



Neck and Arm Pain and Related Symptoms: Cervical Disc Disease

Discussion paper prepared for

The Workplace Safety and Insurance Appeals Tribunal

Revised December 2002

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NECK AND ARM PAIN AND RELATED SYMPTOMS CERVICAL SPINE DISORDERS

The Cervical Spine

The cervical spine consists of 7 vertebrae, each shaped like a building block, separated from one another by shock absorbing pads called intervertebral discs which allow the spine to move freely. Each disc consists of a "nucleus pulposus" (of pulpy consistency) in its centre, surrounded and contained by the tough fibrous membrane called the "annulus fibrosis" which is attached circumferentially to the adjacent vertebral bodies. The cervical spinal column provides strong, flexible support of the head and protection of the spinal cord. It is in constant motion during the waking hours.

Attached to the back of each vertebral body, by two struts of bone called "pedicles", one on each side, is an arch of bone (lamina) that encloses a hollow space, much like a tube, that runs the length of the spine and contains the spinal cord and spinal nerves. 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. 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.

Each vertebra is connected to the vertebrae above and below by several strong ligaments as well as by the discs. Small "unco-vertebral" joints are located at the sides of each vertebral body, one on the right and one on the left, by which each vertebral body articulates with its neighbours. Right and left "facet" joints also support the spinal column, and each vertebra also articulates with its neighbours at the facet joints; they are located behind the vertebral bodies and lateral to the laminae.

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.

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 tend 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.

Pain

Neck pain. Pain nerve endings 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 is felt in the back of the neck, and may spread toward the shoulders *but not down the arms*, and is commonly felt between the shoulder blades ("referred pain").

Neck pain, which is a very common symptom in the general population, 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. In fact, the pain from serious neck injuries such as fractures, dislocations and most cervical spine surgery almost always resolves after 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.

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Cervical nerve root pain. In the relatively rare situation in which a cervical nerve root is severely irritated or compressed, there is severe sharp pain radiating all the way down the arm and into the forearm, aggravated by neck movement, with or without numbness and/or tingling in a portion of the hand, fingers or arm, with or without weakness of arm or hand muscles supplied by that nerve. There may also be pain around the shoulder blades. 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), a constant repair process is at work, and most symptoms subside over a period of time, usually a few weeks, almost regardless of treatment. Only a small percentage of patients with nerve root pain fail to recover, and require surgery.

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.

"Neuralgic amyotrophy" or "brachial plexitis" is a condition in which there is inflammation of the nerves in the brachial plexus in the neck, with severe neck and shoulder pain followed by paralysis of shoulder girdle and upper arm muscles, and spontaneous recovery over a period of months. There is no numbness or sensory change in the arm or hand.

Thoracic outlet syndrome (TOS) is an extremely rare condition in which the nerves in the neck above the collar bone (the brachial plexus), which are the continuation of the cervical nerve roots, are entrapped or squeezed by muscles, ligaments or abnormal bone, causing arm and hand discomfort. The very existence of TOS, except in very rare and very specific situations, is highly controversial. (Please see the discussion paper entitled *thoracic outlet syndrome*).

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.

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Tumours or infections affecting the spinal column, 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.

Shoulder joint pain. Pain from a degenerated or injured shoulder joint often mimics and may be mistaken for nerve root pain, as the pain often spreads well down the top of the arm. 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, possibly caused by impairment of a nerve root. Pain from a diseased or injured shoulder joint is easily distinguished from nerve root pain: shoulder joint pain is usually aggravated by elevating the arm, whereas the arm can be moved freely in the presence of a cervical nerve problem, but neck extension aggravates nerve root pain in the arm.

Headaches are rarely if ever caused by injury, strain or inflammation of cervical joints or ligaments. Ache or pain from sore neck muscles may be felt towards the back of the head. Such headaches may be secondary to abnormalities in the *upper* portion of the cervical spine, perhaps from C-1 down to about C-4 or C-5, but not the *lower* cervical spine. There is an extremely rare condition called occipital neuralgia in which episodic sharp stabbing pain occurs at the back of the head, on one side only, caused by injury or pinching of the 2nd or 3rd cervical nerve root. When a person who has had a neck injury complains of headaches, other causes of the headaches must be sought before attributing the headache to injured or strained neck structures.

