14 MICRODECOMPRESSION ON LUMBAR SPINAL STENOSIS SURGERY

R. Kemal Koc MD

Classification of Lumbar Spinal Stenosis

I- Congenital

- Idiopathic
- Achondroplasia
- Osteopetrosis

II- Acquired

- Degenerative
  - Central
  - Lateral recess or foraminal
  - Degenerative spondylolisthesis
- Idiopathic
- Traumatic
- Other:
  - Acromegaly
  - Ankylosing spondylitis
  - Paget's disease
  - Iatrogenic
  - Neoplastic
  - Fluorosis

III- Combined

Pathophysiology of degenerative lumbar spinal stenosis

- As a result of the degenerative process, the spinal canal volume is reduced due to osteophytic enlargement of the facet joint, thickening of flavum, protrusion of the disc. (Figure 1)
- Dynamic components (hypermobility due to spondylolisthetic or scoliotic mobile segment) aggravate stenosis and symptoms.
- Remains less space for the neural structures.
- Symptoms occurs due to mechanical nerve root compression and vascular insufficiency or venous stasis around the nerve roots.
- Mechanical irritation increases the local inflammatory response.
- Chronic pressure on nerve roots causes edema, demiyelination and Wallerian degeneration of afferent and efferent fibers.

Figure 1: *Lumbar T2-weighted axial MRI revealed spinal canal stenosis due to hypertrophy of facet joints and thickening of ligamentum flavum as a result of the degenerative process, and disc protrusion.*

Symptoms and signs

Symptoms

- Low back pain (95%), claudication (91%), leg pain (71%), leg weakness (33%).
- Symptoms worsen by walking, and ameliorate by sitting and/or lumbar flexion.
- Radicular pain (with disc herniation).

Signs

- Neurologic deficit is minor despite the obvious symptoms.
- Laseque or femoral nerve stretch test may be positive due to presence of a concomitant disc herniation.

Cervical and lumbar stenosis may occur simultaneously.

Stenosis types

1. Central stenosis

- Ligamentum flavum is hypertrophied and folded.
- Superior facet is hypertrophied or osteophyted.
- Intervertebral disc protrusion and/or osteophytic formations contribute decrease in the anterior-posterior diameter of spinal canal. (Figure 2)

2. Lateral stenosis

- Nerve root entry zone
- Foraminal stenosis
- Far lateral stenosis

Nerve root entry zone (Figure 3)

- Lateral recess stenosis
- Superior facet hypertrophy

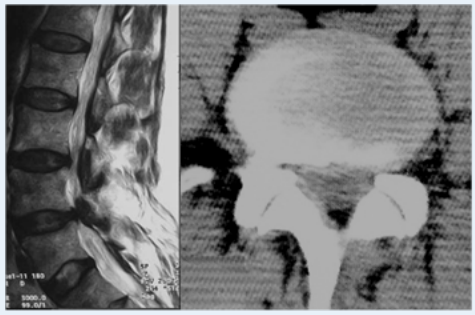

Figure 3: *The L4 right nerve root compression is shown on the exit of the subarticular region.*

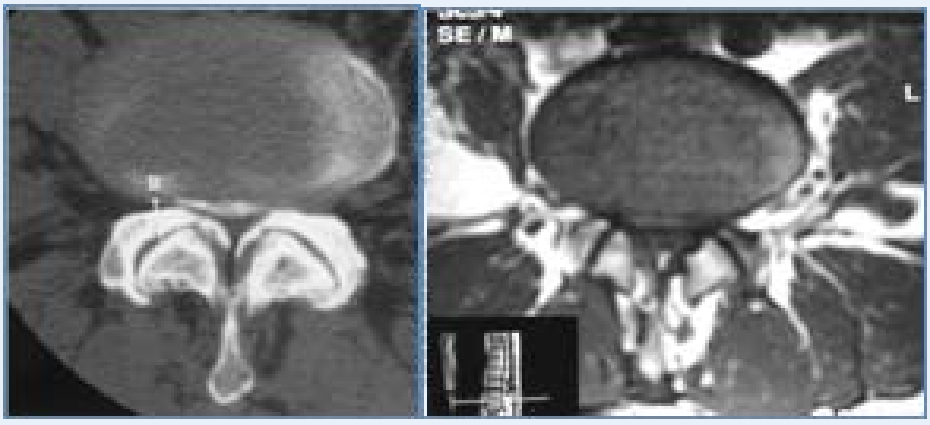

Figure 2: *Lumbar axial CT and T2-weighted MRI revealed distinct decrease A-P diameter of spinal canal in severe lumbar stenosis.*

