



Standard of Care: Lumbar Spinal Stenosis /Physical Therapy Management

Case Type / Diagnosis:

Spinal stenosis refers to a narrowing of the vertebral canal, intervertebral foramen, or both due to either osseous or soft tissue encroachment. Arnoldi et al. classified lumbar spinal stenosis by etiology as either developmental/primary or degenerative/secondary. Primary stenosis is caused by congenital malformations or defects in postnatal development and occurs rarely. It can manifest itself in the 3rd or 4th decade of life. Degenerative lumbar stenosis occurs more frequently and is what is seen typically in the clinical setting. Degenerative lumbar stenosis usually manifests itself in the 6th or 7th decade of life, with slight preponderance in women¹. It results from degenerative osseous or soft tissue changes, spondylolisthesis, postsurgical scarring, intervertebral disc herniation, or from combinations of these conditions. Other less frequent causes of secondary stenosis are fractures, tumors, infection or systemic diseases such as Paget's disease. Combinations of primary and secondary stenosis can occur and are termed as mixed.

Anatomically, lumbar spinal stenosis can be classified as either central or lateral². Central stenosis involves narrowing of the spinal canal around the thecal sac containing the cauda equina, and occurs as a result of the facet joint arthrosis and hypertrophy, thickening and bulging of the ligamentum flavum, bulging of the intervertebral disc, or spondylolisthesis. Stenosis at multiple levels is more common than strictly segmental stenosis. In approximately 40% of cases, central stenosis is caused by soft tissue hypertrophy.³ Lateral stenosis causes encroachment of the spinal nerve in the lateral recess of the spinal canal or in the intervertebral foramen, and results from facet joint hypertrophy, loss of disc height, intervertebral disc bulging, or spondylolisthesis. Knowledge of the pathologic anatomy is important for correlating clinical signs and symptoms with imaging studies and treatment planning. Bony or soft tissue encroachment of an emerging nerve root may occur at any lumbar level. The two lower motion segments (L3-4 and L4-5) are most commonly affected by degenerative stenosis.

NSAIDS are the medication of choice for decreasing inflammation, soft tissue swelling, and neural compression. The use of epidurals is questionable and tends to be more effective for patients with radicular pain symptoms due to herniated intervertebral discs rather than for spinal stenosis alone. If a good response is achieved, a repeated injection is administered in 3-6 months.^{4,5,6}

Computerized tomography, myelography and magnetic resonance imaging are the most important imaging studies for evaluating and quantifying the degree of forminal stenosis and making the diagnosis. However, degenerative changes do not closely correlate with symptoms and abnormal findings occur in the asymptomatic population.⁷ Arbit and Pannullo have summarized well the pathologic anatomy of central and lateral stenosis including what to expect

¹ Arbit, E and Pannullo, S Lumbar Stenosis: A Clinical Review. Clin Ortho 384:137-143, 2001

² Arnoldi CC, Brodsky AE, Cauchoix J Lumbar spinal stenosis and nerve root encroachment syndromes: Definition and classification. Clin Orthop 115:4-5, 1976.

³ Ibid.

⁴ Spivak, JM "Degenerative Lumbar Spinal Stenosis" in JBJS, Vol 80, No. 7, July, 1998, p 1060.

⁵ Simotas, AC "Nonoperative Treatment of Lumbar Spinal Stenosis". Clin Ortho 384, March, 2001, p155-156.

⁶ Sengupta DK, Herkowitz HN. "Lumbar Spinal Stenosis- Treatment Strategies and Indications for Surgery" Ortho Clin N Am 34(2003), p282.

⁷ Simotas, AC Clin Ortho 384:160, 2001.



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from particular imaging studies. Therapists treating patients who have lumbar spinal stenosis are encouraged to review this reference to gain a more in depth understanding of the pathologic findings reported by imaging studies.

