Lumbar spinal stenosis is a common condition in elderly patients and also one of the most frequent reasons to perform spinal surgery (Szpalski and Gunzburg, 1998). It is present in five of every 1,000 Americans over the age of 50. In Sweden, the mean annual rate of surgery for spinal stenosis is 9.7 per 100,000 inhabitants (Jansson et al., 2003). In the United States, rates of surgery for this condition increased eightfold from 1979 to 1992 in patients over age 65 (Ciol et al., 1996).

Stenosis leading to radiculopathy or neurogenic claudication can be caused by different factors, a number of which are related to degenerative processes. The real participation of so-called congenital stenosis is still a subject of debate. True congenital stenosis present at birth is rare outside some specific and rare congenital syndromes or true achondroplasia. It is seldom that stenosis symptoms appear in younger individuals without added degenerative changes. Degenerative disc disease is the most common cause of lumbar spinal stenosis. A bulging degenerated intervertebral disc anteriorly, combined with thickened infolding of ligamenta flava and hypertrophy of the facet joints posteriorly, results in narrowing of the spinal canal. The site of compression may be central, lateral or a combination of both.

Lumbar spinal stenosis is a clinical condition and not a radiological finding or diagnosis. Also specific to spinal degeneration is the fact that even if all elderly patients do not present with osteoarthritis of peripheral joints like hips or knees, nearly all will exhibit radiological images of degeneration on spine imaging—both symptomatic and symptom-free patients (Berney, 1994). The latter observation is interesting; most patients with severe osteoarthritis of the knee or hip will present complaints, whereas many patients with severe images of spinal degeneration will be symptom-free. Furthermore, a poor correlation between radiological stenosis and symptoms has been reported (Herno et al., 1994). This means that, in many cases, spinal degeneration cannot really be considered as a disease, and the relation between complaints and radiological changes must be very cautious.

Both canal size and dural sac size present a Gaussian distribution. An identical canal size can therefore be stenotic for one person and not stenotic for another who happens to have a smaller dural sac size. The size of the canal is only one component in the pathogenesis of symptomatic stenosis. Lumbar spinal stenosis refers to a pathological condition causing a compression of the contents of the canal, particularly the neural and vascular structures. If compression does not occur, the canal should be described as narrow but not stenotic.

The classic symptom characterizing spinal stenosis is neurogenic claudication, the pathophysiology of which is not entirely understood. However, it has been proposed that claudication is caused by venous pooling induced by impairment of venous drainage at root level and will only occur if stenosis is present at a minimum of two adjacent levels (Porter, 2000; Porter and Ward, 1992). This situation is, however, not the rule, and many patients with stenosis do not present with true neurogenic claudication.

The influence of congenital stenosis on the late development of symptoms is controversial. It seems that, excluding severe achondroplasia and some other rare congenital conditions, the so-called congenitally narrow...
canals are just the extreme of the Gaussian distribution of normal patients described above. This is further stressed by the fact that those patients rarely have any troubles unless they develop degenerative changes. The concomitant presence of degenerative changes appears to be a prerequisite to the development of symptomatic spinal stenosis.

Classically, central stenosis and lateral stenosis are described as distinct entities. However, it appears that in elderly patients with marked degenerative changes, central and lateral lesions are linked in the genesis of complaints. Disc bulging and thickening of the ligamentum flavum causing central stenosis are usually associated with facet hypertrophy and osteophytes responsible for a lateral stenotic condition.

![Figure 2](https://example.com/figure2.png)

**Figure 2**

*CT scan of right lateral stenosis with intraforaminal osteophyte (arrow) causing nerve root entrapment.*

*Source: Szpalski M and Gunzburg R (2004)*

**Differential Diagnosis**

The diagnosis is made by history (smoking, previous arterial disease, cold feet, previous lumbar problems, postural or occupation pain factors, walking stairs) and by a complete examination including appropriate orthopedic, neurologic and vascular tests. A complete history and physical exam, including neurologic signs and vascular assessment, usually suggest the diagnosis. In case of doubt, a vascular Doppler sonogram will help differentiate neurogenic claudication from arterial insufficiency. In elderly people, many concurrent pathologies are often present. Among these, vascular disorders—specifically peripheral arterial insufficiency—can be a challenge in the differential diagnosis of spinal stenosis.

Presentation of intermittent leg pain and discomfort (usually during walking) sometimes shows subtle differences between spinal stenosis and arterial pathologies. In both claudications, walking becomes impossible, but only in neurogenic claudication is stooping or sitting necessary to alleviate the symptoms. Likewise, claudication will appear in both cases during a walking test, whereas a bicycling test will only be interfered with by arterial problems. With advanced neurogenic claudication, descending stairs becomes impossible, obligating patients to walk downstairs backward in order to adopt a forward-flexed position; going upstairs is usually without problems, contrary to arterial pathologies in which all stair-walking is difficult.

