

# Spinal Stenosis

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ETIOLOGY ..... 1  
 PATHOPHYSIOLOGY, CLINICAL FEATURES ..... 1  
     Patho..... 1  
     Clinical ..... 1  
 DIAGNOSIS..... 1  
 MEDICAL THERAPY ..... 4  
 SURGICAL THERAPY ..... 4  
     Lumbar stenosis..... 4  
     Cervical stenosis..... 5  
     Thoracic stenosis..... 5

**SPINAL STENOSIS** – anatomical narrowing of *spinal canal*, *root canals*, or *intervertebral foramina* with subsequent *neural compression*.

- PREVALENCE ≈ 0.5%.
- usually in *cervical* and *lumbar* spine; seldom in *thoracic* spine.

## ETIOLOGY

- PRIMARY (CONGENITAL) stenosis** – relatively uncommon:
  - part of **skeletal dysplasias** (e.g. achondroplasia).
  - isolated** - most common in lower lumbar spine: short pedicles, narrow interpediculate distance, coronal orientation of articular facets, interlaminar angle < 90°, shortening or thickening of lamina.
- ACQUIRED stenosis**:
  - spondylosis** (bulging disks, posterior osteophytes, facet hypertrophy, synovial cysts, ligamentum flavum infolding & hypertrophy, degenerative spondylolisthesis & scoliosis). see p. Spin13 >>
  - ossification of posterior longitudinal ligament** see p. Spin13 >>
  - trauma**
  - surgery** (laminectomy, fusion) complications
  - metabolic / endocrine disorders** (epidural lipomatosis, osteoporosis, acromegaly, renal osteodystrophy, hypoparathyroidism)
  - Paget's disease**, diffuse idiopathic skeletal hyperostosis
  - ankylosing spondylitis**, RA

## PATHOPHYSIOLOGY, CLINICAL FEATURES

- monosegmental or multisegmental.
- unilateral or bilateral.

CENTRAL CANAL STENOSIS can cause:

- myelopathy** (cervical)
- cauda equina syndrome** (lumbar).

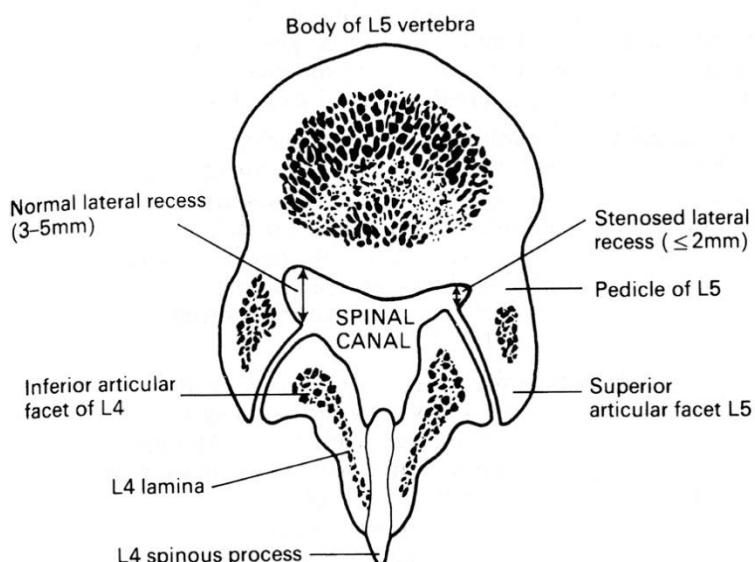
LATERAL RECESS STENOSIS can cause

**radiculopathy**.

NEUROFORAMINAL STENOSIS can cause

**radiculopathy**.

see p. PN1 >>, p. Spin13 >>



These frequently coexist - failure to recognize and correct one component at decompressive surgery is common cause for “failed back surgery syndrome”!

### PATHO

- Disc degeneration → disc protrusion (**central stenosis**), ↓height of intervertebral space →:
- ↓intervertebral foramina (**foraminal stenosis**) → strain on facet joints → facet joint arthrosis, expanding joint cysts (**lateral stenosis**)
  - ligamenta flava form creases (**central stenosis**) - characteristic TREFOIL-SHAPED NARROWING of central canal.