Foraminal Stenosis

- Narrowing of neural foramen due to foraminal disc herniation, foraminal collapse depending on the intervertebral disc space collapse, pedicles king due to the scoliosis, fibrocartilagenous growth due to pars interarticularis defect.
- Distribution: 75%: L5, 15%: L4, 5%: L3
- Can be in the form of craniokaudal stenosis and/or anteroposterior stenosis (Figure 4).
- Dynamic or static stenosis form (15% expansion at lumbar flexion, 12% contraction at lumbar extension) can be occurring.

Figure 4: *Anterior-posterior and craniocaudal stenosis of neural foramen is shown.*

Extraforaminal stenosis

Far lateral disc or spondylosis is pressured the leaving nerve root of a top level. (Figure 5)

Lumbar stenosis conservative treatment

- Drugs: Analgesics, NSAIDS, myelorelaxan
- Training
- Exercise
- Corset
- Epidural steroid injection

  Best results in 50% of the cases

Figure 5: *Nerve root compression in far lateral region shown in T2-weighted sagittal lumbar MRI.*

Surgical Indications

- Reduce the quality of life of neurogenic claudication
- Inability of medical treatment
- Loss of muscle strength
- Cauda equina syndrome

Differential Diagnosis

Vascular

- Peripheral vascular disease
- Aortic aneurysm

Neurological

- Diabetic neuropathy
- Peripheral compressive neuropathy
- Cervical myelopathy
- ALS
- Demyelinating diseases

Musculoskeletal system

- Osteoarthritis of the hip and knee

Other

- Retroperitoneal disease, kidney diseases, psychological

Preoperative Imaging

Direct x-ray

- Sagittal and coronal balance, spinal arthritic changes, bone quality.
- Osteofitik changes, collapse at intervertebral space, loss of lordosis.
- Dynamic x-ray: the presence of instability.

MR

- Evaluation of spinal canal
- Sensitive and non-invasive

BT

- Stenosis (spinal canal area < 100 mm^2)

Accompanying Pathologies

- Degenerative scoliosis
- Degenerative spondylolisthesis
- Degenerative instability
- Disc herniation
- Osteoporosis

Surgical Treatment

The goal; is decompression of the dural sac and the affected nerve root, relief of patient's symptoms while maintaining the spinal stability.

Surgical treatment options

However laminectomy has been preferred as a frequent surgical decompression technique in spinal stenosis, recently minimally-invasive methods especially bilateral decompression via hemilaminotomy technique is being used more widely.

One of the following methods is usually chosen according to the localization of the neural element compression.

- Laminectomy, Trumpet laminectomy
- Hemilaminectomy, hemilaminotomy
- Bilateral laminotomy
- Hemilaminotomy bilateral decompression
- Spinous process-splitting laminectomy
- Laminoplasty
- Microendoscopic posterior decompression
- Far lateral decompression

Basic Principles of Decompression Technique[1,3,5,8,11-13]

- In patient positioning: the patient is given the prone position with the lumbar region brought hiperflexion. Interlaminar distance opens. (Figure 6) Decompression can be done safely, while the broader position of the spinal canal.
- Facet capsules should be protected.
- Cautions in prevention of intraoperative dural injury
  - Usage of microscope and microsurgery tool.
  - Thinning of the lamina and hypertrophic bone with high-speed drill.
  - Use of a blunt dissector or nerve hook to separe the adhesions.
  - Use of a small-tailed Kerrison punch.
  - Decompression could be performed from caudal to cranial then craniocaudally done.
- Spinal stability should be protected during decompression
  - More than 50% of the facet joints complex should not be removed.
  - Nerve root can be decompressed by removal of the medial 1/3 of superior articular process.

Figure 6: *Lumbar hyperflexion position*

- Pars interarticularis should be protected at least 5 mm wide.
- Dissector must be easily moved throughout the course of decompressed nerve root after decompression.

