Spinal Stenosis

Last updated: December 19, 2020

ETIOLOGY

1. PRIMARY (CONGENITAL) stenosis – relatively uncommon:
   a) part of skeletal dysplasia (e.g. achondroplasia).
   b) 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.

2. ACQUIRED stenosis:
   1) degenerative spondylosis (bulging disks with posterior osteophytes, facet hypertrophy, synovial cysts, ligamentum flavum inflating & hypertrophy, degenerative spondylolisthesis & spondylosis). see p. Spin13 >>
   2) ossification of posterior longitudinal ligament
   3) trauma
   4) surgery (laminctomy, fusion) complications
   5) metabolic/or endocrine disorders (epideral lipomatosis, osteoporosis, acromegaly, renal osteodystrophy, hypoparathyroidism)
     – according to studies, 10-35% of lumbar stenosis patients have amyloid disease involving transthyretin (consider biopsy?)
   6) Paget's disease, diffuse idiopathic skeletal hyperostosis
   7) ankylosing spondylitis, RA

PATHOPHYSIOLOGY

- monosegmental or multisegmental.
- unilateral or bilateral.

CENTRAL CANAL STENOSIS can cause:
   a) myelopathy (cervical, thoracic).
   b) cauda equina syndrome (lumbar).

LATERAL RECESS STENOSIS can cause:
   radiculopathy.

NEUROPERIPHERAL STENOSIS can cause:
   radiculopathy.

see p. PNI >>, p. Spin13 >>

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

Disc degeneration → arthrosis of the uncovertebral joints, disc protrusion (central stenosis), [ height of intervertebral space → ]
   − interspinous ligamentum (foraminal stenosis) → strain on facet joints → facet joint arthrosis, expanding joint cysts (lateral stenosis)
   − ligamenta flava redundancy forms creases (central stenosis) - characteristic TREFOIL-SHAPED NARROWING of central canal.

• spondylosis leads to circumferential narrowing of the spinal canal and static compression of the spinal cord.
• movement of the cervical spine places the spinal cord at risk of injury secondary to dynamic forces, such as buckling of the ligamentum flavum in extension and impingement from a disc osteophyte in flexion.
• congenitally narrowed spinal canal predisposes the degenerating spine to spondylotic myelopathy.

CLINICAL FEATURES

CERVICAL RADICULOPATHY

– see p. PNI >>

CERVICAL SPONDYLOMYELOPATHY

Slowly progressive spastic gait disorders / hand numbness and loss of fine motor control in patient > 50 yrs = CERVICAL SPONDYLOMYELOPATHY until proven otherwise.

- hallmark symptoms are UMN signs in legs - gait abnormalities (stiff, spastic) and (proximal*) weakness / stiffness / proprioceptive loss.
  *deltal strength is reduced less frequently
  - usually develop insidiously as subtle changes in gait or balance.
  - symptoms are commonly asymmetric.
  - loss of vibratory sense or proprioception can occur in the feet.
- neck stiffness / pain because of the advanced spondylosis.
- Lhermitte's sign may be present.
- hyperesthesia may occur.
- arm weakness typically begins in triceps and/or hand intrinsic muscles (wasting of the intrinsic hand musculature is a classical finding in CSM).
- have patient make a fist and release it 20 times in 10 seconds - impairment or clumsiness.
- finger escape sign - patient holds his/her fingers extended and adducted; ulnar digits drift into abduction and flexion within 30 to 60 seconds.
- sensory abnormalities start in the fingertips, are confined to the hand, and occur in a nonradicular distribution.
- positive jaw jerk may help distinguish upper cervical cord compression from lesions above the foramen magnum.
- loss of sphincter control and urinary incontinence are rare.
- patients may also present acutely with a central cord syndrome (after blow to the forehead → acute hyperextension injury with preexisting acquired stenosis or myelopathy, resulting in acute spinal cord compression): greater upper extremity weakness than lower extremity weakness.

