



Back Pain

Discussion paper prepared for

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Dr. William Robert Harris graduated from the Faculty of Medicine of the University of Toronto in 1945. After a year in the Canadian Navy, he trained in general and orthopedic surgery in Toronto's Gallie Course and in Boston at the Massachusetts General Hospital. Following a McLaughlin Traveling Fellowship in the United Kingdom and Europe, he joined the University of Toronto faculty. He contributed in many areas of orthopedic surgery including trauma, limb prostheses and rehabilitation. During a long and productive career, he served consecutive terms as Chief of Orthopedic Surgery at both Sunnybrook and the Toronto General Hospital. He lectured widely and received numerous honours and awards for his work. He joined the faculty at the University of Toronto and then held the rank of Professor Emeritus from 1988 in the Department of Surgery. His clinical and research interests were in orthopaedic surgery. He held a number of appointments including Chief of Orthopaedic Surgery at Sunnybrook Hospital and Toronto General Hospital. Dr. Harris was involved with the Tribunal as a medical counsellor until 1997. He died in 2005.

Dr. J.F. Ross Fleming graduated from the University of Toronto Medical School in 1947. He did post-graduate training in neurosurgery at the University of Toronto, at the University of Michigan and at Oxford, England, from 1947 to 1956. He became a Fellow in neurosurgery in 1956. He holds the rank of Professor Emeritus in the Division of Neurosurgery, Department of Surgery, at the University of Toronto. His clinical and research interests were in neurosurgery. He has published widely in that area. He practiced at the Toronto Western Hospital as the Head of the Division of Neurosurgery from 1965 to 1984 and as staff in the Division of Neurosurgery from 1956 to 1996. Dr. Fleming was involved at the Tribunal as an assessor from 1988 to 1992, as a counsellor from 1993 to 1997 and as Chair of the medical counsellors group from 1998 to 2006.

Dr. Gertzbein graduated from the University of Toronto in 1966. He did post-graduate training in Orthopaedics at the University of Toronto from 1966 to 1972. He was granted his fellowship in Orthopaedic Surgery in 1971. He joined the faculty at the University of Toronto in 1974 and held the rank of Associate Professor in the Division of Orthopaedics from 1984. His clinical and research interests were in back and spinal conditions, and he published widely in that area. He served as a consultant in Orthopaedics at Sunnybrook Health Sciences Centre, St Joseph's Hospital and St John's Convalescent Centre. Dr. Gertzbein was an assessor in Orthopaedics for the Tribunal for a number of years until he moved to the United States. He is currently Assistant Clinical Professor in the Department of Orthopedic Surgery at the University of Colorado and Clinical Professor of Orthopedic Surgery at the University of Texas.

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).

W. Robert Harris M.D., F.R.C.S. (C) and
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Anatomy

A vertebra consists of a body which is in front and the laminae (1 on each side) at the back. The right and left laminae join each other in a V like the roof of a house. The apex of the V is prolonged to form the spinous process (the bumps you can feel when you run your hand along the mid line of your back). The joined laminae are sometimes called the neural arch (Fig. 1). The laminae enclose the spinal canal which contains the spinal cord and nerve roots. Vertebrae are joined to each other by the intervertebral disc in front and by facet joints (right and left superior [upper] and right and left inferior [lower]) at the back. The intervertebral disc consists of an inner part, the nucleus pulposus (the pulpy core) and an outer part the annulus fibrosis (the fibrous ring). The nucleus is gelatinous and the annulus is tough and sinewy (Fig. 2). The superior and inferior facets are connected by the pars interarticularis (the part between the facet joints). The spinal cord ends opposite the first or second lumbar vertebra (L1 -2) and the lumbar and sacral nerve roots leave the spinal cord and travel downwards through the spinal canal until they exit from the spinal column at their respective levels (Fig. 3). The spinal cord and nerve roots are bathed in cerebrospinal fluid (CSF) and covered by an inner thin membrane (the arachnoid mater) and an outer thick membrane (the dura mater). Between each pair of vertebrae 2 spinal nerves, one on each side, emerge through an opening (intervertebral foramen) formed by the overlap of the upper facet of the vertebra below, and the lower facet of the vertebra above.

Vertebrae are also connected to each other by a complex of ligaments. (Figs. 4,5)

A number of muscles are attached to the vertebral column. The most important is the sacrospinalis (erector spinae) which is the name of a group of muscles that originate from the pelvis and are attached to the vertebrae from behind. It brings the back to the vertical from the bent position as well as controlling side to side motion.

Where does back pain come from? Tiny pain sensitive nerve endings are located in the ligaments that join the vertebrae together, in the muscles alongside the spinal column, in the facet joints, on the annulus portion of each intervertebral disc, in the periosteum covering certain bone surfaces and on the dural membrane that covers the nerve roots. Pain from irritation

of these nerve endings is usually felt by the patients in or across the low back region and may sometimes spread to the buttocks and groins. Occasionally the pain travels down the back of the thigh(s) towards the knee but never below the knee. This is sometimes called "referred pain". Pain from the facet joints is usually aggravated by arching (extending) the back but not by bending forward (flexing).

In common back strain, it is these ligaments and muscles that are stretched and become painful. It is not possible to determine precisely which ligament or muscle is affected. Most heal in a few days or at most a few weeks and are not likely to be a source of continuing pain.

Another type of pain is that caused by irritation or compression of a spinal nerve root. Such pain usually travels all the way down the extremity to the shin, calf, ankle or foot. It is often, but not always, accompanied by neurological findings such as numbness in a specific area of skin supplied by that nerve root, weakness of specific muscles supplied by that nerve root, decreased or absent knee or ankle reflex (depending on which nerve is affected) and limited nerve stretch test (straight leg raising or hip extension with the knee flexed). This nerve root or radicular pain is different from and must be distinguished from the local or "referred" pain from back muscles, ligaments and facet joints.

Ageing Change Lumbar Spine

Any discussion of back pain is often dominated by the term "Degenerative Disc Disease". This is an inappropriate phrase because what is being described is usually not a disease but normal aging change. A better description would be "age related" change. This normal process produces typical x-ray and CT or MR changes which are commonly misinterpreted by physicians as being evidence of something abnormal. In turn this may lead to unnecessary investigation and, sometimes, surgery.

With gradual aging, there is loss of water from the nucleus pulposus with resulting thinning of the disc space between the adjacent vertebrae and this can be seen on plain x-rays. The narrowing of the disc space causes the annulus fibrosus to "bulge" and this can be seen on CT or MR scans. It does not usually cause symptoms but if the bulging is excessive one or more nerve roots may be compressed with resultant symptoms. The bulge is centrally located and as there is usually plenty of room in the spinal canal nerve roots are rarely compressed. A lateral bulge, if very large, may

sometimes compress a nerve root. This process of bulging is not the result of trauma. Aging is often associated with the formation of a bony out growth (spur, osteophyte, exostosis) at the periphery of the vertebral body. Another result of the height loss is that the facet joints are distorted. This can cause wear and tear changes in them (described as "facet arthritis"). Sometimes the disc narrowing is accompanied by backward ("retrospodylolisthesis") (Fig. 6) or forward (degenerative or pseudo spondylolisthesis) displacement of the upper vertebra on the lower. These tongue twisters simply mean slipping of a vertebra (spondylos=vertebra, listhesis=slip, retro=backwards). (True as opposed to pseudo spondylolisthesis is the result of a bony defect in the structure of the vertebra and will be discussed later {Figs. 7,8}). The incidence of these aging changes is affected by heredity and race. Some families are predisposed to develop marked changes at an early age. Aging change is commoner in Caucasians than in Negroes and Orientals. There is no convincing evidence that these changes which are so obvious on the x-ray or scans cause pain. In most people who have back pain in the presence of aging change, the pain is the result of ligament or muscle strain and not because of the age change seen in the x- ray.

There are three conditions in which aging may cause symptoms: 1) a disc problem (herniated, sequestered, ruptured disc); 2) spinal stenosis (narrowing of the spinal canal); and 3) facet arthritis.