Hemilaminectomy, hemilaminotomy

- Indicated in patients with compression of neural elements and symptomatic unilaterally.
- Ipsilateral lamina and ligamentum flavum are removed.
- Advantages
  - Minor skin incision
  - Single-sided muscle dissection

Laminectomy

- Can be preferred in patients with central and lateral stenosis, especially in the elderly. But the spinal stability is reduced (at forward bending after laminectomy, at standing up after the two levels laminectomy, at axial rotation after the hemifacetectomy).

  Advantages
- Spinal surgeons are accustomed to the technique.
- A direct approach to the posterior pathology.

  Disadvantages
- High risk of instability.
- High risk of epidural scar and laminectomy membrane.
- Restenosis.
- Paravertebral muscle atrophy.

Trumpet (tube) laminectomy[6]

- The cranial and caudal lamina are preserved.
- Interspinous and supraspinous ligaments are preseverved.
- Stability is preserved.

Spinous process-splitting laminectomy[14]

- Spinous process is divided longitudinally in the middle. It is broken from posterior arc.
- Muscle adhesion sites are protected.

Laminoplasty

- Indicated at young patients with central spinal stenosis.
- Removed lamina is stabilized with the screw and miniplaque systems.

Hemilaminotomy and bilateral decompression[1,3,5,8,11-13]

This technique can be applied with success in most of the cases with lumbar degenerative stenosis in stable phase. Technique: The midline skin incision is made, the dorsolumbar fascia is opened. Paravertebral muscle is dissected bluntly. Partial hemilaminotomy or hemilaminectomy is performed with high-speed drill and microscope. Ligamentum flavum is bilaterally removed. Subarticular space decompressed with the Kerrison punch. Base of spinous process is taken by drilling, If necessary, contra-lateral base of the lamina is drilled. Contra-lateral subarticular space decompressed with the Kerrison punch, and nerve root is decompressed. Contra-lateral foramen is controlled by the dissector.[12] (Figure 7)

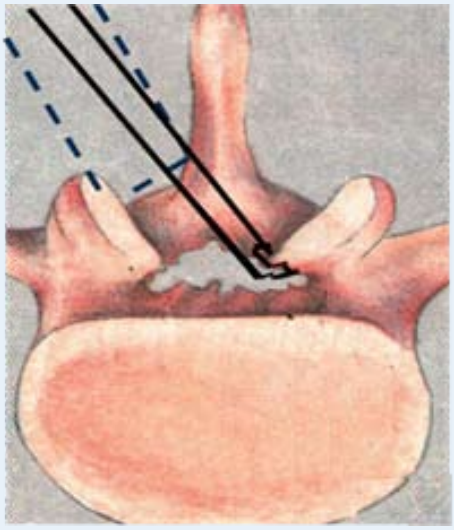

Figure 7: *First, hemilaminectomy or hemilaminotomy is done, then removal of the base of the spinous process by drilling and contra-lateral hypertrophic and osteophytic spurs in subarticular zone with Kerrison punch is done in order to obtain optimal spinal cord and nerve root decompression.*

Advantage

- Spinal instability is minimal
  - Spinous process, interspinous and supraspinous ligaman are preserved.
  - Contra-lateral paravertebral muscle is preserved.
- Less blood loss
- Short hospitalization period
- Better results[1,8,13]
  - 80% good or excellent result
  - 97% patient satisfaction

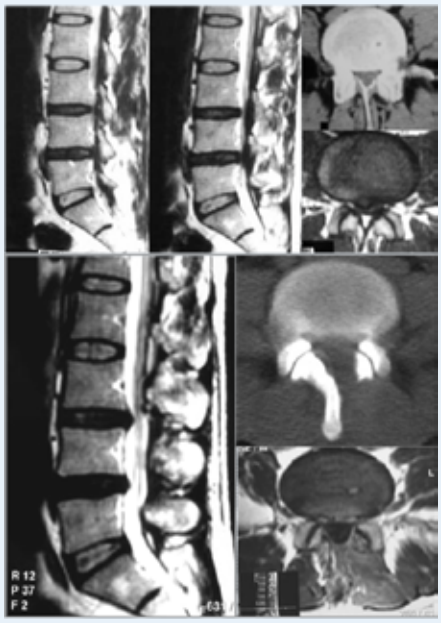

Figure 8: *Case: 52 years old, female, neurogenic claudication 50 m +, Preop Sagittal T2-weighted lumbar MRI and axial lumbar CT (above) reveal significant spinal canal stenosis at L3-4, L4-5 level. Post op MRI and CT (bottom) shows enough decompression.*

