteophytes growing into the exit foramen or canal through which the nerve travels, or (b) bulging of the part of the disc that lies in front of the nerve (the most lateral portion of the disc, not the central portion), or (c) rupture or herniation of a piece of disc (nucleus pulposus) through the outer portion of the disc (annulus) into the nerve canal, or (d) fracture and/or dislocation injury causing bone fragments to narrow and/or impinge on the nerve canal (rare). In (a) (b) and (c), the irritation and compression are most commonly due to the consequences of the aging process or age related degenerative change. A traumatic incident can cause a radicular type pain on a vulnerable site in the neck where there is advanced degenerative changes. This would be experienced by a relatively

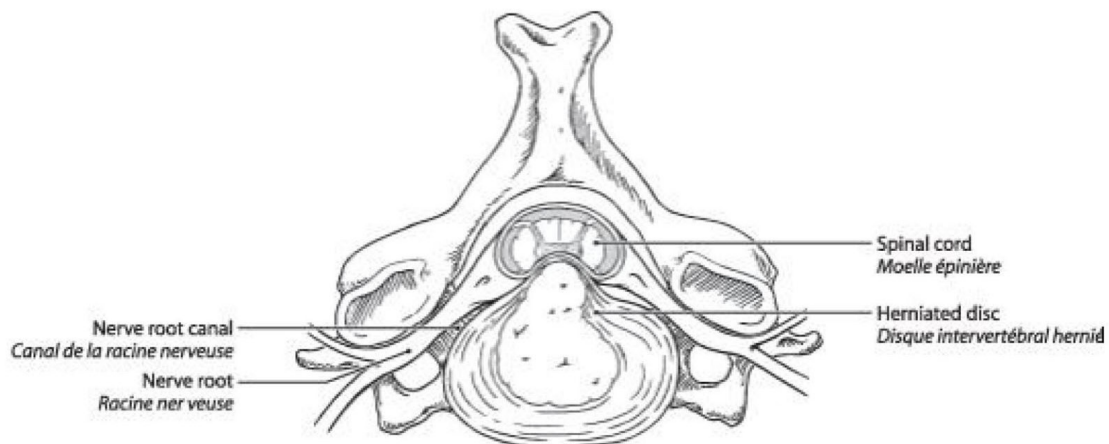
immediate, (within the first 48 hours), onset of radicular symptoms. The vast majority of these patients recover from incidents with time and therapy. Only a small percentage of patients with nerve root pain fail to recover, and require surgery.

**Cross-sections of the cervical spine at the level of a herniated disc**  
*Coupes de la colonne cervicale au niveau d'un disque intervertébral hernié*



A laterally located ruptured nucleus pulposus compressing the nerve root in its canal.

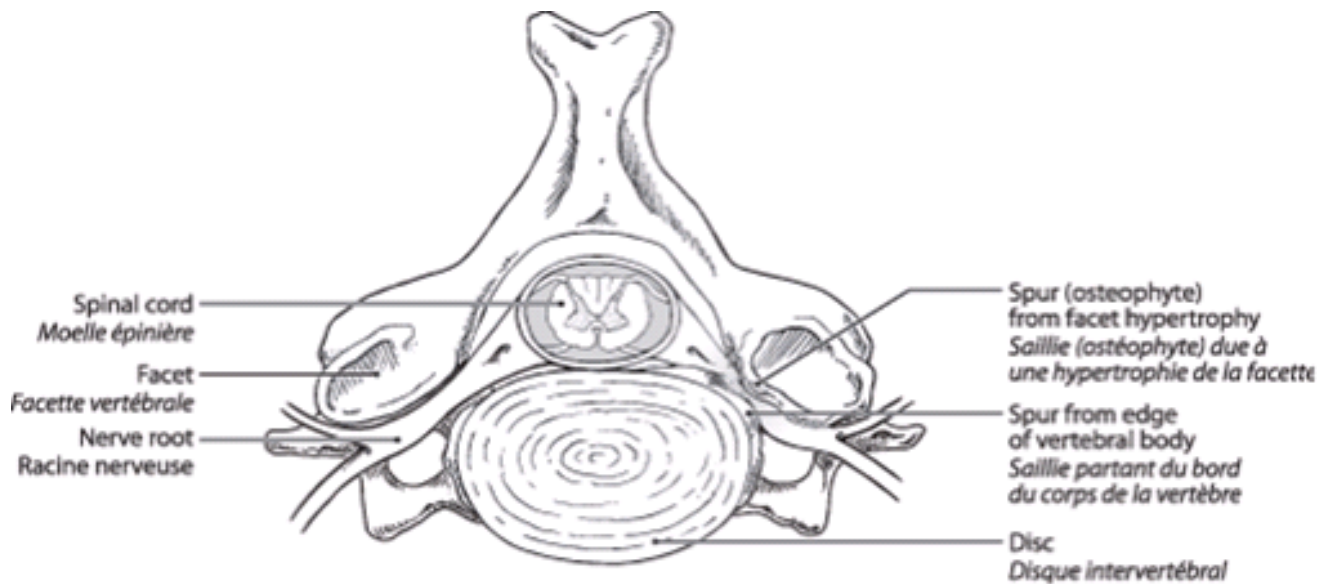
*Hernie discale latérale du noyau gélatineux comprimant la racine nerveuse dans son canal.*



A midline ruptured nucleus pulposus pressing on the spinal cord, but sparing the nerve root.