### CLINICAL

**Classic presentation of lumbar stenosis is NEUROGENIC CLAUDICATION** see p. Spin13 >>

- patients usually have 4-5-year history of back pain (lumbago) that becomes progressively worse;
  - pain starts in lower back and eventually begins to radiate to leg(s) or groin(s) because of nerve root compression (**radicular pain** is most common symptom of spinal stenosis!)
  - spinal stenosis pain is worse with **walking** and **backward extension**\* and relieved by **flexing forward**! (vs. mechanical back pain or disk herniation)
    - \***walking uphill** is usually worse because of associated hyperextension that narrows spinal canal.
  - pain exacerbated further by **vertical load** (epidural pressure is elevated while standing or walking, and lowered when **sitting** and in **flexion**).
  - pain is frequently accompanied by leg **hypesthesia** / **paresthesia** and characteristic **feeling of “heavy legs”** (progressing into leg **paresis**).
  - symptoms are absent at rest.
- **congenital stenosis** is usually asymptomatic; manifests earlier in course of acquired stenosis.
- spinal stenosis predisposes to neurologic dysfunction with superimposed minor disk disease!
- physical findings (specific motor weakness, "stretch signs" by straight leg raising) are often absent!
- 20% patients exhibit symptoms of **depression** and 25% are dissatisfied with their life before surgery!

## DIAGNOSIS

Imaging is absolutely necessary to establish diagnosis!

N.B. **radiological** degree of stenosis does not necessarily correlate with **clinical** degree!

Normal spinal canal:

- widest and almost circular at C<sub>1</sub>;
- narrows in mid cervical levels and slightly widens in lower, becoming more triangular in shape;

- in thoracic region canal is almost circular and becomes wider and more triangular, especially in lower lumbar spine.

Dimensions suggesting stenosis:

**sagittal** dimension:  
 < 13 mm (< 12 mm in cervical spine) – *relative* stenosis  
 < 10 mm – *absolute* stenosis (absence of free CSF space)  
**transverse** interfacet dimension < 10 mm;  
**lateral recess** AP dimension  $\leq$  2 mm (norma 3-5 mm)

LATERAL RECESS is bounded: anteriorly by **vertebral body & disc**, laterally by **pedicles**, and posteriorly by **superior articular process** of adjacent facet joint.

Great **individual** and **regional** variation is rule - precise measurements are generally impracticable!

- **soft tissues contribution** (in addition to bone) is especially important in acquired stenosis:

**theal sac cross-sectional area** < 1 cm<sup>2</sup> (< 100 mm<sup>2</sup>) represents stenosis.

- *currently* CT / MRI are performed in **supine position** (diminished gravity effect on alignment and stenosis); *future* imaging systems that scan patients in **upright weight-bearing position** would reveal more profound stenotic changes (criteria for stenosis may need to be refined).

**Plain radiograph** - for excluding other causes (fracture, spondylolysis, neoplasm).

- **flexion-extension views** - to show spinal instability.

**MRI** - imaging study of choice.

**Open MRI, conventional functional myelography** - functional investigation of spinal flexion and extension during application of axial loading.

**CT myelogram** – better (than MRI) delineates bony anatomy (esp. lateral recess stenosis) and specific nerve root's involvement.

- *theal sac often has characteristic "trefoil" shape* (in axial plane) - anterior indentation by bulging disc and posterolateral indentations by degenerated facet joints and/or hypertrophied ligamenta flava.
- in symptomatic stenosis, contrast medium is usually excluded from involved level.
- redundant **tortuosity of roots**\* (above or below stenosis) is consequence of focal entrapment and stretching of these roots, which have long intradural course.

\*may be confused with large intradural veins

Retrodental **epidural pannus** (T2-MRI):



Source of pictures: Viktoras Palys, MD >>

T2-MRI: normal (*left*) vs. stenotic (*right*) lumbar spine:

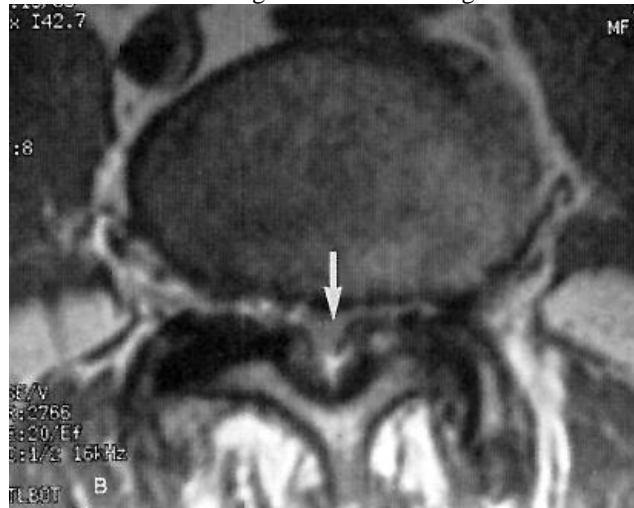


**Central lumbar stenosis** (congenital + acquired):

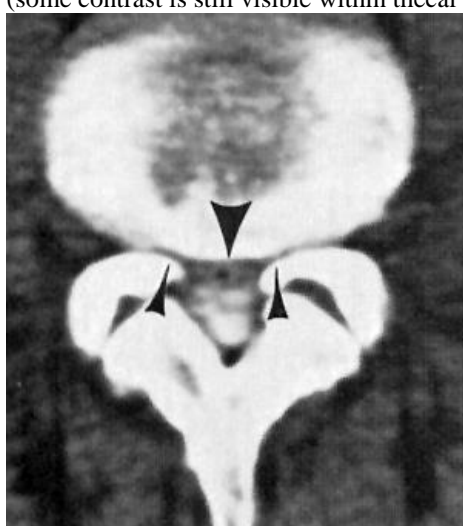




A) generalized narrowing of sagittal canal diameter (< 10 mm) caudal to L2-3 disc; more severe stenosis at L4-5 (associated with degenerative disc changes, including grade 1 spondylolisthesis).  
 B) compression of thecal sac ventrally by bulging disc and posterolaterally by degenerated hypertrophied facet joints and ligamentum flavum; thecal sac (arrow) area < 1 cm<sup>2</sup> and characteristic triangular "trefoil" configuration.



**Lumbar lateral recess stenosis** (CT myelogram): pronounced narrowing of space between vertebral body and facet joints (lateral recess) caused by degenerative hypertrophic changes at disc space (large arrow) and facet joints (small arrows); central canal is narrowed sagittally & transversely (some contrast is still visible within thecal sac):



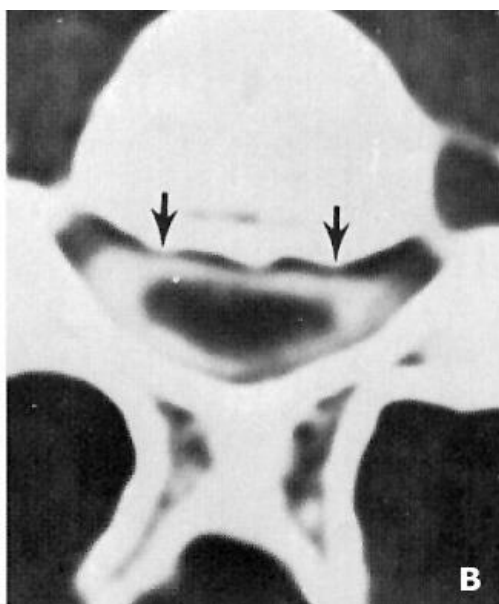
Congenital + superimposed acquired cervical central stenosis in 44-year-old woman with achondroplasia (T2-MRI); note punctate foci of increased signal within cord below narrowed foramen magnum and at level of C5 (arrows):



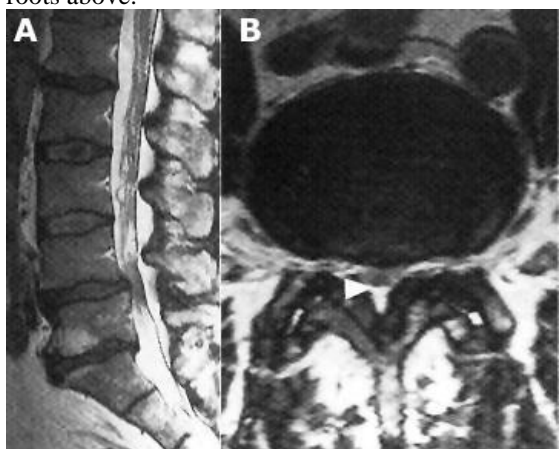
**Cervical degenerative changes** (CT myelography):

A) hypertrophic unciniate processes (black arrows) project into lateral spinal canal and entrance zone of neural foramina; midline disc herniation (white arrow); effacement of ventral CSF.