**QUANTIFICATION**

1. **Hand dynamometry**
2. **Nine hole peg test**
3. **30-meter walk test** - measuring time and number of steps taken over 30 meters (objective, reproducible e.g. preop and postop)
4. **NURICK disability score**
5. **Modified JAPANESE ORTHOPAEDIC ASSOCIATION functional score (mJOA)**

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| ≥ 15 | mild |
| 12-14 | moderate |
| < 12 | severe |
6. Neck Disability Index (NDI)
7. Berg Balance Scale (BBS)
8. Quality of life (nonspecific for CSM) - Medical Outcomes Study Short Form-36 (SF36v2)

Natural history is unclear
Natural course of CSM for any given individual is variable, and a precise prognostication is not possible! Current view is that myelopathy tends to progress:
- Some experts see it as a steadily progressive disease, others think it is episodic disease with periods of plateaus and worsenings.
- Risk factors for progression: older age, motor deficits, long duration of deficits, more severe deficits.
- Patients who present with cervical myelopathic findings:
  - 75% demonstrate a slow progression of disease; in 1/3 of patients clinical course stabilizes.

LUMBAR STENOSIS

History
- 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;
  - "back pain may be absent back pain in lower back and eventually begins to radiate to buttock(s), 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) and recumbency*.
  - *walking uphill is usually worse because of associated hyperextension that narrows spinal canal.
  - Pain is frequently accompanied by leg hypesthesia / paresthesia and characteristic feeling of "heavy legs" (progressing into leg paresis).
  - Symptoms are absent at rest.

Objective examination
- Physical findings (specific motor weakness, "stretch signs" by straight leg raising, abnormal Romberg test, abnormal Achilles tendon reflexes) are often absent!
- Physical findings cannot confirm diagnosis of degenerative lumbar spinal stenosis.

Natural History
- in mild / moderately symptomatic degenerative lumbar stenosis, rapid or catastrophic neurologic decline is rare.
- Natural history of clinically or radiographically severe degenerative lumbar stenosis is less clear (to patients agree to stay untreated).

DIAGNOSIS
- Imaging is absolutely necessary to establish diagnosis! (no objective physical examination findings can confirm diagnosis)

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

Normal spinal canal:
- widest and almost circular at C1;
- 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.

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

Dimensions suggestive of stenosis:
- Sagittal dimension:
  - < 13 mm: relative stenosis
  - < 10 mm: absolute stenosis (absence of free CSF space)
- Transverse interfacet dimension ≤ 10 mm;
- Lateral recess AP dimension ≤ 2 mm (norma 3.5 mm)

LUMBAR STENOSIS

Most commonly used measurements:
1. Depth of the lateral recess; 2. Ligamentous interfacet distance; 3. AP diameter of dural sac; 4. Transverse diameter of dural sac; 5. Angle of the lateral recess.

STUDIES

- 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).
- MRI - imaging study of choice.
- Open MRI, conventional functional myelography - functional investigation of spinal flexion and extension during application of axial loading.
  - MRI or CT with axial loading is suggested as a useful adjunct to routine imaging in patients who have clinical lumbar spinal stenosis and suspected but not verified central or lateral stenosis on routine unloaded MRI or CT.
- CT myelogram - better (than MRI) delineates bony anatomy (esp. lateral recess stenosis) and specific nerve root's involvement; imaging study of choice when MRI is contraindicated.
  - Thecal sac often has characteristic "trefoil" shape (in axial plane) - anterior indentation by bulging disc and posterior/lateral 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 - "spaghetti" sign) is consequence of focal entrapment and stretching of these roots, which have long intradural course.
  - May be confused with large intradural veins.
- EMG detects neuromuscular diseases that may mimic stenosis.

Retrodental epidural pannus (T2-MRI):
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 cm² 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 (arrow).
Spinal Stenosis

Cervical degenerative changes (CT myelography): A) hypertrophic uncinate processes (black arrows) project into lateral spinal canal and entrance zone of neural foramina; B) posterolateral osteophytic edge 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 radiculopathy causing intrathecal spinal roots effacement.