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 "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. Cervical spondylotic 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). There is always an abnormal signal within the spinal cord on MRI.

Injuries to the Neck

Severe neck injuries, such as fractures and/or dislocations are beyond the scope of this paper.

Any sudden unexpected movement of the head may wrench or strain structures such as muscles or ligaments in the cervical spinal column, and these injuries will normally heal within a few weeks. It is very rare for such an injury to cause rupture or herniation of an intervertebral disc, with compression of a nerve root and nerve root pain. 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. Instability is detected when an abnormal amount of forward or backward movement, or slippage, of a vertebra in relation to its neighbor, is seen on "flexion-extension" x-rays of the neck taken with the head flexed forward and then with the head extended backward. Instability usually requires surgical treatment, although neck immobilization by a special collar or a "halo-vest" for a few weeks or months may be sufficient to allow spontaneous healing. The usual outcome in such cases of instability, after treatment, is resolution of pain and other symptoms.

Repetitive stress to the cervical spinal column may result from activities such as in carrying loads on the head (as in some societies), in football, or in high divers (such as in Acapulco). Although premature aging (degenerative) changes are seen in many of the spines of such individuals, pain or other symptoms are very uncommon. Repetitive stresses to the cervical spinal column also occur in individuals with neuro-degenerative disorders such as dystonia or torticollis, who suffer from repeated, sometimes quite violent, uncontrolled writhing and twisting movements of the neck, yet neck pain is remarkably uncommon in these individuals. 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 in some.

Can a neck injury cause degenerative changes or premature aging in the cervical spine? 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.

How Are Neck Injuries Diagnosed?

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 contemporaneous carefully history taking, noting the mechanism and forces of the injury, and the nature and location of the pain and other symptoms, and a contemporaneous physical examination, including palpation for tenderness in neck muscles or spines, the range of neck movements, examination of the shoulders, chest and head, and a neurological examination of the arms and legs. Often, this is all that is needed. 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.

Cervical spine x-rays are commonly taken after a neck injury in order to rule out a fracture or dislocation, or instability. If the x-rays show degenerative changes right after the injury, then they were obviously present prior to the injury. X-rays taken with the neck in both flexion and extension will reveal whether instability is present. Cervical spine x-rays may reveal congenital narrowing of the cervical spinal canal when present.

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CT scan of the cervical spine is valuable in assessing bone injury, such as fracture and/or dislocation. Bulging or herniated discs may or not be visible on CT scan, and if so, may or may not have been caused by the injury (i.e. may predate the injury) and may or may not be related to the patient's symptoms. CT scan is most useful in showing bone structures, and is not as good as MRI in showing spinal cord, nerve roots or discs. CT scan does not show torn ligaments or minor tears of discs.

MR scanning (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, a 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 7th 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 7th 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.