Sometimes some fibres of the annulus fibrosis may give way or tear, either spontaneously or from an injury, resulting in back pain. This usually heals in a few weeks with resolution of the pain. However a tear may allow some of the nucleus pulposus to protrude into or even completely through the annulus (called "herniation" or "sequestration"). This may or may not irritate or compress one or more nerve roots (Figs. 9,10). Even so, the great majority of patients with such a protrusion or rupture get better in a few weeks with healing of the tissues and resolution of the pain. A few such patients fail to get better and may require surgery. A few others may get better but are vulnerable to recurrent pain in the future.

In spinal stenosis (Fig. 11), the gradual formation of bony outgrowths narrows the spinal canal and the openings through which the spinal nerves emerge. This condition is not caused by trauma. In people who have a small diameter spinal canal to begin with, the nerve roots are more vulnerable to compression. This narrowing of the spinal canal produces numbness and weakness ("my legs feel rubbery") in the legs, typically brought on by walking and disappearing slowly with rest. If the symptoms are severe and disabling, surgery to decompress the affected nerve roots may be required.

The above pre-existing conditions, can become symptomatic following trauma. In the case of a herniated disc, presumably the nucleus pulposus had worked its way partially through the annulus fibrosis but not far enough to produce symptoms. Then an injury, sometimes relatively trivial, permits the nucleus to escape completely. In the case of spinal stenosis, the canal is already narrowed but not sufficiently to cause symptoms. Then if an injury causes a disc to bulge or herniate, further narrowing the spinal canal, symptoms are produced. Facet arthritis is the result of loss of disc height distorting the facet joints. It can be the cause of chronic intermittent back ache. When seen soon after an injury it is a pre-existing condition as it takes years for the x-ray changes of facet arthritis to occur. Whether or not it is aggravated by trauma is a moot question. For this to be true, the injury would probably have to be severe rather than a simple lifting strain.

Other Abnormalities of the Lumbar Spine

1) Spondylolysis and Spondylolisthesis

In spondylolysis (Fig. 8) the pars interarticularis instead of being made of bone is made of gristle. As the gristle is not calcified, it appears as a defect in the x-ray. This is spondylolysis. While the gristle is very strong it is not as strong as bone. Over time it may stretch permitting the upper vertebra to slip forward on the lower one. This is spondylolisthesis. Both spondylolysis and spondylolisthesis occur most commonly in the 4th and 5th lumbar vertebrae.

The exact cause of spondylolytic spondylolisthesis is unknown. It occurs in 5% of Caucasians and in almost 20% of Inuit. There is no clear evidence that it is caused by trauma. It is commoner in ballet dancers and acrobats who arch their backs a lot. The majority of people with it have no symptoms. But symptoms (back ache) can occur in a person with pre-existing and painless spondylolisthesis as the result of a strain or repetitive lifting. Once symptoms commence, they tend to recur.

2) Sacralisation of the 5th lumbar vertebra

In this congenital condition, the lowest (5th) lumbar vertebra is fused to the sacrum, reducing the number of joints in the lumbar spine from 5 to 4. It does not cause symptoms. There may be more than usual wear and tear of the next disc up (between L4 and L5) causing premature aging change in some patients. Often the transverse process of the 5th lumbar vertebra is

connected to the pelvis by means of a false joint (pseudoarthrosis) but this does not cause pain.

3) Lumbarisation of the 1st sacral segment

In this congenital condition the first sacral segment is separated from the second by a true intervertebral joint, increasing the number of joints in the lumbar spine from 5 to 6. It does not cause symptoms.

4) Scoliosis

This is sideways curvature of the spine. It can be congenital, secondary to paralysis (such as poliomyelitis) or idiopathic (i.e. no known cause). As the curve increases, the ribs on the concave side are jammed together forcing the vertebrae to rotate. In turn this makes the ribs on the convex side more prominent causing a "hump back". Any type of scoliosis is often associated with premature aging changes in the discs at the apex of the curve. It can cause back pain. But in a recent survey of patients who had films of the abdomen made (usually looking for kidney stones) a considerable proportion had scoliosis with aging change but had no back symptoms. Thus in patients who have scoliosis and claim work related back symptoms, the facts must be interpreted with caution. 'Sciatic' scoliosis is sometimes seen in acute disc protrusions. It is not a structural deformity of the back but the result of muscle spasm.

5) Ankylosing Spondylitis (Marie Strumpell disease, Bechterew's disease)

This is an inflammatory arthritis that affects the spinal column, sacro iliac joints and sometimes the hips. It occurs almost exclusively in young males. Its cause is unknown. It produces fusion of the spinal column, sometimes in a flexed position so that victims of it have trouble seeing where they are going. It is characterised by intermittent flare ups of back pain often with leg radiation so that it can mimic a herniated disc. Eventually the process "burns out" leaving the patient with a stiff but painless spine. Although some authorities believe that trauma plays a role in its onset, the evidence is that it is not caused by trauma.

6) Conditions that physicians may erroneously consider to be the cause of pain.

a) Schuermann's disease

This is an abnormality of the growth plates that are on the upper and lower surfaces of the vertebral body before skeletal maturation. It can result in a marked increase in the normal rounding (kyphosis) of the thoracic spine in adolescents. It is seldom a cause of back pain: its principle effect is cosmetic. It is mentioned here because some physicians are puzzled by it.

b) Schmorl's Nodules.

These are indentations of the nucleus pulposus into the body of the vertebra above. They are normal and are never a source of pain.

c) Separate apophyseal ring.

Sometimes the growth plate (see Schuermann's disease above) fails to fuse completely to the vertebral body at the cessation of growth and appears in the x-ray as triangular piece of bone separated from the upper outer edge of the body. They are a variation of normal anatomy and do not cause symptoms.

7) Spinal tumours, both primary and metastatic, and inflammatory processes such as tuberculosis or osteomyelitis or discitis all cause back pain. They are readily diagnosed by appropriate imaging and with the rare exception of some cases of discitis or osteomyelitis are not caused by trauma.

Back pain may also be caused by an abnormality of organs in or behind the abdominal cavity.

There are a great many causes of back/leg pain and it is important that a careful diagnosis be made in each case before jumping to the conclusion the pain is necessarily due to work related activity or injury.

Symptoms and their Duration

The majority of back pain is the result of a simple soft tissue (ligament and muscle) strain. The pain is in the low back. Commonly it radiates to one or both sides or to the buttocks and thighs. Nearly always it subsides spontaneously in a few days irrespective of the treatment. There is a growing consensus on two things: 1) that it is better for patients to keep active rather than going to bed and 2) there is no statistical evidence that treatment alters the rate of the normal spontaneous recovery.

When the pain results from a true disc herniation, it is in the low back and all the way down the leg (sciatica). The leg pain is worse than the back pain. It may be associated with numbness in the lower part of the leg or foot. The distribution of the leg pain depends on which disc is affected and hence which nerve root is compressed. With the 5th lumbar or 1st sacral root, the pain is in the buttock, back of the thigh, lower leg (shin or calf) and sometimes the foot and/or the toes. In the majority, the symptoms subside within a month or two and only rarely is surgery needed to remove the disc protrusion.

The symptoms of spinal stenosis are pain, numbness and weakness in the lower extremity(ies), brought on by walking or standing erect and relieved by flexing the spine (bending forward or sitting). There are usually no symptoms at rest. Once established the condition is permanent. Surgery to decompress the nerve roots may help.

In spondylolisthesis, pain is usually confined to the back although nerve root irritation caused by the instability of the adjacent bones may cause leg pain similar to that caused by a herniated disc. The pain is characteristically intermittent and brought on by activity. Most patients with x-ray evidence of spondylolisthesis have no symptoms. If treatment is needed the affected vertebra is fused (by bone grafting) with the one below.

Problem Areas in Appeals Related to Back Symptoms

1) Does aging change by itself cause back ache?

Aging changes seen in plain x-rays, CT and MR scans are usually non symptomatic but aging (with or without imaging changes) can result in back pain.

2) Can an injury precipitate aging change?

Rarely. However, a severe injury, such as a fall from a height (as opposed to a lifting strain) may result in the appearance (within a year) of narrowing of a single disc with bony overgrowth (spurs or osteophytes) at the adjacent vertebral margins.

3) Can an injury aggravate or accelerate pre-existing aging change?