Patients with lumbar spinal stenosis who are symptomatic often relate a long history of low back pain, which is consistent with the slow nature of degenerative musculoskeletal changes. Lower extremity pain, bilateral or unilateral, has been reported to occur in 80% of cases and back pain in 65%. Lower extremity pain symptoms are often distal (below knee) but can be proximal as well. Pain symptoms are often poorly localized and variable; symptoms are not likely symmetric when bilateral. Prolonged spinal extension will intensify symptoms and often worsen lower extremity symptoms. Sensory changes occur frequently (51%) and are reported as numbness and/or paresthesias. Patients especially with lateral stenosis may demonstrate radicular symptoms. Amundsen, et al reported ankle reflexes to be diminished or absent in up to 50% of patients with lumbar spinal stenosis; and, objective weakness to vary between 23% to 51% in patients with lumbar spinal stenosis.. Approximately 65% of patients with lumbar spinal stenosis report neurogenic claudication, defined as poorly localized pain, paresthesias or cramping of one or both lower extremities which is brought on by walking and relieved by sitting or rest.⁸ Very rarely will patients with spinal stenosis present with symptoms of cauda equina syndrome. Urinary dysfunction (urinary frequency, incontinence or episodes of frequent urinary tract infections) is not uncommon and has been reported in 10% of patients with advanced spinal stenosis

Patients with lumbar stenosis will often demonstrate a worsening of complaints when position and posture is changed. Symptoms worsen with lumbar extension and with weight bearing; improve with sitting, standing with slight trunk flexion, or lying down. Patients typically stand with a stooped posture or report that they need to bend over in order to keep walking (using a shopping cart or walker). Walking uphill is easier than downhill.

Anatomically, flexed postures widen the spinal canal and foramen and reduce epidural pressure; thus are more relieving than extension posture/ positions. Extension of the lumbar spine causes posterior protrusion of the intervertebral disc and bulging of the ligamentum flavum. This results in additional narrowing of the central and lateral canals. Panjabi et al reported a 20% reduction in the cross-sectional area of the intervertebral foramina in both normal and degenerative spinal segments with spinal extension.⁹ Axial loading has been reported to reduce the cross-sectional area of the spinal canal significantly.¹⁰ Exactly what pathophysiologic effects result from these anatomic changes in the lumbar spine are not yet known. Patients' symptoms may be due to mechanical compression, vascular changes or both.

Lumbar spinal stenosis is becoming more frequently recognized and diagnosed as the population ages. It is the most common diagnosis associated with lumbar spine surgery in

⁸ Katz JN, Dalgas M, Stucki G, et al. Degenerative lumbar spinal stenosis: Diagnostic value of the history and physical examination. *Arthritis Rheum.* 38:1236-1241.1995

⁹ Panjabi MM, Takata K, Goel VK "Kinematics of the Lumbar Intervertebral Foramen" *Spine* 8:356, 1983.

¹⁰ Schonstrom N, Lindahl S, Willen J et al. Dynamic changes in the dimensions of the lumbar spinal canal" An experimental study in vitro. *J Orthop Res* 7:1115-121, 1989.



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patients older than 65 years.¹¹ Surgery for lumbar spinal stenosis has quadrupled in the last 20 years. Surgical decompression should only be considered for patients with unmanageable pain and function which are severely limiting. The first surgical intervention tends to provide the greatest opportunity for relief. The long term effects of surgery are uncertain and deteriorate with time. In 1999, Gibbons et al performed a review of surgical interventions for spinal stenosis and concluded that there is no evidence for the efficacy of any form of decompression or fusion surgery for spinal stenosis.¹²

Indications for Treatment:

The efficacy of nonoperative treatment for spinal stenosis may depend greatly on the nature and severity of the patient's symptomatic and radiographic presentation.¹³ Conservative treatment is advocated in patients with mild to moderate symptoms of lumbar spinal stenosis but clinically a patient with severe symptoms and low functional status may be referred for very basic patient and family education, positioning and conservative pain management instructions and assistance in determining what home/ environmental changes for safety and independence are needed. A physical therapy treatment plan is based on an understanding of the pathoanatomic changes occurring in the particular patient referred and must be tailored to the individual based on the clinical history and results of the physical examination. Patients typically present in physical therapy with impairments of pain, loss of function, especially gait dysfunction, a knowledge deficit in self-management of symptoms with conservative measures, impaired muscle performance and impaired flexibility and/or ROM .

Contraindications / Precautions for Treatment:

Symptoms of cauda equina syndrome (lower back, rectal or genital pain, micturition disturbances, loss of bowel control, perianal sensory disturbances, impotency) must be immediately reported to the referring physician as surgical intervention is essential.

Neurologic findings may differ significantly when a patient is tested pre vs post a period of provocative activity such as walking. Note in your documentation if you have performed provocative activities before performing reflex testing, sensory evaluation, and muscle testing.