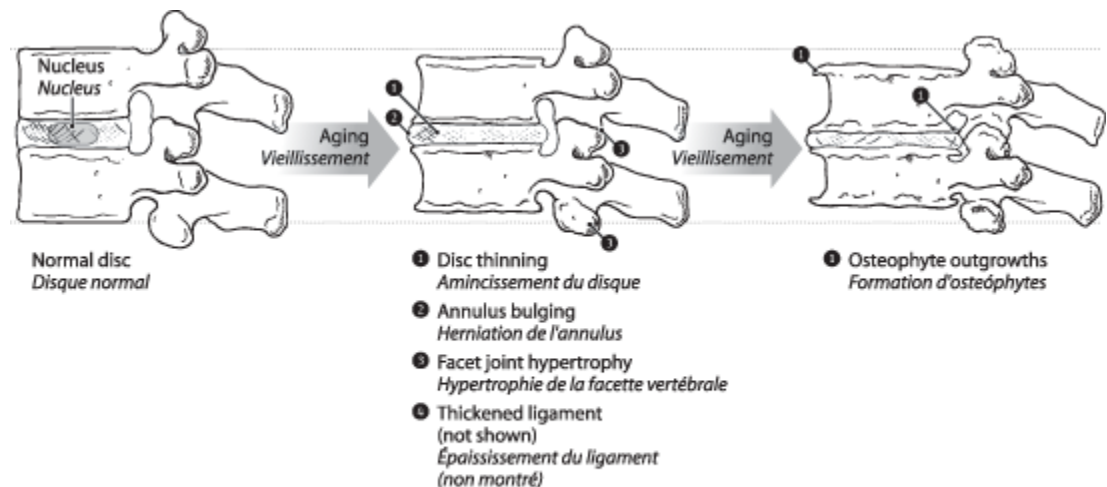
Cervical myelography consists of neck x-rays taken after the injection of radio-opaque contrast material into the spinal fluid via a lumbar puncture, and is followed by post-myelogram CT scan of the cervical spine (myelo-CT). It may provide useful images of the interior of the spinal canal, and can reveal indentations of the spinal fluid sac caused by bulging or herniated discs or bone spurs that might be pressing on the spinal cord or nerves. It is of no value in establishing the diagnosis when the only symptom is neck pain. Its only potential use is in seeking the cause of nerve root compression or spinal cord impairment. Myelography is used less and less today, as MRI has become more readily available. MRI provides superior images of the spinal cord, nerve roots and discs. Any abnormal findings on a myelogram and myelo-CT must be interpreted with the same caution as with MRI; they

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may be of no significance, they may not be the cause of the patient's symptoms, and they may be unrelated to any injury the patient may have suffered. The myelographic findings, like the MRI findings, must be carefully interpreted in the context of the clinical findings by a specialist who is qualified to do so.

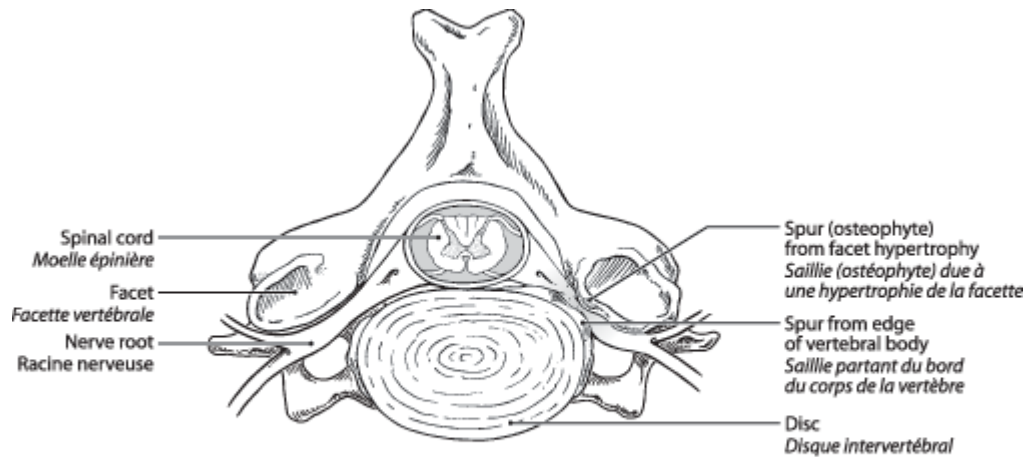
Cervical discography. X-rays taken after the injection of radio-opaque contrast material into one or more discs, through a needle inserted through the front of the neck, is of little if any value, and has been largely discontinued. Discs are best imaged by MRI. The finding of an abnormal disc on discography is of little clinical significance. Reproduction of the patient's pain by forcing contrast material into the disc does not prove that the disc has been injured nor that it is the source of the patient's symptoms.

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 cause. EMG is also useful in ruling out some of the other possible causes of numbness/weakness of the arm or hand, such as ulnar or median nerve entrapment at the elbow or wrist (cubital or carpal tunnel syndrome).