*Hernie discale médiane du noyau gélatineux comprimant la moelle épinière sans toucher la racine nerveuse.*

Figure 8. Cervical disc herniation causing root (above) and cord compression (below)



**Cross-section of the cervical spine showing compression of the nerve root due to the narrowing of the nerve root canal by osteophyte outgrowths**  
***Coupe de la moelle épinière montrant une compression de la racine nerveuse due au rétrécissement du canal de la racine nerveuse par des ostéophytes***

Figure 9. Degenerative changes causing neuroforaminal stenosis

### Differential Diagnosis for Cervical Radiculopathy:

There are a number of conditions with shoulder, arm and neck pain, weakness of arm and/or hand muscles, and/or numbness of the arm or hand, that must be differentiated from cervical disc and nerve root problems.

- i. **Thoracic outlet syndrome (TOS)** is a condition in which the nerves after exiting the spine through the foramina combine to form the brachial plexus and can become compressed dynamically by muscles, ligaments or an abnormal cervical rib on the T1 vertebra causing arm and hand discomfort. Occasionally, symptoms can occur from poor posture. Exercise to elevate the shoulder girdle can relieve the symptoms to the hands.
- ii. **Brachial Plexopathy** can occur from a traction injury to the arm whereby the trunks or divisions of the brachial plexus are injured. This is differentiated from cervical nerve root radiculopathy as there is global weakness in the arm and shoulder girdle. Nerve conduction studies can help differentiate brachial plexus from cervical nerve root pathologies.
- iii. **Peripheral nerves** in the arm or hand may be entrapped or inflamed, giving rise to forearm and hand pain and numbness. Examples are entrapped median nerve at the

wrist (carpal tunnel syndrome), entrapped ulnar nerve at the elbow (cubital tunnel syndrome), and peripheral neuropathy of these nerves due to diabetes.

- iv. **Tumours or infections** affecting the spinal column or the apex of the lung (Pancoast tumour), although rare, must also be considered in the differential diagnosis of a patient who complains of persisting neck or arm pain, weakness and/or numbness. The fact that a patient with these complaints may have had a neck injury does not rule out the existence of a spinal tumour or infection as the cause of the symptoms. Therefore, all patients with persisting neck and arm pain, with or without weakness or numbness, require a thorough clinical history, physical examination and appropriate imaging.
- v. **Shoulder joint pain.** Pain from a degenerated or injured shoulder joint often mimics and may be mistaken for nerve root pain. Shoulder pain can be felt over the top of the shoulder and over the deltoid muscle. Shoulder joint pain may cause pain inhibition when testing muscle strength and should not be confused with true neurologic weakness. With shoulder joint pathology, there would be no other neurological findings of numbness or reflex change.

The most common sources of shoulder pain are: 1) Rotator cuff tendonitis or tear; 2) Osteoarthritis of the glenohumeral joint, and 3) Acromioclavicular joint (AC Joint) arthritis. Pain from a diseased or injured shoulder joint can be distinguished from nerve root pain by provocative testing: Rotator cuff tendonitis creates pain with active shoulder abduction above 30 degrees and impingement testing is positive. Osteoarthritis of the shoulder will have pain with active and passive movement of the shoulder usually in all planes; there may be crepitus and limited range of motion. AC joint arthritis will have tenderness directly over the AC joint and pain with forced adduction and rotation of the shoulder.

### Neck pain:

Neck pain is usually muscular or ligamentous in origin, and is usually self-limited although it can be persistent. The natural processes of healing of areas of inflammation result in improvement in almost all cases. This can be from a few weeks or at most a few months. There is usually little if any correlation between neck pain and the degenerative changes so commonly seen on x-rays and scans. The role of the physician is to rule out other causes of neck pain. In the absence of physical findings, psychosocial factors may play a role and be barriers to recovery. Treatment must address factors such as depression, anxiety, fear, environmental, social and workplace stressors. (Matyselka et al 2010, Leroux 2006, Bot 2005)

Pain nerve endings, “posterior primary rami” are located in the various ligaments and muscles in the neck, as well as in the facet and unco-vertebral joints and the outer layer of the disc (annulus fibrosis). When these structures are irritated, strained or inflamed, pain can be referred upwards to the base of the occiput or to between the shoulder blades. This is referred pain which needs to be distinguished from radicular pain.

