Surgery of lumbar spinal stenosis: When adding an internal fixation?

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Introduction

First clinical description of LSS is attributed to Verbiest in 1954.

Jenis.1 central; 2 lateral recess; 3 foramen; 4 extraforaminal.

Arnold 1976

Lumbar Spinal Stenosis
Best Practice & Research Clinical Rheumatology, Volume 24, Issue 2, April 2010, Pages 253-265
Stephane Genevay, Steven J. Atlas
Prevalence of acquired stenosis increased with age. LSS, associated with a threefold higher risk of experiencing LBP.
Associations between radiographic lumbar spinal stenosis and clinical symptoms in the general population: the Wakayama Spine Study

Osteoarthritis and Cartilage, Volume 21, Issue 6, June 2013, Pages 783-788


Prevalence of clinical symptoms increased with increasing severity of radiographic LSS.
Lumbar spinal stenosis – a current view
Orthopaedics and Trauma, 1 November 2014 Myung-Sang Moon, Sung-Soo Kim, Jang-Cheol Sihn

The double crush phenomenon of the compressed root. How does walking exacerbate symptoms? Vascular dilatation within the nerve roots causing a reduction in available space. Increase in venous pooling with impairment of arteriolar inflow.
With aging, **type I collagen** increases as **type II collagen** decreases, leading to desiccation. Increase in **ratio of keratan sulfate to chondroitin sulfate**. Altered disc structure, loss of disc height, and annular incompetence can lead to bulging of the disc and posterior longitudinal ligament.
Assessment of LSS

Spinal stenosis symptoms may lead to worsening of postural control.

A Comparative Analysis of Static Balance Between Patients With Lumbar Spinal Canal Stenosis and Asymptomatic Participants

Journal of Manipulative and Physiological Therapeutics 26
September 2014 Aleksandra Truszczyńska, Justyna Drzał-Grabiec, Zbigniew Trzaskoma, Kazimierz Rąpała, Adam Tarnowski, Krystyna Górniak
Prospective analysis of clinical evaluation and self-assessment by patients after decompression surgery for degenerative lumbar canal stenosis

The Spine Journal, Volume 8, Issue 2, March–April 2008, Pages 380-384
Hirotaka Haro, Shingo Maekawa, Yoshiki Hamada

SF-36v2, VAS, and ODI scores, a valuable complement to JOA score in evaluating outcomes of surgery for lumbar canal stenosis.

I. Subjective symptoms (9 points)
   A. Low back pain
      1. Frequent mild or occasional severe pain
      2. Occasional mild pain
      3. None
   B. Leg pain and/or tingling
      0. Frequent or continuous severe pain
      1. Frequent slight or occasional severe symptoms
      2. Occasional slight symptom
      3. None
   C. Gait
      0. Unable to walk further than 100 m because of leg pain, tingling, and/or muscle weakness
      1. Unable to walk further than 500 m because of leg pain, tingling, and/or muscle weakness
      2. Able to walk further than 500 m because of leg pain, tingling, and/or muscle weakness
      3. Normal

II. Clinical signs (6 points)
   A. Straight leg raising test (including tight hamstrings)
      0. Less than 30°
      1. 30–70°
      2. Normal
   B. Sensory disturbance
      0. Marked disturbance
      1. Slight disturbance (not subjective)
      2. None
   C. Motor disturbance (MMT)
      0. Marked weakness
      1. Slight disturbance (not subjective)
      2. Normal (grade 5)

III. Restriction of ADL (14 points)
   ADL
   (a) Turn over while lying
   (b) Standing
   (c) Washing
   (d) Leaning forwards
   (e) Sitting (about 1 hour)
   (f) Lifting or holding heavy objects
   (g) Walking
   0. Severe restriction 1 = Moderate restriction 2 = No restriction

IV. Urinary bladder function
   0. Normal
   1. Mild dysuria
   2. Severe dysuria (incontinence, urinary retention)
Lumbar spinal stenosis: Which predictive factors of favorable functional results after decompressive laminectomy?