There is no evidence that the progression of x-ray changes is altered by a single injury (unless it is very severe) or by repetitive movement. However people with aging change might be more prone to develop back symptoms with repetitive strain although the evidence is tenuous. But it should be noted that as the age change progresses, the back becomes stiffer so that eventually the incidence of back pain diminishes.

4) Does previous back surgery cause back pain?

Yes. When surgery is done for a herniated disc, it usually relieves the leg pain (sciatica) but patients commonly have grumbling intermittent back discomfort that persists for years. Thus if the surgery was required for a compensable condition, subsequent episodes of back pain may well be related to the compensable condition. But if the surgery was not compensable, subsequent episodes of back ache should be analysed carefully: they are probably the result of the non-compensable condition.

5) Do spondylolysis and spondylolisthesis cause back pain?

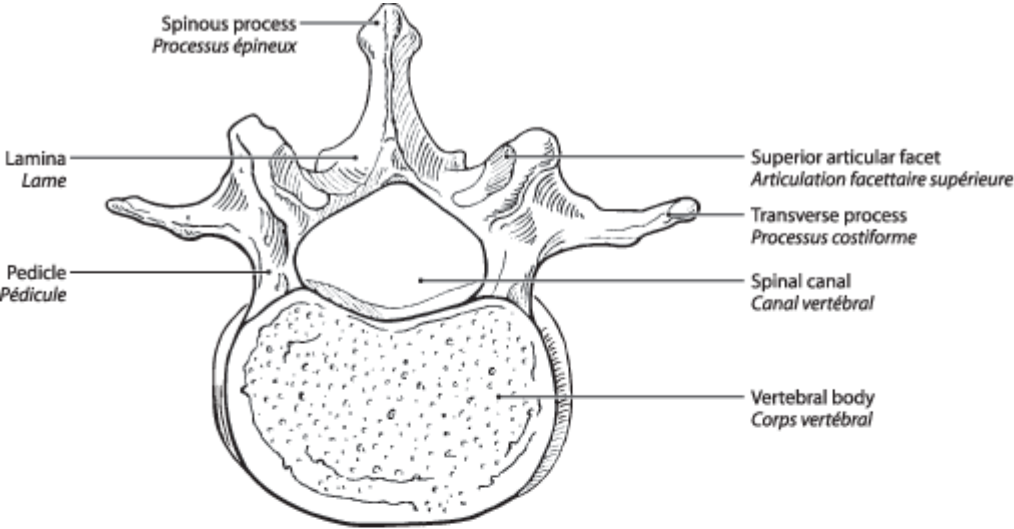
Most patients go through their lives without symptoms. When pain occurs, it may come on spontaneously or it may follow a lifting strain or repetitive lifting. Once symptoms start, they tend to recur often without relation to the nature of the patient's activity. Spondylolysis and spondylolisthesis are usually preexisting and are probably not caused by trauma.

6) Can scoliosis cause back pain?

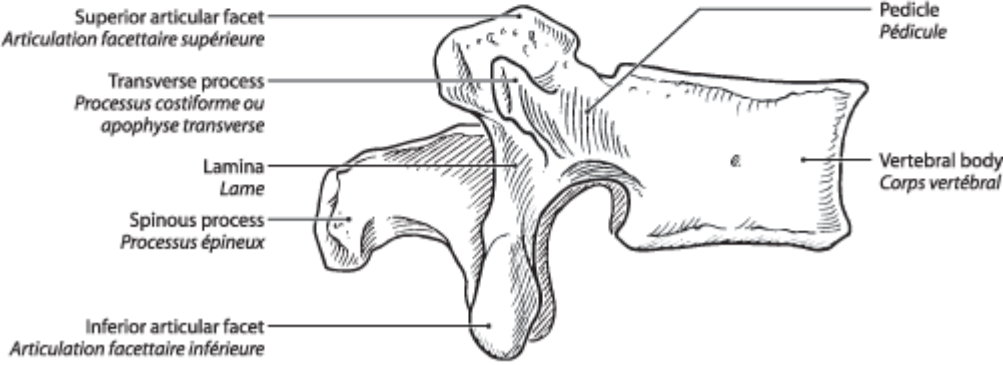
Yes. It is usually causally unrelated to the patient's activity, but activity may cause back pain in patients who have scoliosis. In work related claims for back symptoms, the facts must be interpreted with caution.

Imaging Studies

There is an extremely high incidence of abnormalities seen in spine imaging in people of all ages who have no symptoms. Evaluation of a patient with back pain and its possible relationship to work activity or injury requires thorough evaluation of the history and physical findings by a physician experienced in back problems and cautious in the interpretation of all the patient's imaging studies.



Normal lumbar vertebra, seen from above
Vue supérieure d'une vertèbre lombaire normale