Referred pain is axial neck pain and generally occiput to C3 is referred to the base of the occiput while C4 to C7 is referred between the shoulder blades. Radicular pain is mediated by the nerve roots and is perceived in a specific dermatomal pattern in the arms as has been described above.

### **Soft Tissue Injuries:**

#### **i. Acute Sprain/Strain**

Soft tissue injuries can result from any sudden unexpected movement of the head such as the whiplash associated disorders. In the absence of any boney injury or objective sign of nerve compression, the natural history of this is for recovery in 8-12 weeks. A common type of soft tissue injury is the “whiplash associated disorder”. This occurs following rear impact motor vehicle accidents. These occur from sudden flexion/extension movements of the head following impact leading to soft tissue inflammation of the cervical spine. In the absence of any boney injury or consistent nerve compression, the natural history of this is similar to any soft tissue irritation or inflammation as described above with the normal healing time being 8-12 weeks. Malik et al 2004 found a preponderance of whiplash after relatively minor MVAs despite lack of objective clinical, radiological or a pathological mechanism in comparison with patients with multiple trauma from high velocity MVA with other injuries (ISS >16)\* where only 2/36 patients had neck pain at 8 weeks after accident. This suggests that other factors, such as psychosocial variables are important factors in determining the development of chronic neck pain.

WAD injuries are not unstable. Treatment should be active exercise with some pain relieving modalities as directed by a physiotherapist. It is very rare for such an injury to cause rupture or herniation of an intervertebral disc which results in compression of a nerve root causing nerve root pain.

#### **ii. Chronic Strain**

Muscles which are weak, deconditioned or injured can fatigue more easily and be a source of pain. This can lead to pain when the head is held in a static position for long periods of time. The posterior musculature is required to provide constant antigravity force to maintain head posture. Repetitive neck movements or prolonged awkward positioning of the neck in a workplace activity are usually well tolerated by most individuals, although they may be associated with muscular aches and pains

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\* ISS – Injury Severity Score is an anatomical scoring system that provides an overall score for patients with multiple injuries. Higher score indicates worse injury. (Baker et al. 1974)

exacerbated by weak or deconditioned muscles. Repetitive motions are not proven to cause degenerative disc disease (cervical spondylosis); additionally there is a lack of high level and consistent scientific evidence that it will worsen other non-compensable conditions.

Pain from muscle fatigue is generally self-limiting and responds to rest and strengthening through an active exercise therapy routine supervised by a physiotherapist; however barriers to recovery are not uncommon. Barriers can include fear, perception of significant injury, over-interpretation of incidental radiographic findings and non organic variables that can influence pain and recovery. It is incumbent upon the physician to rule out pathological processes and correctly identify anatomically inconsequential findings in order to minimize development of pain behaviours that can occur from soft tissue strain injuries of the neck.

The most common posture related neck strain is due to repeated extension of the neck or maintaining extension posture for prolonged periods of time. Advanced degenerative changes in the neck may make a patient more vulnerable to neck strain with neck extension.

### **iii. Torticollis**

Adult torticollis is a painful condition of the neck muscles which has also been referred to as cervical dystonia or spasmodic torticollis. The term “wryneck” has also been applied to this condition. Clinically, pain is present with the neck muscles locked into a sustained involuntary contraction (spasm) with the head held in a rotated and tilted position. The cause can be from minor trauma or strain/sprain injury. Another cause of torticollis is infection. A complete history is important to rule out this etiology.

Torticollis is generally acute and resolves within one week. Treatment is use of a collar, NSAIDs, rest and physiotherapy. If symptoms and signs persist longer, a functional CT scan should be performed with the head turned to the maximum contralateral rotation which can differentiate a “wryneck” (where normal motion is seen between C1 and C2) from atlantoaxial rotary fixation where there is no rotational movement between C1 and C2. In the latter condition, referral to a spine surgeon is indicated.

### **iv. Vertebrobasilar Insufficiency**

Occasionally, vertebrobasilar insufficiency causing dizziness can occur with advanced degenerative changes in the cervical spine and be initiated by repeated or prolonged cervical extension. In this disorder, dynamic compression of the vertebral arteries occurs from degenerative osteophytes. The affected person often has limited neck extension due to his preexisting degenerative spondylosis.

### Cervicogenic Headaches

Cervicogenic headaches are a complaint that is attributed to the cervical spine; these are a rare cause of chronic headache disorder. When headache is reported with neck pain, it is called cervicogenic headache.

The C2 and C3 nerves: greater and lesser occipital nerves innervate the back of the occiput to behind the ears. Occipital neuralgia is a sharp stabbing pain caused by injury or pinching of the 2<sup>nd</sup> or 3<sup>rd</sup> cervical nerve roots. Ache or pain from sore neck muscles from C1 to C3 may be felt towards the back of the head or to between the shoulder blades when the irritation is from C4 to C7. Patients with cervicogenic headache will often have altered neck posture or restricted cervical range of motion. There are no neurologic findings of cervical radiculopathy, though the patient might report scalp paresthesia or dysesthesia.