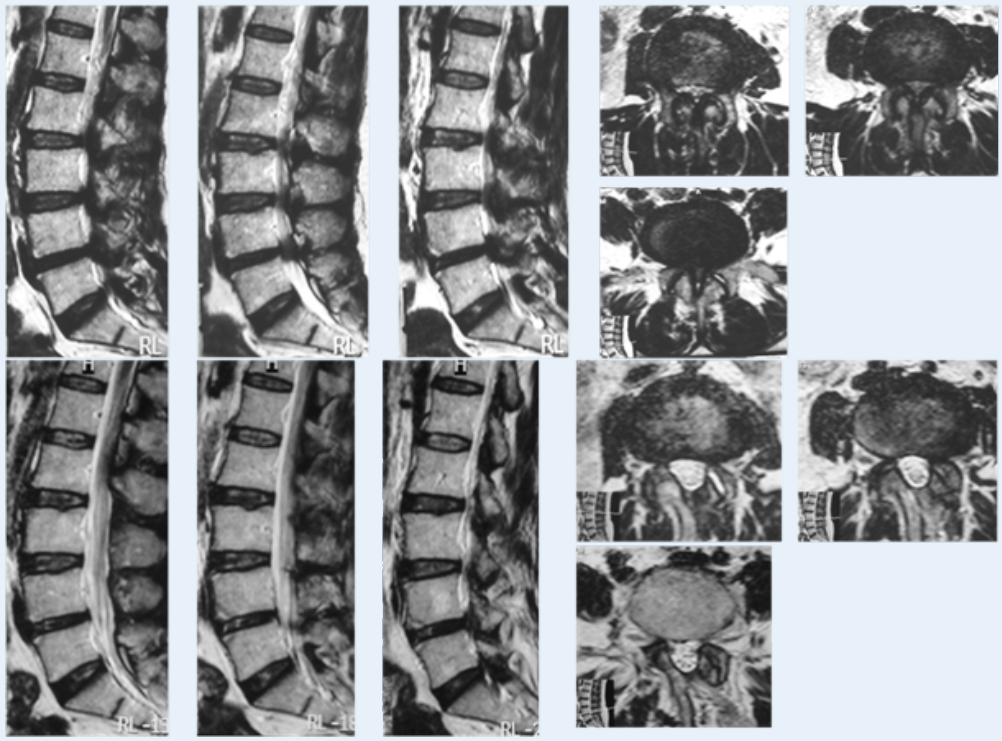

Figure 9: *Case: 53 years old, female: neurogenic claudication 50 m + for 3 years, back pain for 10 years. Lumbar MRI revealed significant stenosis at L2-3, L3-4, L4-5 levels. PO 5. months; walking normal, mild back pain. In check -MRI (bottom) efficacious spinal cord and nerve root decompression.*

Hemilaminotomy and Bilateral Decompression in Degenerative Spondylolisthesis

Better results are reported in the cases with hemilaminotomy and bilateral flavectomy in degenerative spondylolisthesis, although the slippage progressed. (Table 1)

A larger facet effusion size (1.3±0.9) in the patients with lumbar degenerative spondylolisthesis strongly suggested that the affected segment had been instabilized. [3,9] (Figure 10) If interfacet space is separated and T2 hyperintense, only canal decompression is insufficiency, instrumentation should be added.

Table 1:
Results of postoperative satisfactory evaluation in study of Sasai et al.

Satisfaction	Degenerative spondylolisthesis	Degenerative stenosis
Excellent	57%	48%
Good	26%	40%
Moderate	13%	2%
Insufficient	4%	-
Bad	-	-

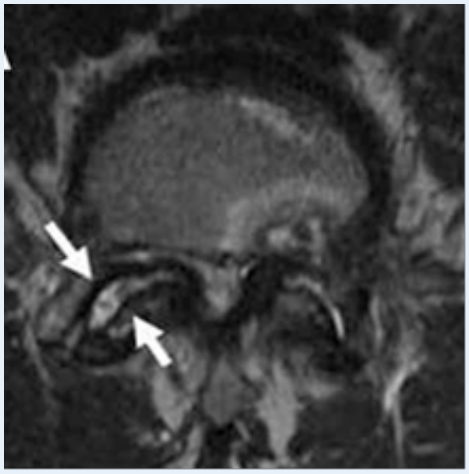

Figure 10: *T2-weighted axial lumbar MRI revealed split and hyperintense changes shadowing out facet joint subluxation in spinal stenosis.*