Normal lumbar vertebra, side view
Vue latérale d'une vertèbre lombaire normale

Figure 1

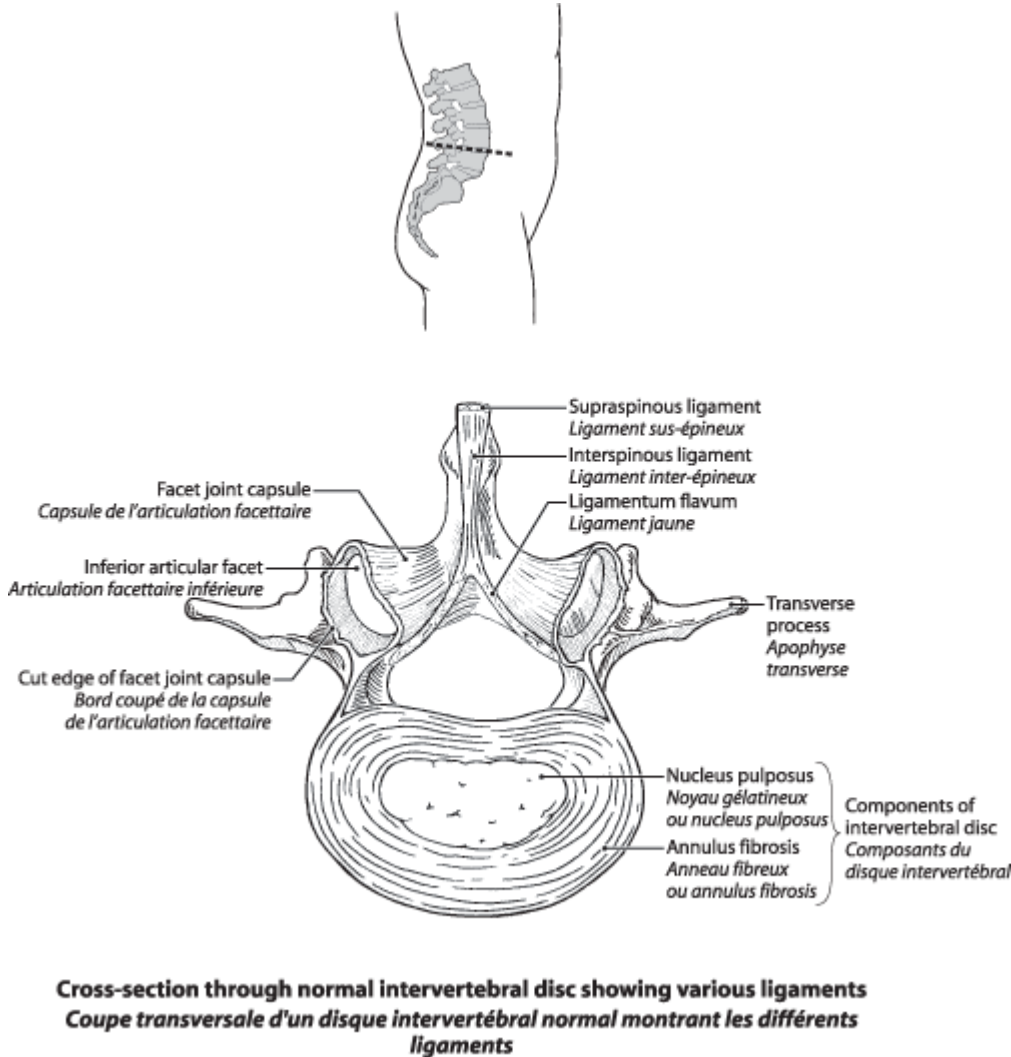
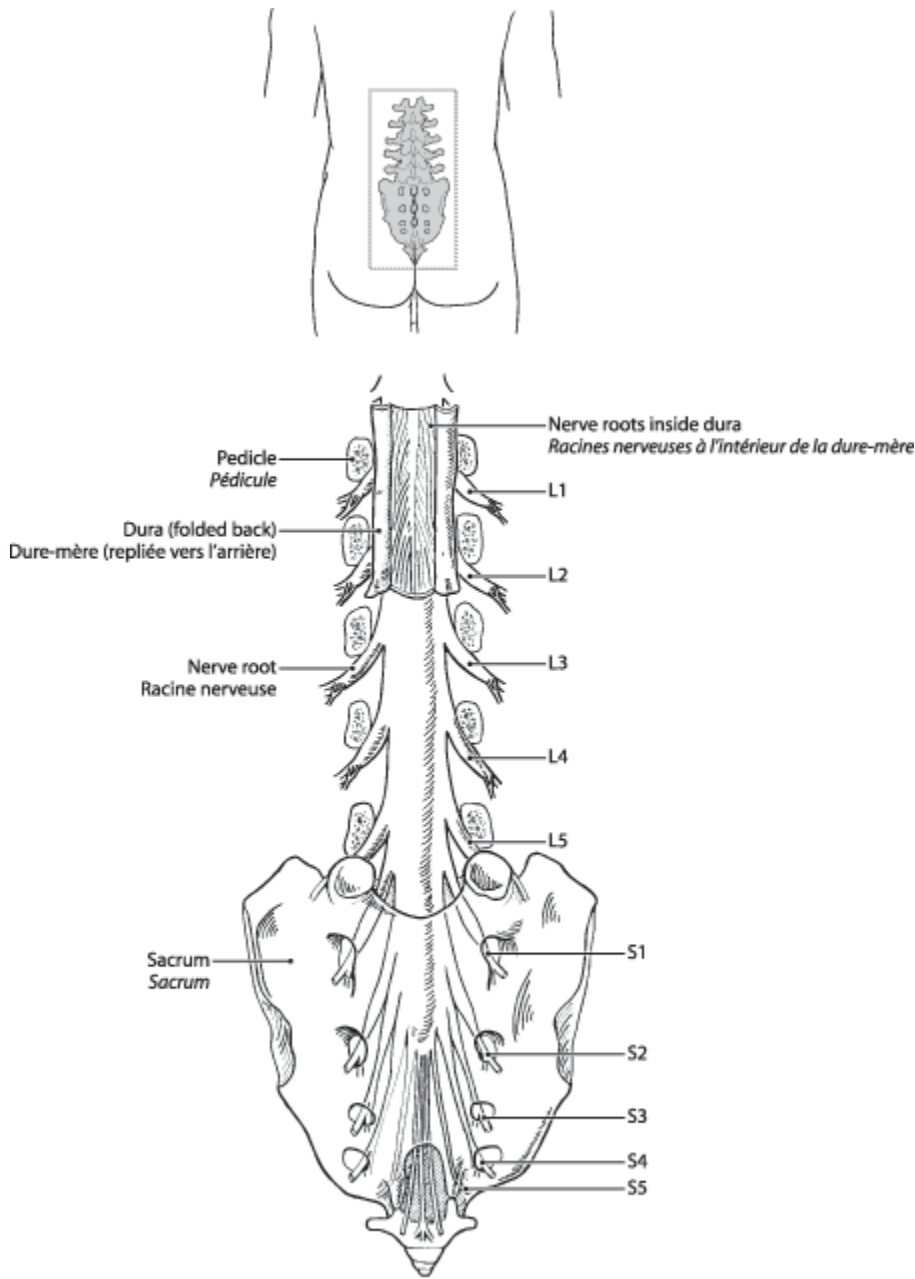
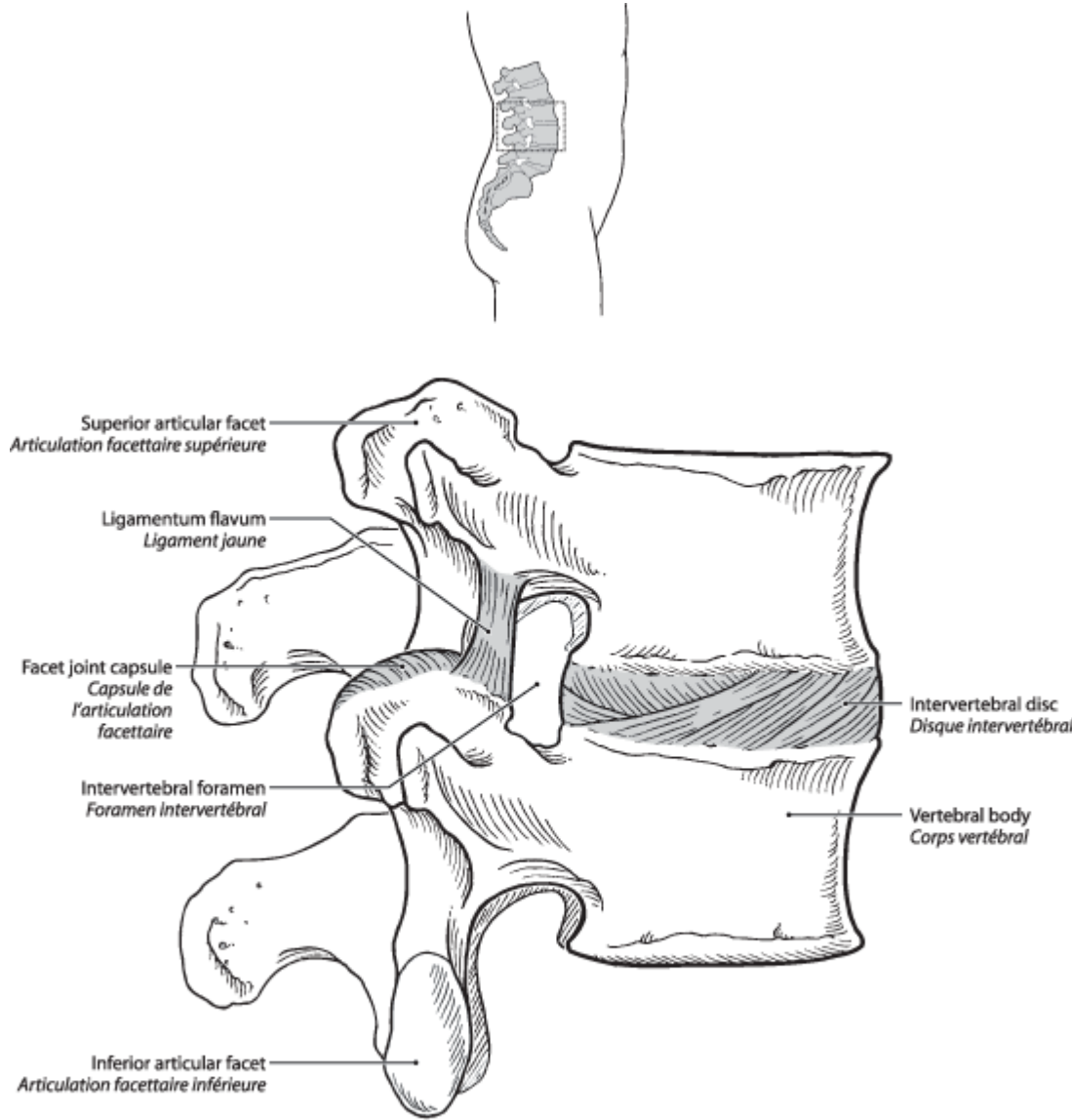