Diagnostic imaging such as radiography, magnetic resonance imaging (MRI), and computed tomography (CT) myelography are generally normal. Diagnostic anesthetic blockade for the evaluation of cervicogenic headache is unreliable as the precise pain generator and the appropriate facet joint or osseous or muscular structure is unknown.

Occipital neuralgia, mediated by C2 and 3 nerve roots, is an exception. Local injections may be helpful to alleviate this condition.

When a person who has neck pain complains of headaches, other causes of the headaches must be sought before attributing the headache to injured or strained neck structures. Post concussive headache should be ruled out by reviewing the history of the accident. Other causes of headaches are numerous and range from eye strain, sleep deprivation, migraine, elevated blood pressure and other causes.

### Spinal Canal Narrowing (Spinal Stenosis)

The spinal canal, through which the spinal cord travels, may become progressively narrow because degenerative or aging changes cause the discs and bony overgrowths to bulge into the spinal canal. If very severe spinal canal narrowing occurs, the spinal cord may be compressed, causing neurological symptoms. Abnormal functioning of the spinal cord is called “myelopathy”, and when it is due to aging changes or spondylosis, it is called “degenerative cervical myelopathy”. (The older term is “cervical spondylotic myelopathy”). Some individuals are born with an unusually narrow spinal canal (congenital spinal stenosis) which predisposes them to spinal cord compression as the normal aging changes progress. Degenerative cervical myelopathy is usually a painless process, and the symptoms, which are caused by interference of spinal cord function, include numbness, weakness and awkwardness of the hands and stiffness (spasticity) of the legs with progressive difficulty walking (numb, clumsy hands and stiff legs). Due to chronic compression of the spinal cord there can be an abnormal signal within the spinal cord on MRI.



### Boney Injuries to the Neck

The vast majority of workplace injuries to the neck are soft tissue in nature. Fractures of the cervical vertebrae can occur with more forceful or rapid mechanisms. Boney injuries with fractures or subluxations will be identified with x-ray. Fractures can be minor and considered stable. Other fractures are unstable and require immobilization and surgery. Instability is where the anatomical structures of the spine cannot resist normal physiological loads; i.e. gravity or flexion and extension of the neck. This can create injury to the nerves and the spinal cord.

Most fractures are minor and have the same clinical consequence as a soft tissue injury. These fractures include spinous process fractures (Clay Shoveler's Fracture), minor compression fractures and undisplaced lamina fractures. Osteophytes can also fracture from the endplate or anterior longitudinal ligament and again be of minimal clinical concern. Some of these fractures are incidental and may represent chronic degenerative changes. X-rays performed for neck pain of any cause may identify a "fracture" and clinical correlation is required to differentiate an incidental chronic degenerative change vs an acute fracture.

More severe fractures will lead to malalignment of the vertebrae, (subluxations) in the case of facet fractures. Fractures that occur from axial loading forces can create a burst type fracture that has a high association with spinal cord injury.

In any neck injury from a traumatic event the neck should be immobilized and evaluated to ensure no severe injury is present. If there has been sufficient tearing or rupture of some of the ligaments that support the cervical vertebrae, instability at the injured level of the spinal column may result. CT scan or MRI will determine if there is a boney or ligamentous injury. If these are normal, the stability of the neck is confirmed with "flexion-extension" x-rays of the neck. These are performed with the head flexed forward and then with the head extended backward. Flexion-extension x-rays may not be able to be performed acutely due to soft tissue pain with normal imaging. After one week these films should be performed with collar for comfort provided during that period. If instability is present, this requires surgical treatment. The usual outcome in such cases of instability, after treatment, is resolution of pain and other symptoms. A complete neurological examination is mandatory to ensure there is no spinal cord or nerve root injury. Specific fracture patterns are beyond the scope of this paper.

### How are neck injuries investigated?

The task of the physician is to integrate the patient's complaints and physical findings, together with appropriate imaging studies, into an accurate diagnosis. First and foremost is a history, noting the mechanism and forces of the injury, and the nature and location of the pain and other symptoms. This is followed by a physical examination, including palpation for tenderness in neck muscles, assessing the range of neck movements, examination of the shoulders, chest and head, and a neurological examination of the arms and legs. Follow-up history taking and physical examination will record the progress and hopefully the resolution of symptoms in the weeks (or months) following the injury.

Careful consideration of the reports of these early histories and examinations is probably the most important step when attempting to determine the underlying nature of the injury when evaluating an injured person a long time after the injury. For most soft tissue neck complaints, no imaging is necessary. In the absence of any traumatic event imaging will commonly show incidental age commensurate changes.