Progressive changes in the normally aging spine
Changements progressifs observés dans le vieillissement de la colonne vertébrale

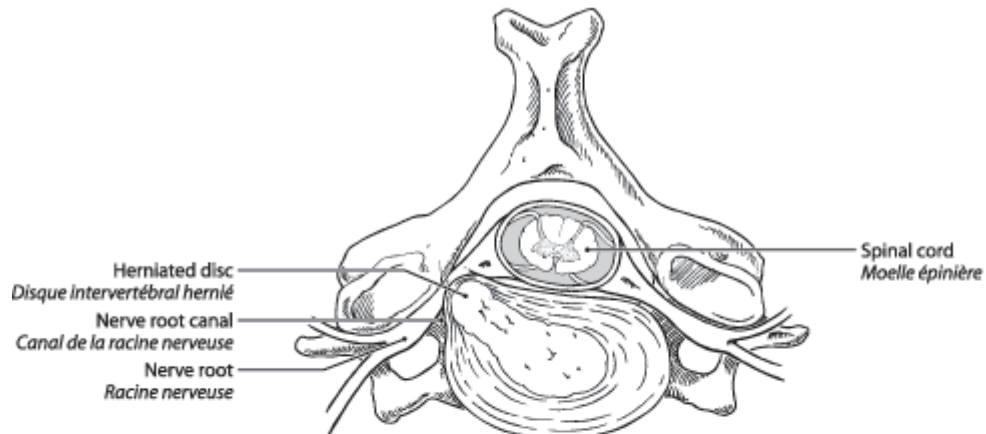
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Cross-section of the cervical spine showing compression of the nerve root due to the narrowing of the nerve root canal by osteophyte outgrowths
Coupe de la moelle épinière montrant une compression de la racine nerveuse due au rétrécissement du canal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

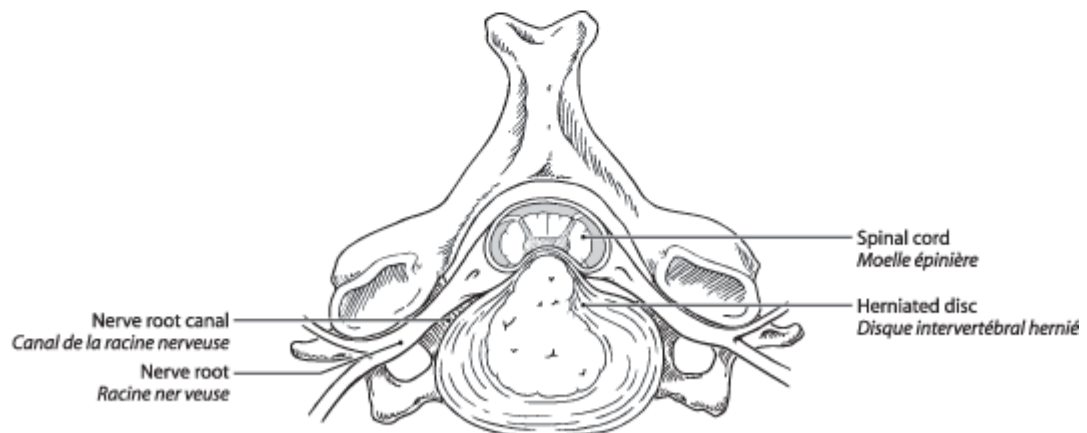
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Cross-sections of the cervical spine at the level of a herniated disc *Coupes de la colonne cervicale au niveau d'un disque intervertébral hernié*



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

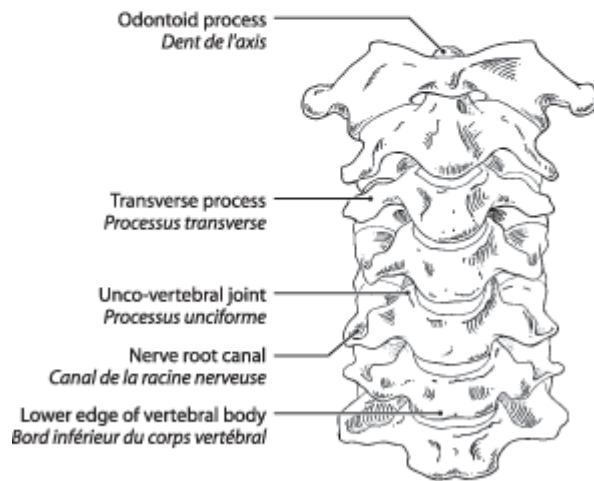
Le noyau gélatineux (nucleus pulposus) dont la hernie latérale comprime la racine nerveuse dans son canal.