Lumbar stenosis (myelography) - two patients (note tortuosity of trapped roots): A) Focal (arrow) posterosilateral impression due to hypertrophic postural bone. B) Extensive stenosis below L3-4.

Degenerative lumbar stenosis at L4-5 (T2-MRI): A) rosbience 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).

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

CERVICAL STENOSIS


*successful surgery may reverse some symptoms (esp. mild ones)

1) anti-inflammatory drugs – concern for side effects with chronic use
2) analgesics – Tylenol is agent of choice; opioids have no end organ toxicity, no dose ceiling effect.
3) muscle relaxants – only for acute episodes.
4) antidepressants
5) anticonvulsants (Gabapentin, etc)
6) steroids – systemic (1-2 week courses) or ESI (axial neck pain is a poor indication for ESI)
7) facet joint RF ablation – for chronic axial neck pain.
8) physical therapy (adequate pain reduction is needed prior to PT to facilitate its utilization)
9) cervical immobilization with an external cervical orthosis have been recommended for symptomatic relief in myelopathy (esp. combined with isometric exercises), but no effect on long-term outcomes, including neurological progression, has been demonstrated. N.B. cervical collars may not prevent deterioration in cervical spondylotic myelopathy (esp. if > 2 yrs duration). Wilkinson M: The clinical aspects of myelopathy due to cervical spondylosis. Acta Neurol Belg 76:276–278, 1976

10) manipulation and traction show some efficacy for axial neck pain and radiculopathies; contraindicated for myelopathy because of the potential for aggravation of neurological injury!

LUMBAR STENOSIS

- 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 (dolorlising physiotherapy).
2. Anti-inflammatory drugs
3. Epidural steroid injections with contrast-enhanced fluoroscopy guidance:
   - steroids are used in combination with local anesthetics in epidural, deep paravertebral, paracaudal 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. Addition of GARAPNITIN to a PT can result in greater short-term improvement.

5. PGE IV shows promise in treating neurogenic intermittent claudication.

NASS Clinical Guidelines for Lumbar Stenosis (2011):

There is insufficient evidence to make a recommendation for or against the use of pharmacological treatment.

Medical/interventional treatment may be considered to provide long-term (2-10 years) improvement and has been shown to improve outcomes in a large percentage of patients.

There is insufficient evidence to make a recommendation for or against the use of physical therapy or exercise as stand-alone treatments. Based on limited course of active PT it is an option.

Epidural steroid injections: INTERLAMINAR injections are suggested to provide short-term (2 weeks to 6 months) symptom relief. Multiple TRANSFORAMINAL injections or CAUDAL injections are suggested to produce medium-term (3-36 months) relief of pain. There is, however, conflicting evidence concerning long-term (21-5-24 months) efficacy.

Lumbar surgical improvement is suggested to increase walking distance and decrease pain; no evidence that results are sustained once the brace is removed (grade B recommendation).

**SURGICAL THERAPY, OUTCOMES**

**INDICATIONS**

1. Myelopathy, esp. with demonstrated progression and age > 60 yrs (Nurick’s criteria), mJOA ≤ 14 points.
   - treatment of mJOA > 15 patients remains controversial; experts lean towards surgery for patients with predominance of neck pain, motor symptoms (gait dysfunction and hand weakness), and female gender – surgical intervention results in greater gains.

2. Cauda equina syndrome → urgent surgery

3. Severe radiculopathy:
   - significant muscle weakness.
   - 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 SCI after a minor trauma.

   - **Clinical Focus:** The Risk of Acute Spinal Cord Injury After Minor Trauma in Patients With Preexisting Cervical Stenosis: Neurosurgery October 2015 - Volume 77 - Issue 4 - p 561-10, DOI: 10.1093/neuros/nuv260 (A prospective cohort study). SCI is an 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.