Given the age group involved, both pathologies may be present in one patient. In those cases, the differential diagnosis, especially if surgery is foreseeable, may be a headache. Vascular and stenotic problems are possibly more frequently intercorrelated than generally assumed, and we advocate a basic vascular investigation prior to spinal stenosis surgery to avoid useless surgical procedures (Spratt et al., 2004).

In patients with diabetes, it may be difficult to differentiate between lumbar stenosis and diabetic polyneuropathy, as the latter is also common in older individuals. Electrophysiological investigations will help to distinguish between these two pathologies, although they appear to be of more limited utility in the investigation of neurogenic claudication (Adamova et al., 2003).

**Classification and Etiology**

**Central stenosis.** Central stenosis in the elderly is the result of a combination of factors. Disc degeneration and collapse of the disc results in a uniform bulging of the posterior annulus, which encroaches upon the neural canal surface. In some cases, symptoms may only be present in sagittal extension, as a borderline stenosis may only appear in this position (Szpalski et al., 1996). Also as a result of disc collapse, secondary zygapophyseal degenerative changes with facet hypertrophy occur due to the abnormal loads on the facets, resulting from the loss of height of the disc. The degenerative changes, hypertrophy and osteophytes further diminish the central canal at the intervertebral level. **Figure 1** shows a classical image of central stenosis.

Due to this disc collapse and decrease of intervertebral height, the often thickened ligamentum flavum may buckle, thus further decreasing canal space at the disc level. It must, however, be stressed that in elderly patients, central and lateral lesions very often participate together to the stenotic pathology.

**Lateral or root canal stenosis.** Lateral stenosis is defined as an entity in which a nerve root, dorsal root ganglion or spinal nerve is entrapped in its pathway. In the case of degenerative changes, the nerve root can be subject to compression secondary to the disc collapse by narrowing of the pedicles due to the decrease in disc height. Furthermore, hypertrophy of the facet joint or other osteophytes can compress the root at its entrance in the foramen or in the foramen itself (**Figure 2**). Other osteophytes can be found, like those resulting from the calcification of an arthro-synovial cyst (**Figure 3**).

**Degenerative spondylolisthesis.** Degenerative spondylolisthesis, described by McNab (1950) as “spondylolisthesis with an intact neural arch,” most frequently presents at the L4L5 level, may result in a stenotic condition. The displacement, due to facet hypertrophy, can critically narrow the canal. Claudication, or much more often sciatic pain, is the symptom encountered in stenosis secondary to degenerative spondylolisthesis.

**Metabolic causes.** Other conditions can cause spinal stenosis in elderly patients. Neurologic complications are common in

![Figure 3](https://example.com/figure3.png)

**Figure 3**

*CT scan of a calcified arthro-synovial cyst (circled) causing left nerve root entrapment.*

*Source: Szpalski M and Gunzburg R (2004)*
Paget’s disease, as the spine is one of the most common sites it affects. An enlargement of the vertebral body is commonly observed (Figure 4), and this flattened body can compromise the integrity of the intervertebral foramina, interfere with the blood supply to the dura and nerve roots, or lead to spinal stenosis (Schmidek, 1977).

Marcelli et al. (1996) reported that some cases of amyloidosis associated with prolonged hemodialysis or amyloid tumors may cause spinal stenosis or even cauda equina syndrome.

Iatrogenic stenosis. Iatrogenic stenosis is, of course, not specific to elderly patients. It can happen after spinal surgery at any age (Figure 5). However, some spinal disorders specific to elderly people are often treated in a very aggressive way, and the generous use of instrumentation (or even abuse of it) may cause stenotic situations. In most cases, simple decompression will suffice in improving the symptoms and quality of life. Added instrumented fusion is linked to a much higher frequency of complications and often is not justified.

Surgical Treatment

Canal stenosis is the most common indication for lumbar spine surgery in older people. Because increasing numbers of elderly patients are undergoing surgery for lumbar spinal stenosis, it is likely that the incidence of surgical decompressions will increase as the older population continues to grow (Ciol et al., 1996).

Conservative treatment of lumbar spinal stenosis comprises physiotherapy, anti-inflammatory medications, lumbar corset and epidural infiltration. Surgery is usually indicated if well-conducted conservative management fails. The aim of surgery is to improve the quality of life. In recent publications from the Maine Lumbar Spine Study, Atlas et al. (2000, 1996) reported a greater improvement in patient-recorded outcomes for surgery compared to nonsurgical treatment at one- and four-year follow-ups.