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

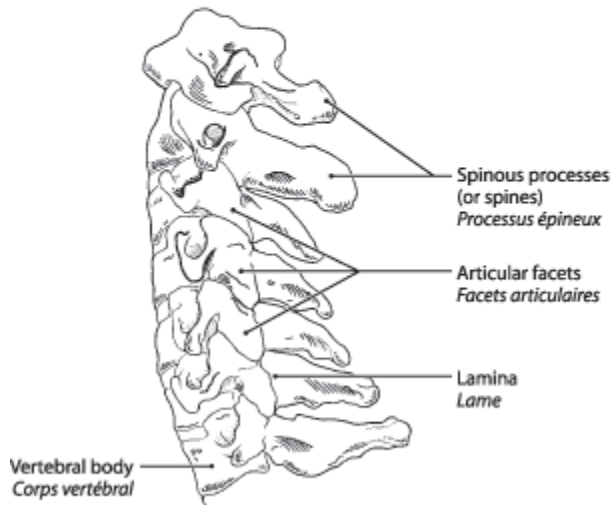
Le noyau gélatineux (nucleus pulposus) dont la hernie médiane comprime la moelle épinière mais n'affecte pas la racine nerveuse.

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Front view of cervical spine
Vue de face de la colonne cervicale

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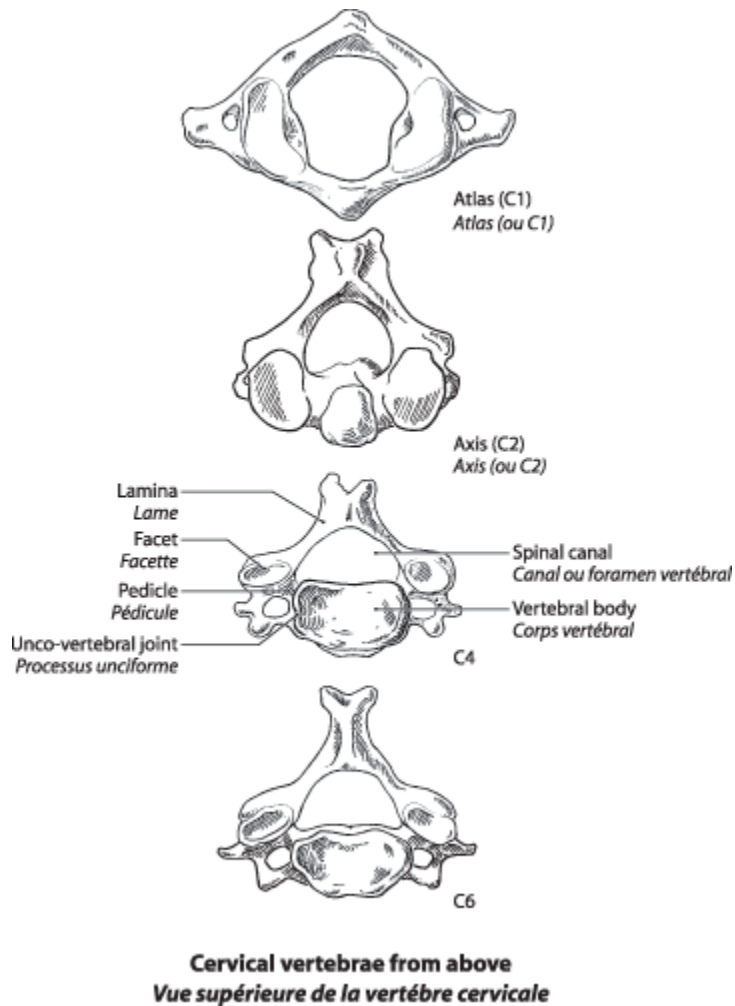


Side view of cervical vertebrae
Vue latérale des vertèbres cervicales



Side view cross-section
Coupe latérale

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Reference

Boden SD, McCowin PR, Davis DO et al: Abnormal cervical spine MR scans in asymptomatic individuals: a prospective and blinded investigation. *J. Bone Joint Surgery* 72A: 1178-1184, 1990