### Imaging Modalities:

- 1) **Cervical spine x-rays** are indicated to rule out a fracture, dislocation, or instability. Clinical decision rules have been developed to permit more selective ordering of cervical spine x-rays. The most commonly used is the Canadian C- Spine Rule which is based on three high risk criteria and five low risk criteria, and the ability of patients to rotate their necks (Stiell 2001).

# Canadian C-Spine Rule

For alert (GCS=15) and stable trauma patients where cervical spine injury is a concern

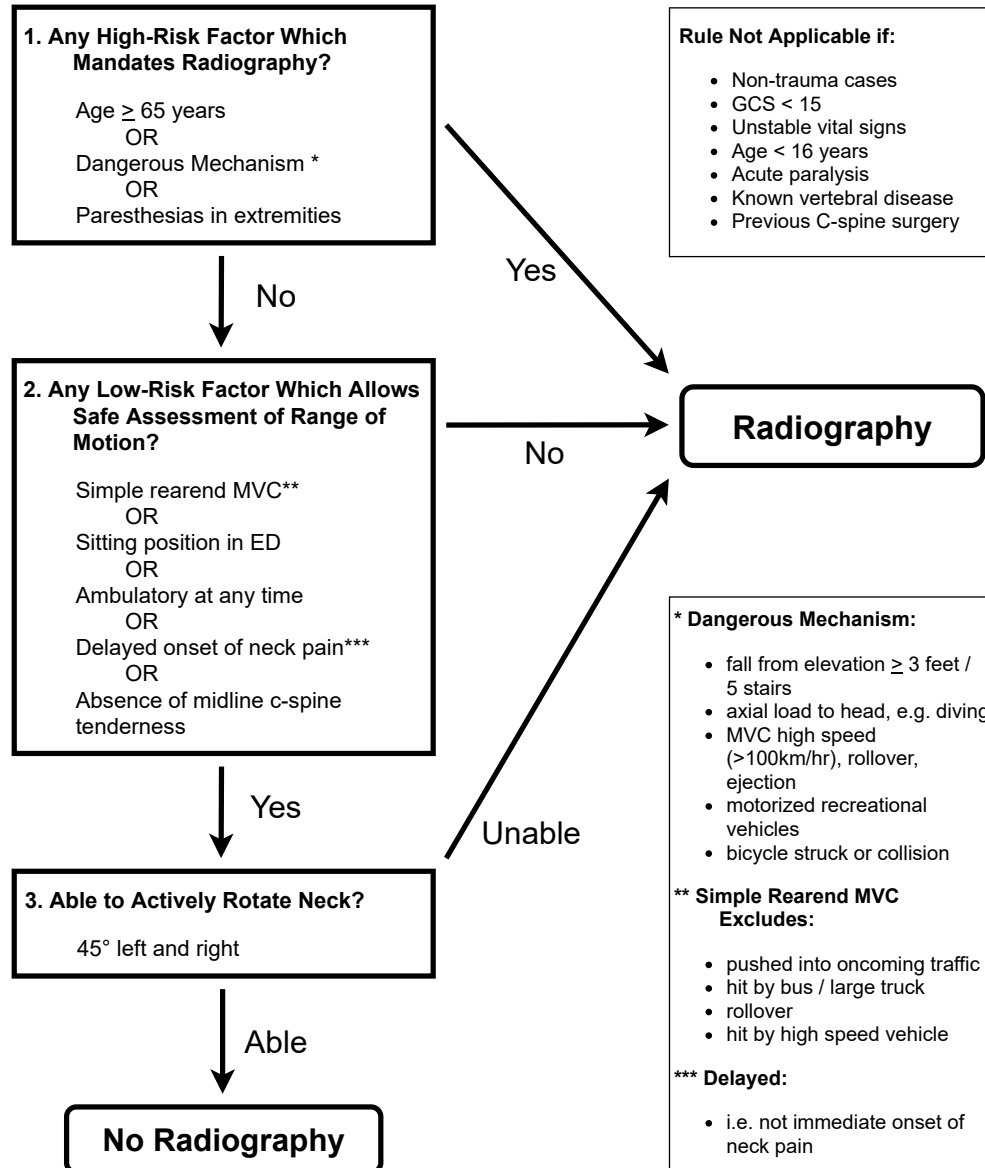


Figure 10: Canadian Cervical Spine Rule

The Canadian C- spine rule allows for a more standardized care of alert, stable trauma patients, to rapidly “clear” the cervical spine, and to be more selective in the use of cervical spine radiography without jeopardizing patient care. This CCR will further allow a physician to put any ordered imaging into proper context and not over diagnose the imaging results. Degenerative changes on x-rays right after the injury,

then were obviously present prior to the injury. Anterolisthesis (forward translation) of one vertebrae on the other is not uncommon and can be present normally up to 2 mm. X-rays taken with the neck in both flexion and extension will reveal whether instability is present.