Figure 2



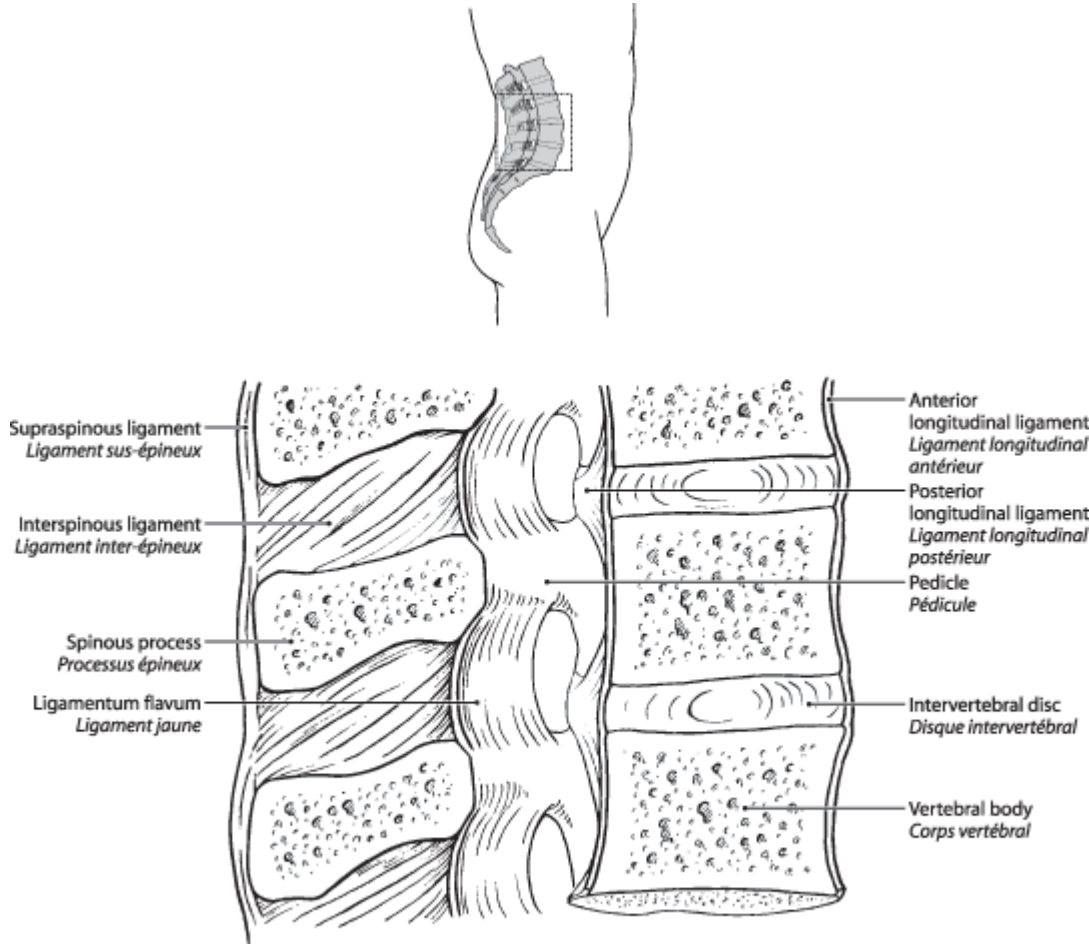
Lumbar and sacral spine from behind showing nerve roots
Vue postérieure de la colonne lombaire et sacrée montrant les racines nerveuses

Figure 3



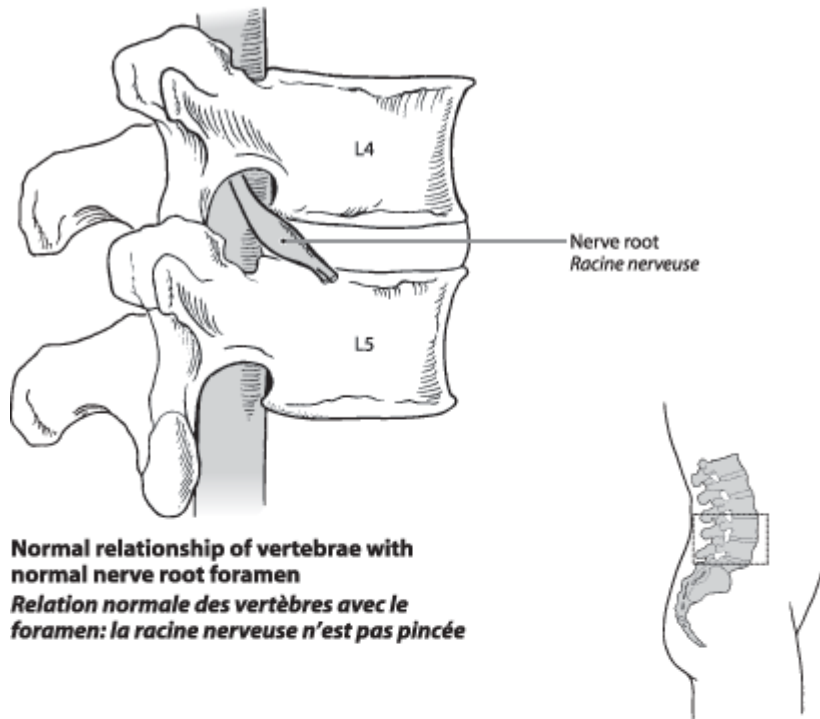
Side view of normal vertebrae showing ligaments and intervertebral disc
Vue latérale d'une vertèbre normale montrant les ligaments et le disque intervertébral

Figure 4

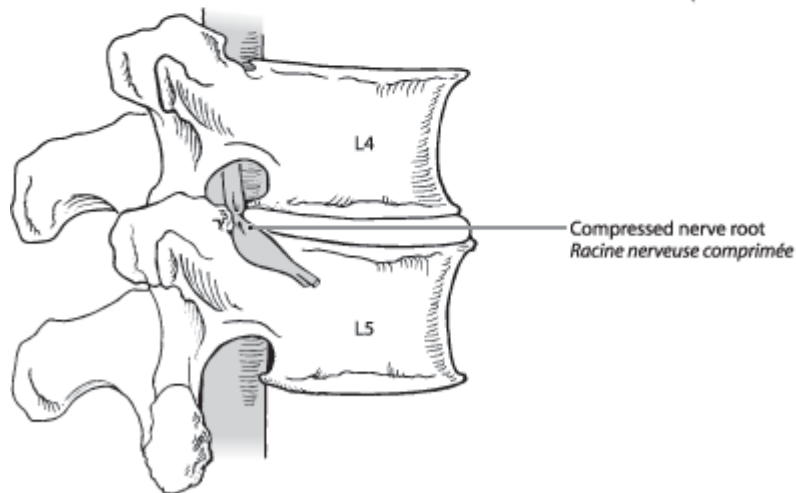


Midline section through the vertebral column and principal ligaments
Coupe médiane à travers la colonne vertébrale et les principaux ligaments