Neurochirurgie, Volume 59, Issue 1, February 2013, Pages 23-29

E. Foulongne, S. Derrey, M. Ould Slimane, S. Levèque, A.-C. Tobenas, F. Dujardin, P. Fréger, P. Chassagne, F. Proust

Outbreak of a neurological deficit and a Beaujon score below 11, appropriate threshold in order to obtain optimal long-term results.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Number of patients</th>
<th>Follow-up</th>
<th>Criteria of evaluation</th>
<th>Results at the end of follow-up</th>
<th>Predictive factors of favorable outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turner et al., 1992</td>
<td>Average: 47 (74 articles) Meta-analysis</td>
<td>5 years</td>
<td>Pain, ability to work, functional status</td>
<td>Excellent and good: 64% (26 to 100%)</td>
<td>Degenerative arthrosis of the spine, low BMI, smoking</td>
</tr>
<tr>
<td>Jonkro et al., 1996</td>
<td>Pre-op: 105 Follow-up: 88</td>
<td>Patient satisfaction</td>
<td>Excellent: 52%</td>
<td>Anterior-posterior diameter of the foramen, low BMI, smoking</td>
<td></td>
</tr>
<tr>
<td>Javid and Hadar, 1988</td>
<td>Pre-op: 170 Follow-up: 140</td>
<td>1 at 11 years</td>
<td>Self-assessment Pain</td>
<td>Success: 66.0%</td>
<td></td>
</tr>
<tr>
<td>Amundsen et al., 2000</td>
<td>Pre-op: 32 Follow-up: 28</td>
<td>10 years</td>
<td>Walking distance Physical activity</td>
<td>Good result: 71%</td>
<td></td>
</tr>
<tr>
<td>Iguchi et al., 2000</td>
<td>Pre-op: 150 Follow-up: 37</td>
<td>13 years</td>
<td>JOA score</td>
<td>Excellent and good: 68%</td>
<td>1 level recalibrated</td>
</tr>
<tr>
<td>Attar et al., 2005</td>
<td>Pre-op: 65 Follow-up: 56</td>
<td>8 at 10 years</td>
<td>Function: pain, satisfaction</td>
<td>Satisfaction: 55%</td>
<td>No significant factor</td>
</tr>
<tr>
<td>Yamashita et al., 2013</td>
<td>Pre-op: 102 Follow-up: 70</td>
<td>5 years</td>
<td>VAS score</td>
<td>Improved low back pain (P = 0.0002) and leg pain (P = 0.0001)</td>
<td>Age &gt; 65 years</td>
</tr>
<tr>
<td>Foulongne et al., 2012</td>
<td>Pre-op: 152 Follow-up: 98</td>
<td>5 years</td>
<td>Beaujon score</td>
<td>Improved Beaujon score (P = 0.01)</td>
<td>Low comorbidity (P = 0.01)</td>
</tr>
</tbody>
</table>

Pre-op: preoperatively; mm: millimeter.
Pre-op: en préopératoire; mm: millimètre.
Anatomic radiological variations in developmental lumbar spinal stenosis: a prospective, control-matched comparative analysis

The Spine Journal, Volume 14, Issue 5, 1 May 2014, Pages 808-815
Sameer A. Kitab, Ali M. Alsulaiman, Edward C. Benzel

Three morphologies identified: (1) reduced spinal canal AP diameter, (2) reduced interlaminar angle, and (3) global reduction of all canal parameters.

<table>
<thead>
<tr>
<th>Stenosis grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade A</td>
<td>CSF is clearly visible inside the dural sac, but its distribution is inhomogenous.</td>
</tr>
<tr>
<td>Grade B</td>
<td>The rootlets occupy the entire dural sac, but they can still be individualized. Some CSF is still present, giving a granular appearance to the sac.</td>
</tr>
<tr>
<td>Grade C</td>
<td>No rootlets can be recognized, with the dural sac demonstrating a homogeneous gray signal with no CSF signal visible. There is epidural fat present dorsally.</td>
</tr>
<tr>
<td>Grade D</td>
<td>In addition to no rootlets being recognizable, there is no dorsal epidural fat.</td>
</tr>
</tbody>
</table>
More severe stenosis below a CSA critical threshold of 70 mm²: significantly greater functional disability.
At an earlier age (40–50s) with less radiographic evidence of spondylosis.
MRI, study of choice; however, patient comorbidities and other factors may necessitate use of other imaging modalities: CT scan, myelography, radiographs, and dynamic CT or MRI.
Factors affecting dynamic foraminal stenosis in the lumbar spine