Combined Lateral and Medial Approach in Lumbar Foraminal Stenosis

If foraminal stenosis is compressed the superior and inferior nerve roots, superior lateral part of the facet joint and top and lateral edge of the interarticular sections are drilled using the high speed drill and surgical microscope. Intertransverse ligament is excised and superior nerve root is exposed. The affected nerve root is decompressed throughout neural foramina. Then inferior nerve root is decompressed by drilling the medial of facet and inferior of lamina by standard interlaminar approach.[4] (Figure 11)

Far Lateral Decompression[7]

- There are two options in L5 nerve root compression.
  1. L5 hemilaminotomy, the lower part of superior facet is removed by Kerrison punch and curette.
  2. Far lateral decompression

Microendoskopic Decompression[5]

- Microendoskopic bilateral decompression by single-sided approach.
- Advantage
  - Small incision
- Disadvantages
  - Field of view is narrow.
  - Further education and experience is required.
  - There are no superiority to hemilaminotomy bilateral decompression by using Williams retractor and microscope.

Recurrences of Stenosis After Surgery[11]

- No recurrence 12%
- Mild recurrence 48%
- Moderate recurrence 28%
- Severe recurrence 12%

There is no satisfactory clinical results in 60% of cases with severe recurrence.

Indications of Instrumentation in Lumbar Stenosis

- Instability
- Progressive deformities (scoliosis, kyphosis)
- Resection of more than 50% of facet, or taken of single facet.
- Extensive decompression
- Loss of lordosis
- Stenosis at previously decompressed level
- Facet effusion in T2 axial MR is more than 1.3±0.9 mm in degenerative spondylolisthesis.

Instrumentation Options in Lumbar Stenosis

- Rigid instrumentation + fusion
- Dynamic instrumentation

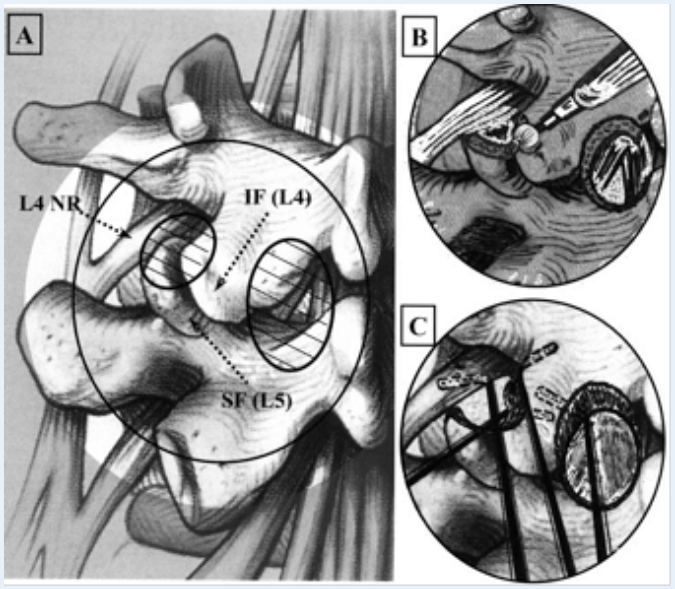

Figure 11: *Decompressed nerve root at the top and bottom (From Hejazi N, J Neurosurg (Spine 1) 96: 118-121, 2002)*

Complications

Peroperative/early postoperative complications

- Dural injury
- Cauda equina syndrome
- Nerve root injury
- Epidural hematoma
- Infection

Late complications

- Segmental instability
- Epidural scar formation

Prognosis[2]

- Many variables (due to type of stenosis, number of stenosis, applied surgical method, etc.).
- Overall, good or excellent result is 82%.
- Good or excellent result is 96% in non-related symptoms with posture.
- Low back pain is more likely to continue after the decompression.

Results

- Most of the cases benefit from conservative treatment.
- Aim of surgery; is achieving optimal neural element decompression in a balanced and stable spine.
- Muscle, bone and ligamentous structures should be protected as much as possible.
- Hemilaminotomy bilateral decompression is enough in the majority of cases (especially in elderly patients).
- In cases of clinical and radiological instability, the instrumentation is added (especially for young patients).

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