B) posterior osteophytic ridge at C5-6 compromises sagittal diameter of canal, flattening ventral aspect of cervical spinal cord.



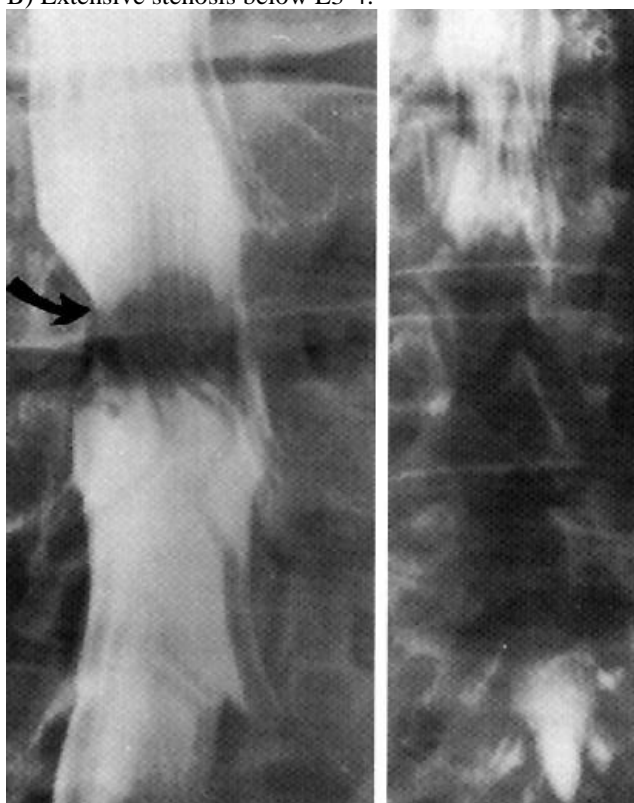
Degenerative **lumbar stenosis** (T2-MRI): severe stenosis at L4-5 with entrapment of cauda equina (obliteration of CSF signal from thecal sac at site of compression - arrowhead) and redundant coiling of intrathecal spinal roots above:



**Lumbar stenosis** (myelography) - two patients (note tortuosity of trapped roots):

A) Focal (arrow) posterolateral impression due to hypertrophic posterior joint.

B) Extensive stenosis below L3-4.