Figure 5

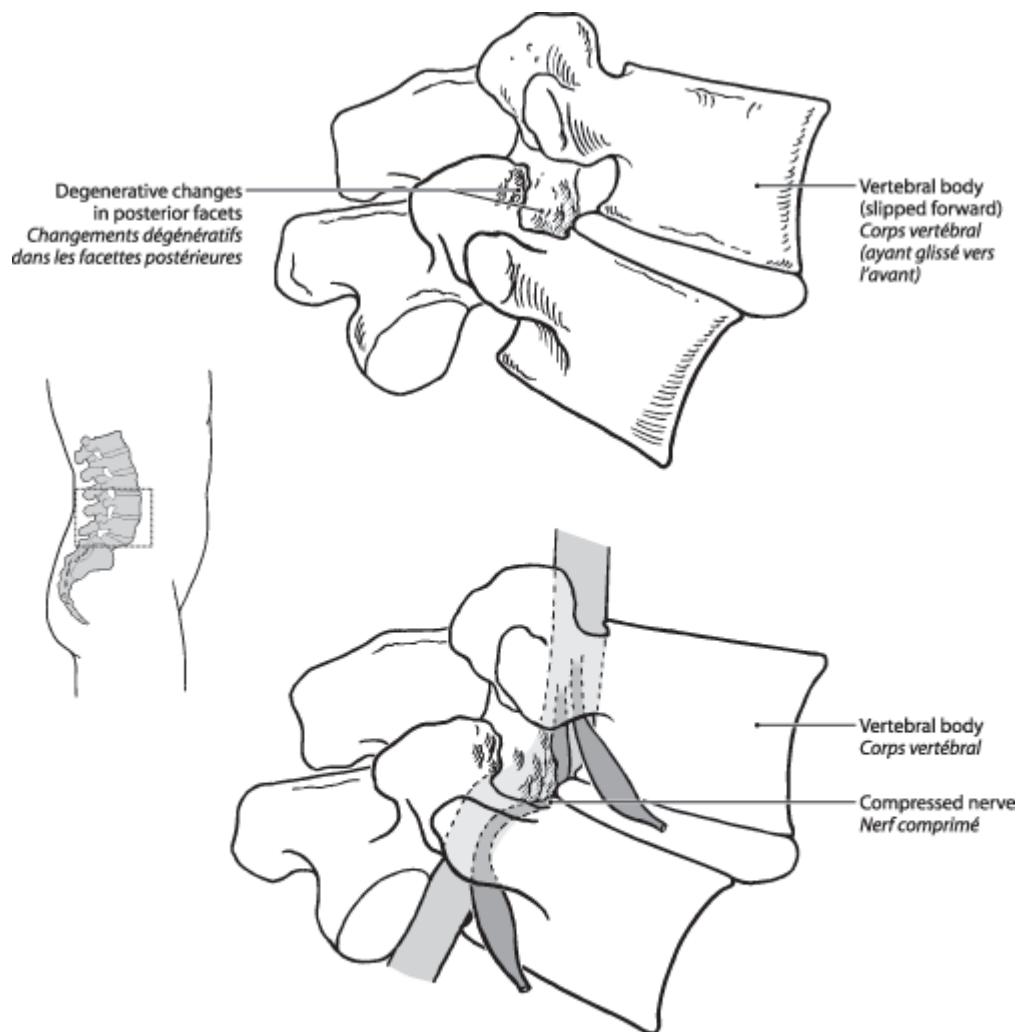


Normal relationship of vertebrae with normal nerve root foramen
Relation normale des vertèbres avec le foramen: la racine nerveuse n'est pas pincée



Backward slip (retrospondylolisthesis) of L4 upon L5 caused by degenerative weakening of ligaments and facet joints
Glissement vers l'arrière (rétrolisthésis) de L4 par rapport à L5 causé par un affaiblissement de type dégénératif des ligaments et des articulations facettaires

Figure 6



Degenerative spondylolisthesis — forward slip of L4 upon L5 vertebra due to degenerative changes in ligaments and facet joints. Lower picture shows how nerve root may be compressed.

Spondylolisthésis dégénératif — glissement vers l'avant de L4 sur L5 dû à des changements dégénératifs dans les ligaments et les facettes articulaires. Le deuxième croquis montre comment la racine nerveuse peut-être comprimée

Figure 7

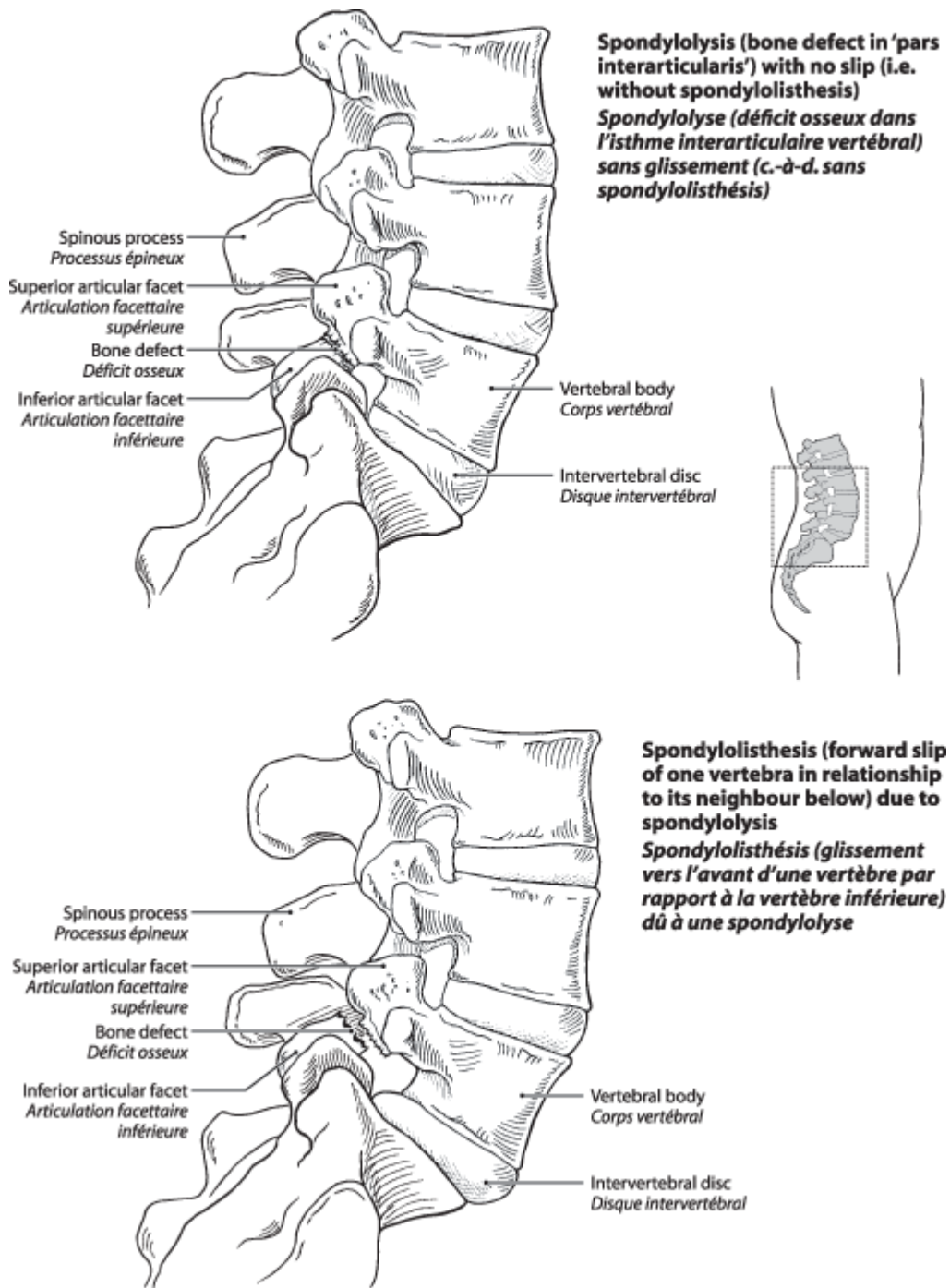
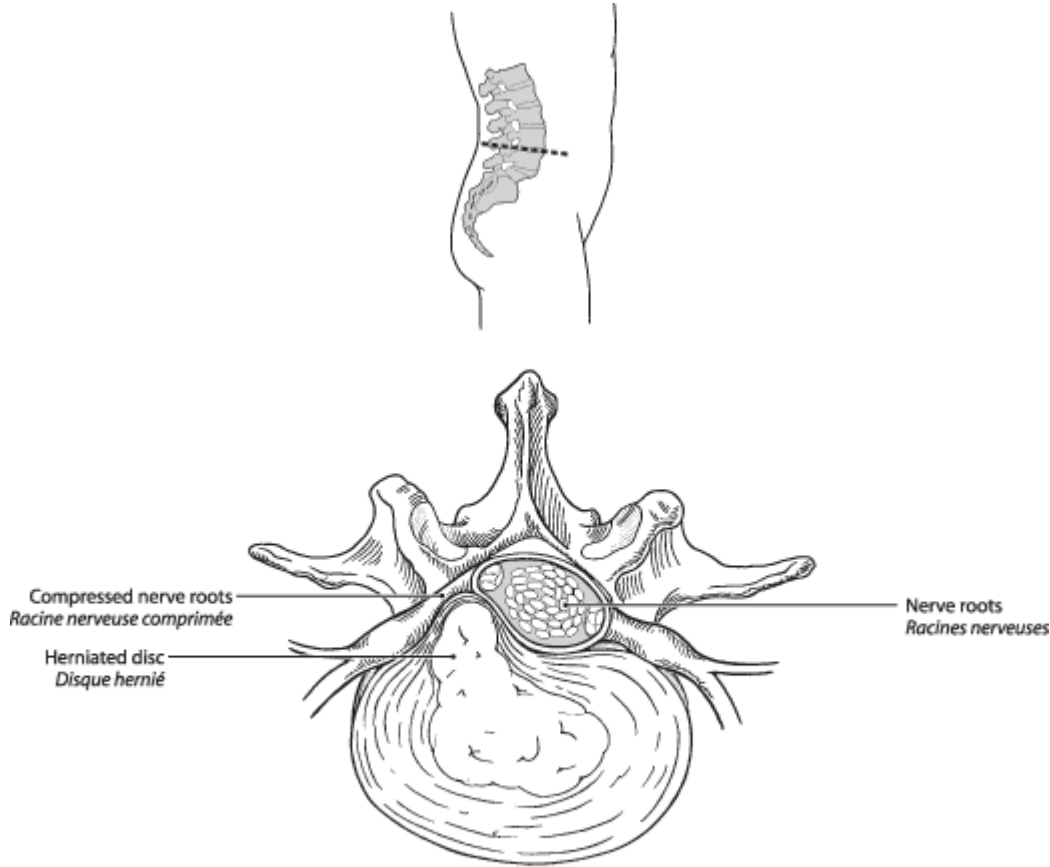
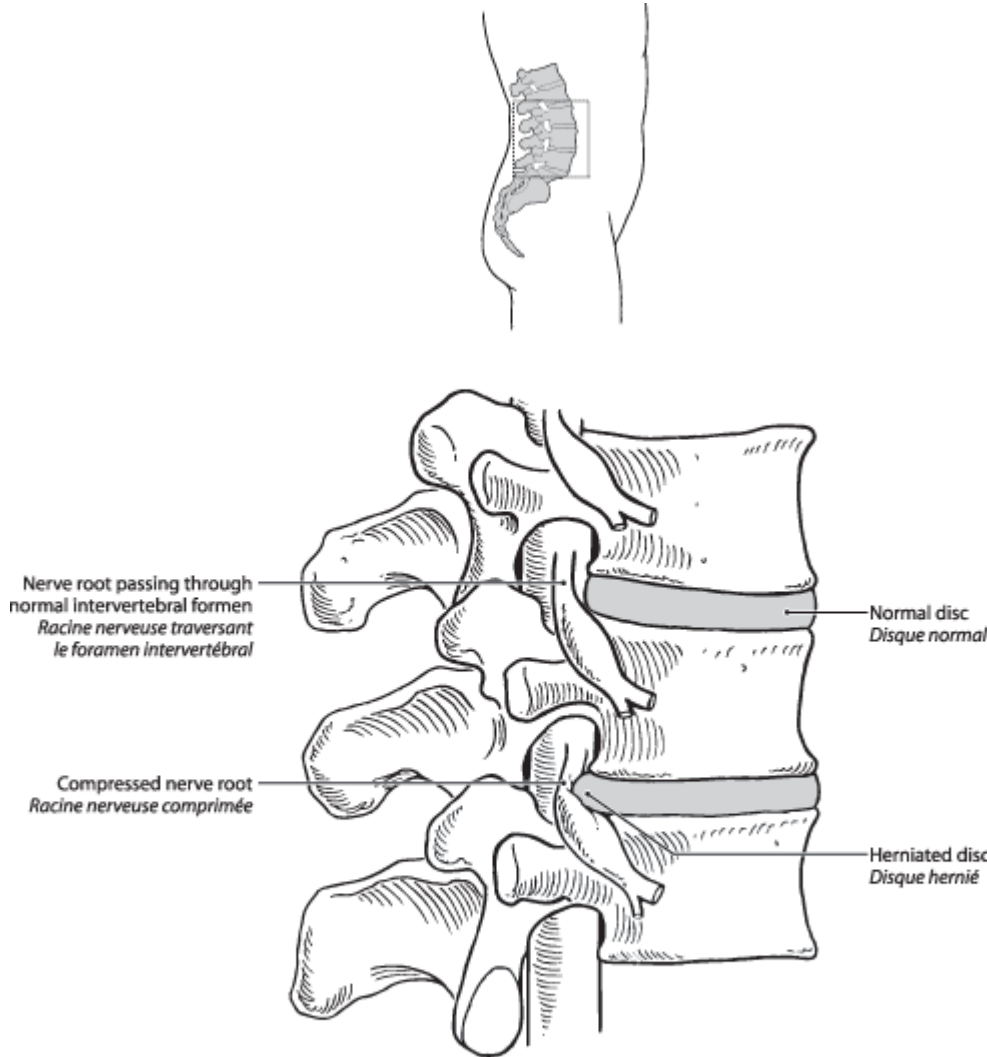