- 2) **CT scan** of the cervical spine is valuable in assessing bone injury, such as fracture and/or dislocation. A herniated disc if present from a traumatic event can be detected and if the onset of symptoms is contemporaneous with the event and the dermatomal distribution is consistent with the imaging, then the disc can be considered acute. Bulging or herniated discs are commonly seen as incidental findings as are osteochondral bars and osteophytes. These “bone spurs” contribute to narrowing of the spinal canal and can create acquired spinal stenosis or cervical spondylitic myelopathy. A patient can have symptoms of radiculopathy or myelopathy on the basis of these findings without an injury or without neck pain. Surgery is indicated for an unresolving radiculopathy or with myelopathy.

CT Axial imaging is not indicated in the absence of trauma or in the absence of any hard objective neurological findings as again the sensitivity of these tests for clinically insignificant findings increases and will result in false positive diagnoses.

- 3) **Magnetic Resonance Imaging, (MRI)** of the cervical spine is the best method of imaging the spinal cord and nerve roots, the intervertebral discs, and the ligaments. However it must be remembered that 50% of all adults have “abnormalities” in MR scans of the cervical spine. In the population over 40 years old, the frequency of these abnormalities was found by Boden *et al* to be as follows: bony spurs (70%), narrow discs (57%), degenerated discs (57%), herniated discs (13%), bulging discs (19%), and foraminal stenosis (48%). These findings have been confirmed by numerous other investigators. Therefore abnormal MRI findings can only be considered to be significant if a *specific* abnormality in the scan exactly matches the *specific* symptoms and signs of the patient.

As an example, a patient complains of severe nerve root pain radiating all the way down the arm and forearm, numbness of the index and middle fingers, has a weak triceps muscle and absent triceps tendon reflex, with aggravation of the arm pain during neck extension. In this case, the clinical diagnosis is clearly a 7<sup>th</sup> cervical nerve root compression. The only MRI abnormality that would be of significance in this case would be the finding of a herniated disc pressing on the 7<sup>th</sup> cervical nerve root as it lies on the C 6-7 intervertebral disc or as it travels out its intervertebral foramen or canal. This same MRI finding would be of no significance in a patient whose only symptoms were vague diffuse neck pain. Thus MRI findings can only be of value when they are interpreted together with and in the light of the entire clinical picture, and exactly match the clinical findings.

- 4) **Cervical myelography** is no longer performed but for rare instances.
- 5) **Electrodiagnostic studies** (E.M.G. and nerve conduction velocities) are useful in evaluating weakness of hand and arm muscles, and can determine whether the weakness is due to abnormality or compression of a cervical nerve root, or to some other peripheral cause; (carpal tunnel syndrome, ulnar neuropathy).

### Issues:

#### Common Questions Related to Neck Symptoms

- 1) **Can a neck injury cause degenerative changes or premature aging in the cervical spine?**

This can be the case when there is a bony injury that involves the facet joint or endplate/disc junction. An injury to a disc or ligaments may be visible on MRI shortly after an injury, and will gradually heal. Localized bony overgrowth, hypertrophy and spurs at the site of injury may develop in a small percentage of individuals who have sustained a severe localized injury to the cervical spinal column; however, these “degenerative” localized bony changes take a long time (possibly a year or more) to develop. Thus, severe injury to ligaments and/or disc at a single vertebral level may result in delayed x-ray or scan evidence of localized degenerative changes at that level many months or years after the injury. If such bony changes are seen soon after the injury, they must have been present before the injury and were not caused by the injury.

Soft tissue injuries without any instability such as a whiplash associated disorder, (WAD) do not alter the natural aging progression of the cervical spine. Without any injury, everyone’s spine structurally will ‘age’ over time as evidenced by repeated radiographic imaging of the same individual over the years.

- 2) **Can aging changes cause neck pain?**

Aging change may or may not be the source of neck pain. Radiologic findings suggestive of aging changes include degeneration of discs, osteophytes, disc bulges/ disc herniation, and spinal stenosis. These radiographic findings may or may not be associated with symptoms. All these structural changes are recognized to occur with aging and do not usually imply trauma or work-related injury. It is important to note that there is no proportional relationship between the presence and severity of degenerative changes and the presence and severity of symptoms.

Overuse of x-rays can create confusion and misattribution of pain symptoms. There is a high false positive rate with any imaging as incidental age commensurate findings will be present in all individuals and clinical correlation is necessary. The Canadian C- Spine Rule is a clinical decision aid to guide the physician when x-rays are indicated in the acute setting. In more chronic complaints the use of MRI and CT scans will have greater sensitivity to incidental findings and again clinical correlation is necessary to determine what is a clinically significant finding vs what is not.