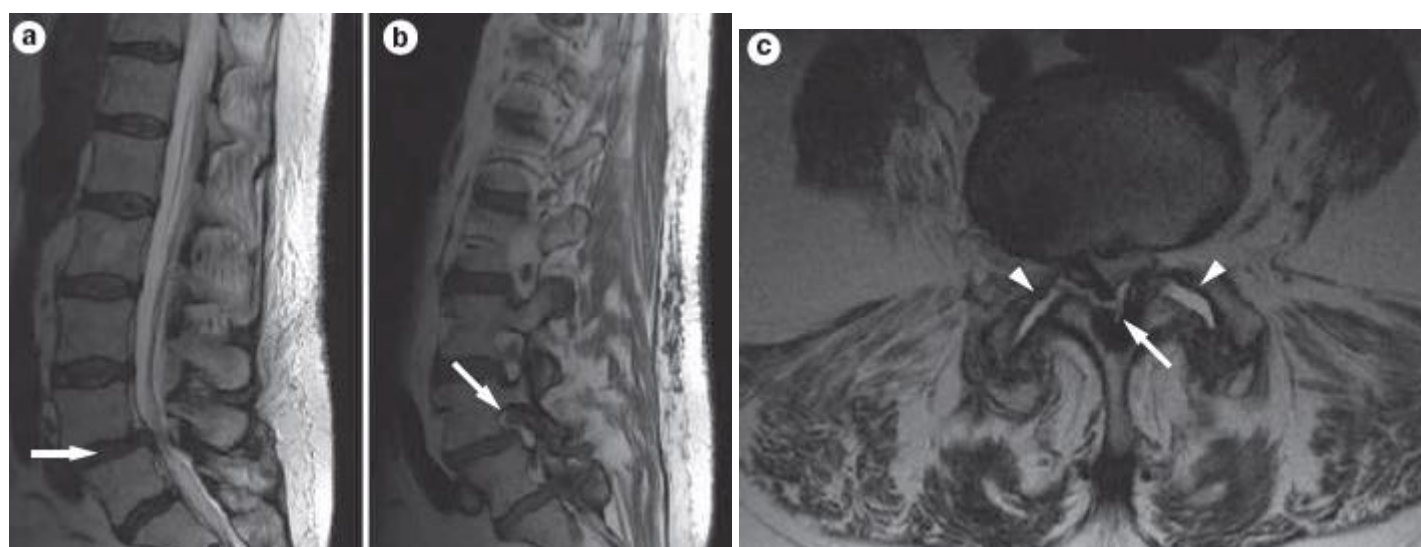


**Monosegmental lumbar stenosis** at L4-5 (T2-MRI):

a. reductions in disc signal and disc space height; disc bulging and slight ventral listhesis of L4 (arrow) b. narrowing of neuroforamen (arrow), which affects right L4 radix.

c. hypertrophic facet joint degeneration with intra-articular effusions (arrowheads) and hypertrophy of lig. flavum (arrow):





Source of picture: Medscape Neurology from WebMD >>

### MEDICAL THERAPY

- for *mild to moderate* symptoms (also 3-6 months trial for *severe* symptoms – if no good response → surgery):

1. **Physical therapy**, exercise to reduce lumbar lordosis (delordosing physiotherapy).
2. **Anti-inflammatory drugs**
3. **Epidural steroid injections.**
  - steroids are used in combination with local anesthetics in epidural, deep paravertebral, paravertebral and facet joint injections.
  - epidural injections have become prerequisite for many spinal surgery insurance authorizations.
  - **LESS (Lumbar Epidural Steroid Injections for Spinal Stenosis) trial** - epidural steroids should be used sparingly or not at all as steroids give very little on top of local anesthetics and results are temporary.
4. **PGE<sub>1</sub> IV** shows promise in treating neurogenic intermittent claudication.

### SURGICAL THERAPY

#### INDICATIONS

1. **Myelopathy** → **urgent surgery**
2. **Cauda equina syndrome** → **urgent surgery**
3. **Severe radiculopathy:**
  - 1) significant muscle weakness.
  - 2) pain affecting patient's quality of life.
4. Prevention of SCI in **cervical stenosis**
  - asymptomatic and mildly symptomatic cervical stenosis patients are commonly recommended to undergo surgery due to risk of paralysis after a minor traumatic event.  
*Chang, Victor "The Risk of Acute Spinal Cord Injury After Minor Trauma in Patients With Preexisting Cervical Stenosis" Neurosurgery: October 2015 - Volume 77 - Issue 4 - p 561–565*  
10 patients (18%) experienced a traumatic event during the follow-up, with none sustaining an SCI - it seems that occurrence of SCI in this patient population after minor trauma is likely smaller than many physicians surmise