The likelihood of comorbidity in patients who present with lumbar spinal stenosis is high. Osteoarthritis, cardiovascular and/or pulmonary disease in combination with lumbar spinal stenosis will require patients to be closely monitored. A home exercise program that is specifically prescribed and well tolerated needs to be established.

¹¹ Turner JA, Ersek M, Herron L, et al Surgery for lumbar spinal stenosis: Attempted meta-analysis of the literature. *Spine*17:1-8,1992.

¹² Gibson JNA, Waddell G and Grant IC, Surgery for Degenerative Lumbar Spondylosis, *Cochrane Lib.*, Vol 4, 2004.

¹³ Simotas, AC Nonoperative treatment for Lumbar Spinal Stenosis. *Clin Orthop* 384:153-161,2001.



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Patients who cannot tolerate NSAIDs may progress more slowly due to the inability to sufficiently manage inflammatory tissue conditions.

The referring physician should be contacted if the patient's pain symptoms and/or neurological findings continue to worsen despite conservative measures and compliance with activity modulation as part of the physical therapy treatment plan. Not all patients will respond positively to physical therapy interventions.

Examination:

Medical History: Carefully review for comorbidities: Osteoarthritis- especially hip and/ or knee may require specific therapeutic measures in conjunction with direct treatment of the lumbar spine. Patients with diabetes may also have peripheral neuropathy symptoms that confound the reports of lower extremity sensory changes. Obese patients have weakened abdominal tone and strength and likely hyperlordosis. Determine how long a history of low back pain or lower extremity symptoms the patient has had. Has the patient had a prior history of surgery to the abdomen or back which could have further compromised muscle performance, posture and/or tolerance to activity? What imaging studies have been preformed? What other special tests (EMG) done?

History of Present Illness: Are lower extremity symptoms worse than lower back symptoms? Where are symptoms? What provokes symptoms? When is patient most uncomfortable? What helps relieve symptoms? Has the patient fallen or stumbled recently? Does the patient use anything to help when walking? A careful and detailed history is very revealing and can be more useful than the objective clinical examination or the imaging studies in patients with lumbar spinal stenosis.

Social History: Suggested interview questions include but are not limited to:

- Does patient live alone?
- Level of activity?
- Frequency of exercise?
- What behaviors have already been modified in order to accommodate the level of symptoms?
- What recreational activities would the patient like to do that currently are intolerable?
- Patient's goal (s)?

Medications: NSAIDS? Any history of epidural injection? Other?

Examination:

This section is intended to capture the minimum data set and identify specific circumstance(s) that might require additional tests and measures.

Pain History: Visual Analog Scale (VAS) current vs. with sitting, standing, walking (consider monitoring the time it takes before symptoms become worsened/ unacceptable to the patient).



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Locus and nature of complaints, pattern am vs. pm, rest vs. activity. What does patient do to obtain relief of symptoms?

Posture: Posture is typically stooped with flattening of the lumbar spine; but lordosis may be pronounced in some patients. Note if weight bearing is equally distributed. Base of support is often widened.

ROM: All planes active of spine, active and passive hip, knee and ankle ROM as appropriate. Spinal and hip extension are often restricted active and passively. Passive spinal ROM may need to be deferred if significant worsening of pain during active ROM examination. Note the ability of the spine to flex segmentally. Avoid prolonged extension of the spine as symptoms will be easily provoked.

Flexibility Testing: Thomas test, Ober test, hamstring length, quadriceps length and gastrocnemius length.

Special Tests: Scour (David J. Magee's text Orthopedic Physical Assessment is a comprehensive source for any review of these tests)

Neurologic: Typically there are few neurologic signs. Findings are often more pronounced after symptom provoking activities. Note whether the findings of deep tendon reflexes, sensory changes and/or muscle weakness are prior to or post-provocative walking or trunk extension activities.

Muscle Testing: Specific MMT for gluteals and abdominal muscles as these muscles are often deconditioned and weakened due to prolonged pain and compromised posture and activity. Perform additional MMT depending upon findings of lower quadrant screening and patient's subjective reports of weakness.

Neurodynamic Special Tests: Reflex testing of ankle and knee.

Straight leg raise testing. May or may not be positive.

Sensory: Assess reported numbness and/or paraesthesias. Note the locus of symptoms (dermatomal distribution) and level of severity associated with the defined level of activity.