The Spine Journal, Volume 13, Issue 9, September 2013, Pages 1080-1087
Vijay Singh, Scott R. Montgomery, Bayan Aghdasi, Hirokazu Inoue, Jeffrey C. Wang, Michael D. Daubs

Decrease in Foraminal Area from flexion to extension. Translation Motion not strongly correlated to changes in Foraminal Area.
Clinical validity of the nerve root sedimentation sign in patients with suspected lumbar spinal stenosis

The Spine Journal, Volume 14, Issue 4, 1 April 2014, Pages 667-674

Thomas Barz, Lukas P. Staub, Markus Melloh, Gregor Hamann, Sarah J. Lord, Mark D. Chatfield, Patrick M. Bossuyt, Joern Lange, Harry R. Merk

In nonsurgically treated patients, a positive sign is associated with more limited improvement. In these cases, surgery might be effective.
Clinical significance of redundant nerve roots of the cauda equina in lumbar spinal stenosis

Clinical Neurology and Neurosurgery, Volume 110, Issue 1, January 2008, Pages 14-18
Jun-Hong Min, Jee-Soo Jang, Sang-Ho Lee

Redundant nerve roots (RNR) of cauda equina first described by Verbiest in 1954, and subsequently named by Cressman and Pawl in 1968. Tortousity of elongated and enlarged nerve roots in subarachnoid space of lumbar spine.
Clinical Significance of Postoperative Changes in Redundant Nerve Roots After Decompressive Laminectomy for Lumbar Spinal Canal Stenosis

World Neurosurgery, 19 September 2013 Kunio Yokoyama, Masahiro Kawanishi, Makoto Yamada, Hidekazu Tanaka, Yutaka Ito, Masashi Hirano, Shinji Kawabata, Toshihiko Kuroiwa

Poor functional outcome of patients with persistent RNRs postoperatively.
Many patients do not seek therapy until significant deficits are present or often due to painful syndromes of concurrent lumbar degenerative disease.
Concomitant Cervical and Lumbar Stenosis: Strategies for Treatment and Outcomes

5 to 10%
Combination of upper and lower motor neuron findings.
Implications of disease progression, more significant at cervical level, and there is concern that minor trauma could result in neurological injury in presence of cervical spinal stenosis.
Success of Surgical Treatment

Conservative treatment for spinal stenosis in elderly patients: low rate of success.

<table>
<thead>
<tr>
<th>Satisfaction</th>
<th>Number of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very satisfied</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Pretty satisfied</td>
<td>3 (8)</td>
</tr>
<tr>
<td>Not so satisfied</td>
<td>13 (36)</td>
</tr>
<tr>
<td>Unsatisfied</td>
<td>20 (56)</td>
</tr>
<tr>
<td>Total</td>
<td>36 (100)</td>
</tr>
</tbody>
</table>

**Failure of conservative treatment for lumbar spinal stenosis in elderly patients**

The natural history of lumbar degenerative spinal stenosis
Michel Benoist

Amundsen’s recommendations: If low-back and leg pain remains or becomes severe, surgery offers a good chance of stable improvement.

<table>
<thead>
<tr>
<th></th>
<th>Better %</th>
<th>Same %</th>
<th>Worse %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low back pain</td>
<td>77</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>Leg pain</td>
<td>78</td>
<td>13</td>
<td>6</td>
</tr>
</tbody>
</table>
Surgical treatment of lumbar spinal stenosis in patients aged 65 years and older *Archives of Gerontology and Geriatrics, Volume 35, Issue 2, September–October 2002, Pages 143-152*.

S. Shabat, Y. Leitner, M. Nyska, Y. Berner, B. Fredman, R. Gepstein

**Operative success** not decreased in very old (over 75 years), not related to sex, background disease, number of segments involved, neurological signs or duration of disease.