   *20-40% of patients with mild/lower lumbar stenosis receiving medical/interventional treatment will require surgical intervention within 10 years; of the patients who do not require surgical intervention, 50-70% will have improvement in their pain.

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

**SURGICAL THERAPY, OUTCOMES**

**SURGICAL THERAPY, OUTCOMES**

**CERVICAL STENOSIS**

Indications – see above >>

Decompression through:

A) posterolateral approach - laminectomy (CLAM) - for 1 multilevel compression, _hypertrophied_ ligamentum flavum.

N.B. wide decompression (pencerectional laminectomy) with removal of much of facet joints may result in mid-neck deformity (esp. if patient already has loss of lordosis preoperatively) - spine cord becomes deformed along the dorsal aspect of ventral compressing structures with worsening static cord compression; to avoid this, use PCF or alternative techniques.

(a) expansive laminectomy.

7b) _suggestion laminectomy_ - laminae are divided and separated from lateral elements by fragments of bone held in place by sutures.

B) interior approach - ACDF:

- *some authors report that disease involving > 2 vertebral body levels may be better one addressed by a dorsal approach.*

- if stenosis is also behind vertebral bodies (incl. OPLL) – need corpectomy (or at least ACDF with **Climaform technique**).

- OPLL tends to progress after surgery, so need to decompress also levels above and below stenosis.

Moderate and Severe Degenerative Cervical Myelopathy


- although the main goal of surgery is symptom stabilization, a subset of patients achieves remarkable improvements.

- 20.3% (51 out of 251) with moderate or severe baseline myelopathy achieved an mJOA score of 18 (no signs of myelopathy) at 2 yr.

- T1W hypointensity on MRI and longer walking time (on 30-m walking test) predict a less likelihood of achieving return to normal neurological function after surgery for moderate or severe DCM.

- 9.7% deteriorated within 2 yr after surgery! – on univariate analysis, male gender (P = .01) was associated with higher odds of deterioration, whereas severe baseline myelopathy was associated with lower odds of deterioration in a multivariate analysis; male gender was found to significantly increase the odds of deterioration at 2 yr of follow-up (OR 3.23, 95% CI, 1.29-8.07; P = .01). Crudie deterioration rates between males and females were 13.5 vs 4.4% (P = .004).

**CERVICAL STENOSIS**

Indications – see above >>

LAMINECTOMY & FACETOMY at involved levels.

- 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.

- patients should be aware that benefits of surgery decrease with time but still remain significant till 4 years, esp. with demonstrated progression, and age > 60 yrs (Nurick’s criteria).

- **failed back syndrome** (sciar, residual stenosis); H: reoperation or spinal cord stimulator.

- dynamic stabilizing device (Coflex) is an adjunct to flavectomy; offloads facet joints and affords spine stabilization without traditional instrumentation; flattens lordosis → worsened sagittal balance.
Surgical versus nonoperative treatment for lumbar spinal stenosis; class II evidence.

Exclusions: spondylolisthesis, instability (defined on lateral X-ray).

Surgical patients maintain substantially greater improvement in pain and function through 4 years!!


NASS Clinical Guidelines for Lumbar Stenosis (2011):

Decompressive surgery is suggested to improve outcomes* in moderate to severe lumbar stenosis (grade B recommendation), incl > 75 yo.

Decompression alone** is suggested for leg predominant symptoms without instability***(grade B recommendation).

There is insufficient evidence for or against an interspinous process spacing device in lumbar stenosis.

*good or excellent results in 80% of patients at 4-year and 70% at 10 years follow-up.

**i.e. without fusion

***(i.e. < 5 mm intervertebral translation

N.B. patients who have medical/interventional therapy first but then cross over to surgery will not harm their chances of success with surgery.

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Treatment algorithm for symptomatic lumbar spinal stenosis:

BIBLIOGRAPHY for ch. “Spinal Disorders” — follow this LINK >>