### 3) Does previous cervical spine surgery cause neck pain?

When surgery is performed for arm pain caused by nerve root compression, a fusion of the affected motion segment is required. It is common that there is neck pain present from the associated degenerative changes in addition to the arm pain. Surgery most reliably treats the arm pain; neck pain can be improved partially or fully.

In an individual who undergoes a cervical fusion, increased mechanical loads are placed on motion segments that remain above and below the fusion region. Over time, the individual may develop neck pain and possibly new onset arm pain as a result of the increased loads placed on adjacent motion segments. This has been called adjacent segment degeneration. The increased loads can result in more advanced degeneration that would have developed only through the natural course of aging.

### 4) What, if any, would be the indicators that would support a finding that a soft tissue injury has not resolved, i.e. that it has not behaved as expected – i.e. that the case that is the subject of the appeal is the rare case in which a permanent impairment has occurred from a strain injury?

The situation where a cervical soft tissue strain injury has not resolved based on the worker's subjective complaints where the expectation is for recovery can be summarized in "Observed vs Expected Mismatch".

Firstly, it is necessary to ensure there is no objectively based neurological or musculoskeletal impairment. This is determined by physical examination. Self limitation or non organic physical findings must be differentiated from true physiological limitation. The assessor often feels obligated to order imaging studies which would not necessarily have been indicated but for the requirement to "rule out" objective injury. The potential for false positive findings create further confusion and can create potential barriers to recovery as incidental findings are often misconstrued by the worker/patient as clinically significant. Patient education is necessary to ensure the worker has correct understanding about the significance or lack thereof, of the imaging results. It needs to be clarified that imaging findings must match objective examination results.

When the expected trajectory of outcome does not occur despite no objective or clinically significant imaging abnormality, an exploration of potential work, environmental and social stressors should be undertaken with the assistance of a social worker and psychologist to help resolve potential non organic concerns. In the absence of non organic physical findings and absence of environmental stressors, chronic neck pain from a strain injury can occasionally result from pre existing degenerative changes that have become symptomatic.

### **5) How is neck injury diagnosed?**

A neck injury is diagnosed based on a history which will include an identification of the mechanism of injury. This is generally a traumatic event such as a fall or sudden acceleration/deceleration force as occurs in a motor vehicle accident. An examination of the patient will look for findings of muscle tenderness and possibly spasm. An assessment of range of motion is performed which may be restricted initially due to muscle splinting. Neurological evaluation looks for objective evidence of motor weakness anatomically linked to specific nerve roots, reflex changes and numbness in a dermatomal nerve root distribution. Most injuries are soft tissue and imaging is of no value, except to rule out a boney injury if there is a suspicion of this. Canadian Cervical Spine Rule is a decision making tool to guide appropriate use of imaging in the acute injury context.

Imaging when performed needs to be evaluated in the context of incidental degenerative changes in the neck and not be over interpreted as injury findings. CT scan, MRI and EMG Nerve Conduction Studies are adjunctive tests that are indicated when a clinical suspicion of fracture or nerve root compression is present.

Prolonged static postures such as maintaining the head in a forward flexed position or with prolonged extension can lead to muscle strain which is not traumatic. It is self-limiting in the vast majority of individuals. Over treatment, or non efficacious treatment and immobilization can create barriers to recovery.

### **6) What is the relationship, if any, between any particular neck condition and any other specific mechanisms of injury?**

Spondylosis, particularly facet arthropathy changes can predispose to limitation in extension of the neck. Forced extension such as overhead work will cause pain. There is no direct causal link between repetitive activities and the onset of spondylosis. There is no proportional relationship between the presence and severity of degenerative changes and the presence and severity of symptoms.

Other conditions of the spine such as Ankylosing Spondylitis can predispose a patient to pain and a higher risk of fracture even with low impact mechanisms as the spine is more brittle in this condition.

**7) Can there be a delay in the onset of symptoms after neck injury? If so, to what extent?**

Muscle fatigue from prolonged postures may come on in a delayed fashion by a few hours to a day. This is a strained muscle and is generally self-limiting. This would be expected to resolve with anti-inflammatory medication and muscle conditioning exercises.

Neck pain presents acutely very shortly after a traumatic injury. In some patients who develop a radiculopathy (radiating arm pain arising from the nerves), from an acute disc herniation, the onset of arm/hand symptoms may be more gradual typically presenting within 2 weeks from the onset of injury. However, the onset of neck pain from the injury is also immediate in these individuals. Radiculopathies often resolve over a period of weeks to months. Surgery is reserved for cases that present with motor weakness, intractable pain or persistent numbness without resolution in the expected time period.