<table>
<thead>
<tr>
<th>Satisfaction</th>
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<tbody>
<tr>
<td>Very satisfied</td>
<td>25 (54%)</td>
</tr>
<tr>
<td>Pretty satisfied</td>
<td>15 (33%)</td>
</tr>
<tr>
<td>Not so satisfied</td>
<td>3 (6.5%)</td>
</tr>
<tr>
<td>Unsatisfied</td>
<td>3 (6.5%)</td>
</tr>
<tr>
<td>Total</td>
<td>46 (100%)</td>
</tr>
</tbody>
</table>
Study of dural sac cross-sectional area in early and late phases after lumbar decompression surgery

The Spine Journal, Volume 13, Issue 9, September 2013, Pages 1088-1094

Hiroki Oba, Jun Takahashi, Toshimasa Futatsugi, Yuji Mogami, Syunichi Shibata, Yoshihito Ohji, Hirotaka Tanikawa

Dural sac area increased significantly between early and late postoperative phases.
Spinal canal enlargement procedure by restorative laminoplasty for the treatment of lumbar canal stenosis


Ko Adachi, Toshiro Futami, Ario Ebihara, Tomoyasu Yamaya, Norikazu Kasai, Toshiyuki Nakazawa, Takayuki Imura

**Best results** obtained if surgery performed **within 2 years** of onset of LCS.
Minimal Surgery with No Fixation

Traditional operation for degenerative lumbar canal stenosis has been extensive laminectomy. Potential problems of iatrogenic instability and post-op morbidity.

Minimal Invasive Surgery-Microscopic Laminotomy for Lumbar Canal Stenosis
Apollo Medicine, Volume 3, Issue 4, December 2006, Pages 404-406Shyam Sunder, Rajendra Prasad
Decompression alone is suggested for patients with leg predominant symptoms without instability.
Laminotomy is a good and feasible option of surgical intervention for degenerative lumbar spinal stenosis without spinal instability.
Decreasing approach-related morbidity while achieving goals of more conventional open procedures.
Tubular decompression is feasible for 1 and 2 level procedures but not for 3 and greater.
Indirect Decompression

An effective treatment for patients suffering from mild NIC secondary to lumbar spinal stenosis. Local or general anesthesia and only 24 h of hospitalization.

Interspinous spacer decompression (X-STOP) for lumbar spinal stenosis and degenerative disk disease: A multicenter study with a minimum 3-year follow-up

Clinical Neurology and Neurosurgery, Volume 124, September 2014, Pages 166-174

Fabrizio Puzzilli, Roberto Gazzeri, Marcelo Galarza, Massimiliano Neroni, Konstantinos Panagiotopoulos, Andrea Bolognini, Giorgio Callovini, Umberto Agrillo, Alex Alfieri
Interspinous Spacers for Lumbar Spinal Stenosis
Operative Techniques in Orthopaedics, Volume 21, Issue 3, September 2011, Pages 208-212
William D. Long III, Peter G. Whang

By distracting interspinous space, ISSs have been shown to increase dimensions of spinal canal and foramina.
Interspinous Process Devices versus Standard Conventional Surgical Decompression for Lumbar Spinal Stenosis: Cost Utility Analysis


Highly unlikely to be cost-effective compared with bony decompression for patients with intermittent neurogenic claudication caused by lumbar spinal stenosis.
**Interspinous Process Distraction Devices for Spinal Stenosis**


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**Indications**

- Neurogenic claudication
- One- or two-level stenosis between L1 and L5
- Failed nonoperative treatment
- >50% stenosis

**Contraindications**

- Significant neurologic deficits or cauda equina syndrome
- Isthmic spondylolysis
- Motion segment ankylosis
- Degenerative spondylolisthesis with >25% subluxation
- Osteoporotic insufficiency fractures
- Spinous process fracture
Interspinous Spacers as Treatment for Lumbar Stenosis

Seminars in Spine Surgery, Volume 23, Issue 1, March 2011, Pages 27-33
Rolf Sobottke, Jan Siewe, Thomas Kaulhausen, Christina Otto, Peer Eysel

ISL/SSL complex, thoracolumbar fascia, and associated musculature crucial for maintenance of spinal column stability. Damaged by median approaches. Posterolateral or lateral approaches preferable.
Indirect spinal decompression for lumbar stenosis
Okezie K. Aguwa, Daniel K. Park

Both interspinous and interbody fusion techniques have demonstrated the ability to decrease low back pain and provide clinically significant pain relief from neurogenic claudication through indirect means.
Posterior interbody fusion using a diagonal cage with unilateral transpedicular screw fixation for lumbar stenosis

Journal of Clinical Neuroscience, Volume 18, Issue 3, March 2011, Pages 324-328
Jian Zhao, Feng Zhang, Xiaoqing Chen, Yu Yao

Minimal invasion of paraspinal muscle and posterior structures.