It appears that the morbidity associated with surgical treatment of lumbar stenosis in elderly patients is important, as these patients often present with a number of pre-existing endocrine, cardiovascular and pulmonary comorbidities (Deyo et al., 1992; Katz et al., 1995). Increased complication rates have also been shown to be associated with spinal fusion performed for lumbar stenosis in elderly patients (Ciol et al., 1996). Therefore, we will describe two less invasive techniques as they are preferable.

Wide decompressive laminectomy, often combined with medial facetectomy and foraminotomy, used to be the standard treatment. In recent years, however, a growing tendency toward less invasive decompressive surgery has emerged as a logical surgical alternative, sparing anatomical structures and decreasing the risk for postoperative instability. Because stenosis in elderly patients is mainly due to a combination of facet hypertrophy and soft tissue buckling, it is logical to limit the resection to the causative structures to minimize damage and instability. One such procedure, laminarthrectomy, refers to a surgical decompression involving a partial laminectomy of the vertebra above and below the stenotic level, combined with a partial arthrectomy at that level.

The partial laminectomy/arthrectomy or laminarthrectomy procedure has been described in detail (Fraser and Hall, 1992). It involves a limited decompression of the canal and foramen after osteotomy of the spinous processes, leaving an intact remaining laminae bridge and an intact interspinous ligament. We conducted a one-year prospective study of 40 patients treated with this procedure, and we observed successful outcomes in 58% of patients and partial improvement in two-thirds of the remaining patients at a minimum one-year follow-up (Gunzburg et al., 2003).

Other less invasive and less destructive techniques have recently been proposed. Among these are devices inserted between the spinous processes to abolish postural lordosis at the level of the narrowed functional unit. The X-Stop is currently undergoing a prospective study for U.S. Food and Drug Administration approval. This device is implanted between the spinous processes, thus reducing extension at the symptomatic level(s), yet it allows flexion and unrestricted axial rotation and lateral flexion (Figure 6). The major portion of the interspinous ligament is preserved. It is indicated in patients where the symptoms are increased in extension. In a prospective, randomized, multicenter study, Zucherman et al. (2004) showed a success rate at one year of 59% with the X-Stop compared to 12% in the conservative-treatment control group.

Conclusion

Lumbar spinal stenosis is a very common indication for decompressive surgery and/or fusion. Lumbar stenosis in elderly patients is often multifactorial, and the classical segmentation of stenotic pathology is rarely applicable. Furthermore, because frequent concomitant pathologies exist in aging patients, the differential diagnosis can be challenging. The evaluation of stenotic symptoms should be assessed carefully and thoroughly and should include technical exams such as vascular investigations. This is of utmost importance, especially if a surgical sanction is considered in order to avoid disappointing results.

Surgery for lumbar spinal stenosis is generally accepted when conservative treatment has failed and aims at improving the quality of life through a reduction of symptoms such as neurogenic claudication, restless legs and radiating neurogenic pain. Surgery usually does not reduce low back pain, even though most patients with lumbar spinal stenosis frequently complain of low back pain. Studies have reported increased morbidity, surgical complications and mortality (Ciol et al., 1996; Deyo et al., 1992). Postoperative complications increase with greater use of resources, particularly when fusion is being performed (Ciol et al., 1996). In light of the rapid increase in surgery rates in some areas, these contradic-
The use of wide decompressive procedures for spinal stenosis without regard for the integrity of the laminae and facet joints, and without preservation of the spinous processes and interspinous ligaments, may lead to mechanical failure of the spine and a chronic pain syndrome. Hence, wide decompressive procedures are often combined with fusion. A number of recent studies have reported on less aggressive surgical techniques that provide for adequate decompression (Caspar et al., 1994; Epstein, 1998; Munting et al., 2000). These procedures have been described as fenestration, laminotomy, selective decompression and laminarctomy, and are purported to improve postoperative morbidity, provide early mobility and reduce hospital stay. Conservative surgical decompression allows the patient to maintain spinal stability because tissue disruption is minimized, and the decompression is carried out without violating the integrity of the laminae, facet joints and interspinous ligaments. These considerations are particularly pertinent for elderly patients.

The X-Stop interspinous process distraction device is minimally invasive, and the preliminary clinical results appear very satisfactory in those patients where symptoms are enhanced by extension. The operation is short and easy to perform and can even be done in the lateral decubitus position. For some elderly patients with important comorbidities, this may be an additional advantage.

The success rates obtained with these methods (58% with laminarctomy and 59% with the interspinous process distraction device) are similar to the success rate generally reported for classic wide decompressive surgery (Turner et al., 1992). If longer-term studies confirm these outcomes, such techniques that preserve much of the anatomy and the biomechanical function of the lumbar spine may prove highly indicated in the surgical treatment of lumbar stenosis, especially in elderly patients.

**References**


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