**8) Are there any particular ergonomic risk factors, e.g. awkward positioning, repetitiveness or particular force in work activities that would create an increased risk (i.e. be likely to be compatible with) gradual onset or other neck injuries? Can you please explain when and how spontaneous neck pain occurs that is not related to an injury, and that arises in the absence of an external injuring process?**

The posterior cervical musculature requires a constant degree of tonicity or contraction to counteract the effect of gravity on the head. Muscles which are weak, deconditioned or injured can fatigue more easily and be a source of pain. This is generally self-limited pain which responds to rest and strengthening; however barriers to recovery are not uncommon which can be due to misdiagnosis or fear perception of having a significant injury. Over interpretation of incidental radiographic findings and other non organic variables can influence pain and recovery. Ergonomically optimal head positions are ideal to prevent muscle fatigue. Cervical strain is generally not disabling and resolves with short periods of rest.

Repetitive hyperextension (looking skyward) with advanced spondylosis of the cervical spine may present with pain on rare occasions. This is not an injury but an example of tolerance limitations. This is in contradistinction to other joints such as the shoulder where repetitive overhead work is a risk factor for rotator cuff tendonitis.



**9) What type of frequency of activity would be considered repetitive in this context?**

A degenerative joint can be painful with one neck rotation. Repetitive movements of a muscle can lead to fatigue pain which would have a variable frequency before fatigue depending on the intrinsic condition of the muscle. A sudden onset pain from a force such as overextension or flexion can lead to strain and short term inflammation of the muscle. This is self-limiting and a short period of avoidance is indicated. Return to normal activities in 48-72 hours is the best treatment option as prolonged immobility leads to further deconditioning and potential for injury and pain.

**10) Can neck pain radiate to the shoulder, arm or hand? Under what circumstances would that occur? Can hand, arm or shoulder pain radiate to the neck? Are there ways to distinguish when the pain is due to a neck injury as distinct from another condition? What is myofascial vs neurogenic pain?**

The posterior muscles of the cervical spine can be divided into superficial, middle and deep layers. The most superficial of the cervical muscles are muscles of the shoulder girdle - upper trapezius, rhomboids and the levator scapulae. The middle layer is the splenius capitis and cervicis. The deep layer is collectively known as the erector spinae muscles which are made up from medial to lateral of the spinalis and semispinalis capitis and colli, longissimus capitis and colli.

The interconnection between the shoulder and cervical spine musculature helps explain why neck and shoulder pain complaints are often described together by the patient. Special tests for the shoulder are needed to exclude an intrinsic shoulder injury and confirm that the patient's pain report is due to a cervical spine cause.

Pain from a degenerated or injured shoulder joint often mimics and may be mistaken for nerve root pain, as the pain is often referred to the deltoid tubercle at the top of the arm. Cervical (non radicular) pain is most usually referred to the occiput and to the interscapular regions and is interchangeably called mechanical neck pain or myofascial pain.

Neurogenic pain is related to a nerve root and will be described in a specific dermatomal pattern, (skin mapping as described in Figure 4). Shoulder joint pain may inhibit the patient's willingness to contract the arm or hand muscles strongly when these muscles are being tested for strength, thus leading to the erroneous conclusion that there is true muscle weakness.

- 11) What is the relationship, if any, between any particular neck condition and cervicogenic headaches? What is a cervicogenic headache? What are its causes and clinical significance, if any? How does one distinguish between cervicogenic headaches and primary headache disorders?**

Ache or pain from sore neck muscles from C1 to C3 may be felt towards the back of the head. This is called cervicogenic headache. Patients with cervicogenic headache may have altered neck posture or restricted cervical range of motion. There are no neurologic findings of cervical radiculopathy, though the patient might report scalp paresthesia or dysesthesia called occipital neuralgia. This is mediated by C2 and C3 nerve roots. Ice and local injections may be helpful to alleviate this condition.

Diagnostic imaging such as radiography, magnetic resonance imaging (MRI), and computed tomography (CT) are generally normal. Muscle fatigue is a cause of sore neck muscles when the head is held in a static position for long periods of time. The posterior musculature is required to provide constant antigravity force to maintain the head posture optimally and can lead to pain in the neck and back of the head. When a person who has had a neck injury complains of headaches, other causes of headaches are numerous and range from eye strain, sleep deprivation, migraine, elevated blood pressure and other causes before attributing the headache to injured or strained neck structures.

- 12) If someone has sustained a neck injury, are there any particular restrictions in work activities that would be appropriate?**

In the absence of any fracture there are no restrictions. Soft tissue pain can be a cause of tolerance limitations. Certain activities may be an initiator of pain and these should be avoided for a short finite period of time. If a specific risk factor such as extreme loss of neck extension exists due to advanced spondylosis or with vertebrasilar insufficiency then overhead work should be eliminated.

Mandated medical restrictions (i.e. a physician suggests that this physical activity is not medically recommended) need to be individualized. In general, in the acute phase after neck injury, a brief period of rest, 1-2 days followed by a graduated physical activity regime is recommended. Patient functional tolerances may reflect what an individual may be able to perform physically and any restrictions need to take into account a patient's particular work related activities.

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