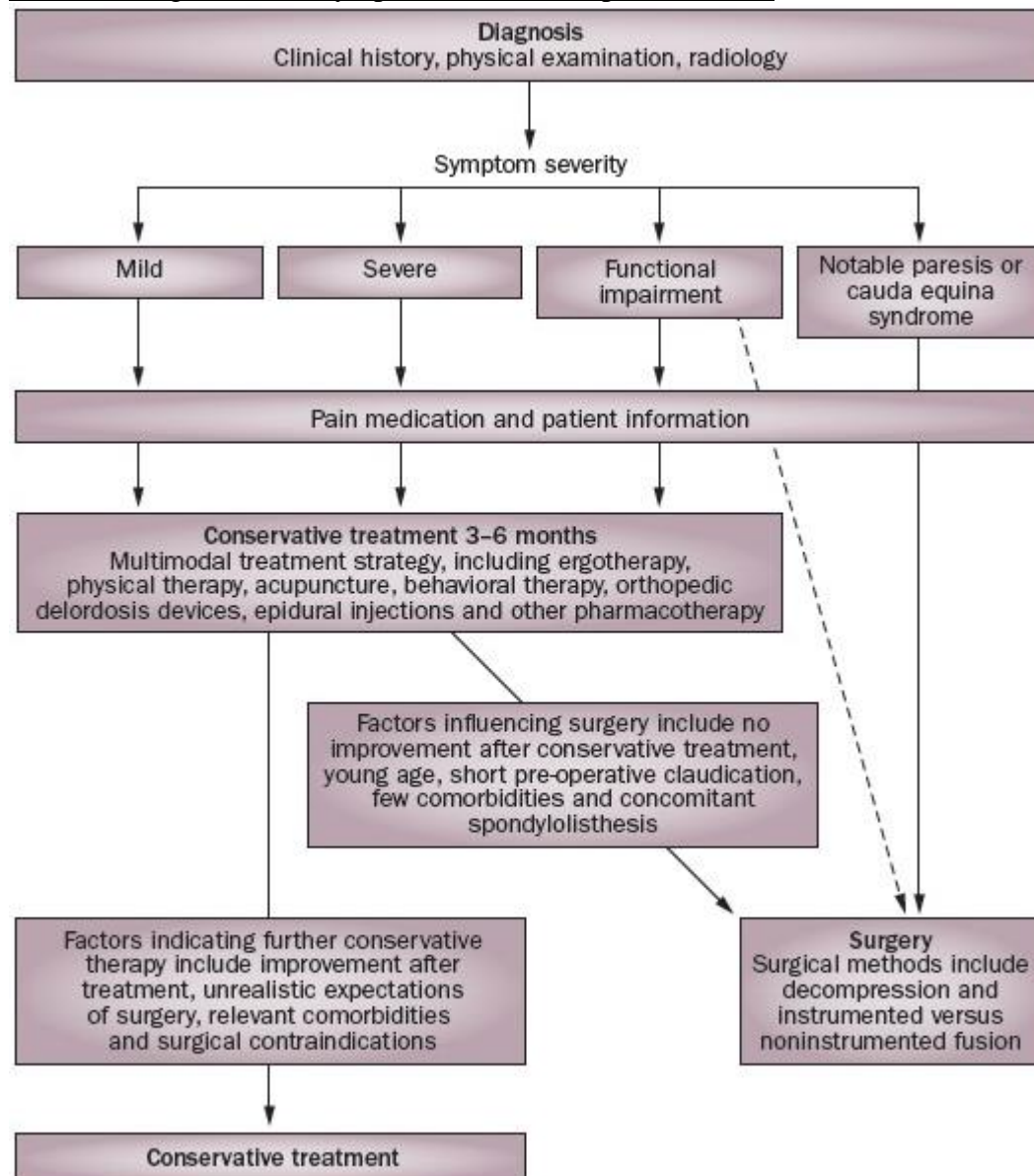
Extent of radiological findings is generally of little help for identification of surgery indication!

### LUMBAR STENOSIS

**LAMINECTOMY & POSTERIOR FORAMINOTOMY** at involved levels.

- most difficult and time-consuming part - *developing plane between dura and ligamentum flavum* (frequently hypertrophic and closely adherent to underlying dura – risk of dural lesion with CSF escape).
- for lateral recess decompression – *facetectomy* (removal of medial part of hypertrophic facet joint).  
N.B. wide decompression with removal of much (> 50%) of facet joints may result in *spondylolisthesis*; H: spinal fusion.
- patients should be aware that benefits of surgery decrease with time but still remain significant till 4 (and possibly 10) years later. However, obtaining improvement for such a period is worthwhile even if it were to fade thereafter.
- **"failed back syndrome"** (scar, residual stenosis); H: reoperation.
- **dynamic stabilizing device** (Coflex) is an adjunct to flavectomy and afford spine stabilization without traditional instrumentation.

Treatment algorithm for symptomatic lumbar spinal stenosis:



### Spine Patient Outcomes Research Trial (SPORT)

- surgical versus nonoperative treatment for lumbar spinal stenosis

Patients with symptomatic spinal stenosis treated surgically compared to those treated nonoperatively maintain substantially greater improvement in pain and function through 4 years!!!

### CERVICAL STENOSIS

- decompression through:

A) **posterior approach** – for <sup>1</sup>multilevel compression, <sup>2</sup>hypertrophied ligamentum flavum.

N.B. wide decompression (pancervical laminectomy) with removal of much of facet joints may result in *swan-neck deformity*; H: use alternative techniques (instead of laminectomy):

- a) *laminoplasty* - decompression of cord and unilateral roots with preservation of contralateral facet joints.
- b) *suspension laminotomy* - laminae are divided and separated from lateral elements by fragments of bone held in place by sutures.

B) **anterior approach** – for anterior compression at few levels.

- often requires fusion. see p. Spin11 >>

### THORACIC STENOSIS

– as for **cervical**.

BIBLIOGRAPHY for ch. “Spinal Disorders” → follow this [LINK](#) >>