Figure 8



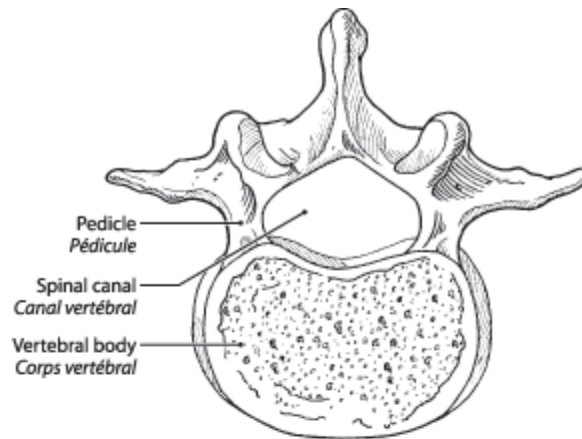
A ruptured (herniated) nucleus pulposus compressing the nerve root, as seen on cross-section.
Coupe transversale montrant un nucleus pulposus hernié comprimant la racine nerveuse.

Figure 9

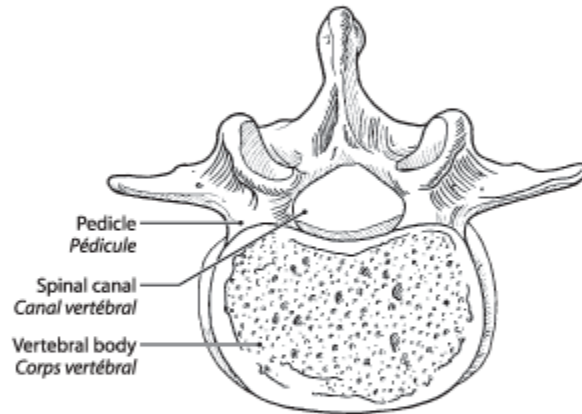


Side view showing ruptured nucleus pulposus compressing the nerve root in the intervertebral foramen
Vue latérale d'un nucleus pulposus hernié comprimant la racine nerveuse dans le foramen intervertébral

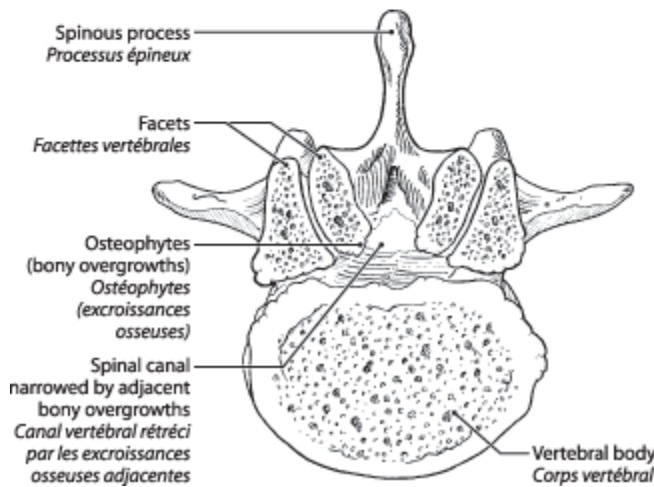
Figure 10



Normal spinal canal
Canal vertébral normal



Developmental (congenital) spinal stenosis (narrowing of spinal canal) due to very short, thick, bony pedicles.
Sténose vertébrale congénitale (rétrécissement du canal vertébral) due à des pédicules osseux très courts et épais.



Degenerative spinal stenosis: cross-section of lumbar vertebra showing bony overgrowths (hypertrophy) of facets causing narrowing of spinal canal. This condition is the result of degenerative changes which are part of the aging process.
Sténose vertébrale dégénérative — coupe transversale d'une vertèbre lombaire montrant les excroissances osseuses des facettes qui causent un rétrécissement du canal vertébral. Cet état pathologique résulte de changements dégénératifs faisant partie du processus de vieillissement.