Reducing excessive rigidity of traditional bilateral fixation may potentially lessen occurrence of adjacent level degeneration.
Failure of traditional surgery

Swedish national study: risk of being operated after 1, 2, 5, and 10 years, 2%, 5%, 8%, and 11% after surgery for lumbar spinal stenosis.

Reoperations After Surgery for Lumbar Spinal Stenosis
World Neurosurgery, Volume 75, Issues 5–6, May–June 2011, Pages 737-742
Vijayakumar Javalkar, Raul Cardenas, Tamir A. Tawfik, Imtiaz R. Khan, Papireddy Bollam, Anirban Deep Banerjee, Anil Nanda
Reoperation rate after surgery for lumbar spinal stenosis without spondylolisthesis: a nationwide cohort study

*The Spine Journal, Volume 13, Issue 10, October 2013, Pages 1230-1237*

Chi Heon Kim, Chun Kee Chung, Choon Seon Park, Boram Choi, Seokyoung Hahn, Min Jung Kim, Kun Sei Lee, Byung Joo Park

Not different between decompression and fusion surgeries. **Higher than in past.**
Lead to regression of functional gains achieved from index surgery.
Symptomatic progression of degenerative scoliosis after decompression and limited fusion surgery for lumbar spinal stenosis

Journal of Clinical Neuroscience, Volume 20, Issue 4, April 2013, Pages 613-615

John K. Houten, Rani Nasser

Significant degenerative scoliosis together with lumbar spinal stenosis increases complexity of planning a surgical intervention. Iatrogenic instability may be introduced by decompression.
Internal Fixation

Patients with **flat back** and **limited lumbar mobility** before surgery: **poor results** in terms of LBP. **Sagittal parameters** taken into account when laminectomy.

**Radiographic predictors of residual low back pain after laminectomy for lumbar canal stenosis: a minimum of 6-year follow-up**

Degenerative lumbar scoliosis: a **dynamic and static** condition. **True instability**, evident only on standing. **Supine MRI** does not fully represent degree of canal and nerve root **stenosis**.
Reasonable evidence to support fusion in surgical treatment of stenosis with degenerative lumbar spondylolisthesis or when preoperative instability demonstrated on x-rays. Iatrogenic instability during surgery from need for aggressive decompression for lateral stenosis that sacrifices integrity of facet joints would also logically benefit from fusion with decompression.
Optimal to manage whole pathology with only one operation. Lumbar decompression, fusion, and instrumentation, appropriate for most of patients with degenerative lumbar scoliosis and stenosis.
Interbody fusion? In osteoporosis, prior surgery, obesity or smoking. Increase in neuroforaminal volume by distraction. Fusions to sacrum. Rates of pseudoarthrosis drastically improved when combined anterior support, S1 pedicle fixation, and iliac.
Study Group

11 patients since 2009 to date.

- 9 women and 2 men

- 3 scoliosis
- 3 spondylolysthesis
- 5 stenosis

61 years

- 100% decompression + fusion + instrumentation

- 11 patients since 2009 to date.
Advancements

Lateral retroperitoneal approach, a minimally invasive technique to achieve interbody fusion and indirect decompression. Effective in treating foraminal, lateral recess, and moderate central stenosis. Correction of degenerative lumbar deformity especially in coronal plane.

Indirect decompression for lumbar spinal stenosis with the minimally invasive lateral approach

Management of Adjacent Segment Degeneration and Spinal Stenosis (Scar)

Michael J. Vives, Christopher M. Bono, Steven R. Garfin

Alternative strategy of so-called dynamic stabilization for neighboring unfused lumbar segments.
Continuous intraoperative electromyographic and transcranial motor evoked potential recordings in spinal stenosis surgery

Journal of Clinical Neuroscience, Volume 17, Issue 2, February 2010, Pages 274-276
Spyridon Voulgaris, Dimitrios Karagiorgiadis, George A. Alexiou, Evaggelos Mihos, Andreas Zigouris, George Fotakopoulos, Dimitrios Drosos, Dimitrios Pahaturidis

**Effective** procedure that diminish risk of spinal cord injury during surgery.
No contraindications to RA. Favorable hemodynamic profile and decreased post-op narcotic requirement. In older patients who may not tolerate GA due to a decreased cardiopulmonary reserve.