Figure 11

STANLEY D. GERTZBEIN, M.D. F.R.C.S.(C)

November 21, 1989

Ms. Marie Makinson
Medical Liaison Officer
Workers' Compensation Appeals Tribunal
505 University Avenue, 7th Floor
Toronto, Ontario M5G 1X4

Dear Ms. Makinson:

Thank you for your letter of October 25 requesting information on the subject of intervertebral disc protrusion. I assume that you were referring to the lumbar spine as the cervical and thoracic spine areas may have other factors associated with protrusion.

I will answer the questions that you have posed in the order in which they were raised.

By way of background, the intervertebral disc is a rubbery structure located between two vertebral bodies occupying the anterior two-thirds of the cross-section of a vertebra. The intervertebral disc lies anterior to the spinal canal and therefore anterior to the nerve roots in the lumbar spine.

The lumbar intervertebral disc consists of two components. A central gelatinous or watery material called the nucleus pulposus which occupies the central one-third of the disc and the outer fibres consisting of the annulus fibrosis which is a tough tissue very much like the ligaments that join bones together. The structure is circular and surrounds the nucleus pulposus and occupies two-thirds of the diameter.

A disc protrusion is a condition in which the nucleus pulposus migrates from its central position, usually backwards or backwards and to the side, stretching the fibres of the annulus fibrosis or tearing them and ultimately extending backwards towards the spinal canal. The nucleus pulposus may cause the outer fibres of the annulus fibrosis to stretch and produce a bulging effect compressing the nerve roots which pass by the disc. If the nucleus pulposus projects further it is called a disc prolapse which means that most of the nucleus pulposus material has extended beyond the annulus fibrosis but is still covered by an outer lining of ligament that normally covers

the annulus fibrosis on its posterior surface. In more severe cases the nucleus pulposus can project beyond the ligament itself and lie freely in the spinal canal. This condition is known as a sequestered disc fragment. In all of these situations nerve tissue can be compressed and result in the common symptom of sciatica.

During the normal process of aging the chemistry of the nucleus pulposus and the annulus fibrosis change. The most dramatic change is drop in the water content and a loss of resilience of the disc. When the disc loses its resilience it does not respond to normal motion and activity and does not stretch in a normal way. The fibres of the annulus fibrosis may then develop microscopic tears as a result of relatively normal activity. The weakening of the annulus fibrosis during this process sets up the nucleus pulposus for a path of least resistance under certain circumstances. During increased pressures in the disc which occur normally with activities such as bending, lifting and twisting, the nucleus pulposus is subjected to great pressures and may tend to move in a direction of least resistance, namely backwards or backwards and sideways where most of the microscopic tears have occurred in the annulus fibrosis. All these changes occur with aging and do not necessarily reflect trauma or work-related activity.

In answer to the first question, the significant trauma superimposed on these underlying conditions can produce a disc protrusion. However, in many cases a major injury is not determined but a simple activity such as bending, twisting or lifting may generate sufficient forces within the disc to cause it to protrude through a path of least resistance, namely the microscopic injuries to the annulus fibrosis. Therefore, the answer to the first question is that there does not always need to be significant trauma to lead to a disc protrusion.

Disc protrusions may rarely occur in healthy discs. They are seen in teenagers whose discs are thought to be quite normal. In these situations extreme forces are exerted on the disc which will cause rupture of the annulus fibrosis in much the same way as a rupture occurs with any ligament. In almost every case there is a significant history of trauma in these young individuals. On the other hand, once an adult reaches the age of 20 to 25 the aging changes have already begun and the predisposing factors mentioned above can lead to disc protrusion with much lesser trauma. There are a number of factors which have been related to a higher incidence of disc protrusion. These are primarily those of vocational choices such as construction work and other manual employment, e.g. garbage collectors and warehouse workers. High risk industries include mining and

transportation, the latter thought to be secondary to low frequency vibration causing damage to the discs. This is particularly seen in long-distance truck drivers. Most of these jobs involve repetitive bending, heavy lifting and twisting, all of which take their toll on the disc, particularly in the face of the normal aging process.

In answer to the third question, a number of findings in an assessment of a patient with back pain can be elicited through the usual history, physical and diagnostic investigations which would assist in determining whether a disc protrusion was related to a previous accident.

In the history, a definite history of trauma to the back producing back pain and sciatica would draw attention to the accident itself being the source of the disc protrusion. The classical symptoms of sciatica would also indicate that a disc protrusion was present at a time soon after the accident occurred, i.e. within seconds, minutes or days. The relationship of various treatment modalities to the subsidence of pain would also be important in a patient who was thought to have had an injury causing his disc protrusion. Most patients' symptoms with a disc protrusion following trauma will resolve over a period of several weeks and by three months at least 90 percent of patients will be significantly better.

With regard to the physical findings those are primarily the findings of neurological deficits, namely motor weakness, sensory deficit and reflex changes. Occasionally in rare situations a massive disc prolapse can result in bowel and bladder findings. Localized findings to the back itself do not necessarily point to a disc protrusion, although they may indicate that the trauma was significantly severe to result in injury to the spinal and paraspinal structures.

The diagnostic investigations are the most definitive. Usually plain radiographs are not very valuable in themselves as a fresh disc prolapse due to trauma does not change the radiographic appearance. However, the next step in the investigation is a CT scan which allows one quite clearly to identify the disc and any protruding fragments. Both Magnetic Resonance Imaging (MRI) and myelograms are also excellent methods of making the diagnosis following an injury which does not settle with the standard conservative measures. Discogram pain studies have been used as well to reproduce pain with the dye extruding posteriorly in the direction of the disc prolapse. More recently the dye has been injected and a CT scan is performed and this quite clearly demonstrates the tracking of dye to the area of the disc protrusion. None of these investigations will diagnose with certainty the direct relationship of the protrusion to the previous accident only that a protrusion is present. If they are done within a recent time frame,

namely a few weeks to a few months following an accident in which a patient previously had no back history they would point towards the accident causing the protrusion. If, however, a patient had multiple episodes of back and leg pain caused by several accidents or several flare-ups of pain, late investigations could not determine that one or other accident was the cause.

In the fourth question you have queried the relationship of a number of variables. I have touched on age as a factor. In the teenage group severe trauma is the usual cause of disc protrusion. With increasing age from about 20 through to 50 the incidence of disc protrusion increases but after the age of 50-60 with further dehydration of the disc the nucleus pulposus is unlikely to extrude in a fashion similar to that described above. Therefore, in the older age group it is uncommon to have a disc prolapse as the main source of sciatica. Gender in itself is not particularly a factor but males tend to be engaged in more work-related activities which will stress the spine and in this sense there is a higher incidence of male patients with disc prolapse. Weight is a major contributor to the *persistence* of symptoms. I do not know if studies have showed that weight in itself as a primary factor is the cause of disc prolapse although it may be a factor in the production of degenerative disc disease in a general sense. Lifestyle activities such as sports which require repetitive bending, lifting of heavy weights and twisting may result in a higher incidence of disc prolapse. This is also true of the type of vocation that one is employed in and relates to comments I made earlier regarding certain types of jobs and industries. Thus, these factors can produce a situation whereby a traumatic episode will cause a disc protrusion.

It is difficult to be dogmatic regarding the answer to question five. If an accident produced a significant back problem but not a disc protrusion it could result in acceleration of deterioration of the disc and predispose it at a future time to a disc protrusion. There may in fact be some changes on x-rays noted after a four year interval following the accident and prior to or at the time of a disc prolapse. However, there is not necessarily a radiographic finding to note at the time of the accident itself. Should a disc protrusion occur four years after a back injury it is not necessarily the case that x-ray changes would be present at the end of that four year interval.

In reply to the last question, if an accident were to be the primary cause of a disc prolapse I would expect the features of the disc protrusion to be present within a few hours to a few days after. I have occasionally seen the onset of a disc protrusion two or three weeks after a definite accident. It is difficult to determine what factors influence this range of time but in some cases a significant injury to the annulus fibrosus will weaken it and with some

additional pressures on the nucleus pulposus from normal activity the disc will prolapse through the damaged annulus within the first few days.

There are undoubtedly a number of questions raised by my discussion of this condition. I would be pleased to provide you with any additional information should the need arise. Please do not hesitate to contact me.

Yours sincerely,
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