Circulation: If a patient with lumbar spinal stenosis also has comorbidities of cardiovascular insufficiency and/or diabetes mellitus, take bilateral distal peripheral pulses- popliteal and dorsal pedis. Patients with peripheral vascular disease may have symptoms which complicate and make the presentation of symptoms with walking difficult to differentiate from neurogenic claudication. Observe and record integument changes. Compare pulses pre and post activity and right vs. left (involved vs. uninvolved) and if a vascular component is suspected, compared upper extremity ipsilateral pulse (radial) with lower extremity ipsilateral pulse to assess any difference in rate and strength of the pulse palpated.



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Gait: Evaluate gait pattern and independence. Assess for neurogenic claudication symptoms. Note how long it takes for symptoms to be relieved and what does patient do to obtain relief. (eg must patient lie down, sit or just stop the activity in order to obtain reasonable relief of intensified symptoms).

Function: • Transfer ability

- Balance ability- bilateral stance vs single limb stance ability.
- Sitting and standing tolerance. (minutes)
- Step and stair negotiation- safe step up and step down (height)
- Recreational ability and frequency
- Reported ADL status especially don/doff of socks/shoes, ability to pick up objects off floor, dressing ability, hygiene (remember to inquire re urinary dysfunction). Is patient able to safely get to the bathroom at night as often as needed?

Special Test: The Timed Get Up and Go¹⁴ is useful measure to determine baseline performance in patients with transfer and gait dysfunction. Consider using this measure to track progress of the patient's compromised function. Other functional tests (Berg¹⁵, Tinetti¹⁶, etc may be more useful and appropriate if balance is impaired or there is a history of falling)

Note if initial evaluation was modified due to patient's complaints or inability to tolerate further physical examination at the time.

Differential Diagnosis:

- Clinically, differentiate between neurogenic claudication attributed to nerve root compression and claudication due to peripheral vascular disease. Vascular claudication will often be described as "cramping", the peripheral pulses will diminish or be absent, and there will be trophic changes.
- Hip evaluation must be sufficient to rule out or rule in contributing impairments due to osteoarthritis.

Evaluation / Assessment:

Establish Diagnosis and Need for Skilled Services

Problem List (Identify Impairment(s) and/ or dysfunction(s))

1. Knowledge deficit re understanding of diagnosis, relationship of posture and upright activity on symptoms, correct use of joint protection techniques, modification(s) of

¹⁴ Podsiadlo D, Richardson S. J Am Geriatr Soc, 1991,39:142-148.

¹⁵ BogleThorban, LD and Newton RA Physical Therapy, 76 (1996).

¹⁶ Tinetti ME JAGS, 1986, 34:119-126.



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activity level, proper positioning and stretching techniques, use of assistive device(s) and posture cues, and use of cold/ heat, massage and other comfort measures.

2. Pain - management with conservative measures of positioning, pacing and/ or modification of functional activities, therapeutic exercise, and conditioning activities.
3. Impaired muscle performance
4. Impaired function.
5. Impaired ROM (active and/or passive restrictions)

Prognosis:

Patients with this diagnosis have pain that typically progresses over an extended period of time. The natural history of the disease is frequently non-progressive. Sengupta and Herkowitz summarized that in patients who have been followed for 5-10 years after diagnosis 15% of patients improved, 45% stayed the same and 30% reported progressive worsening of symptoms.¹⁷

Worsening of nerve root compression with progressive muscle weakness, severe leg symptoms and further loss of reflex or pain which is not able to be managed with conservative measures and use of prescribed medications should be reported to the referring physician.

Goals:

1. Independent home program and avoidance of provoking postures and activities; progressive independence in advancing home program over 6-8 treatments.
2. Independent pain management with proper use of joint protection methods including posture, positioning, use of assistive device(s), pacing of activities, modification of activities, body mechanics and, as needed, use of comfort measures (heat, ice, massage, relaxation techniques); 4-6 treatments
3. Improve function including safe and proper transfers and ambulation with or without ambulatory device(s) and/or frequency or distance of walking; 2-4 treatments.
4. Improve muscle performance; progressive improvement in quality of performance, number and nature of exercises, MMT and/or number of repetitions tolerated over 6-8 treatments
5. Improve flexibility of identified tight soft tissue structures; measurable decrease per particular measure over 6-8 treatments. Eg 25% decrease in hip flexor tightness as measured by the Thomas Test.
6. Improve level of fitness; patient to return to conditioning activities or recreational activities. 6-8 treatments

Age Specific Considerations: The peak incidence of degenerative spinal stenosis is in the 7th decade so the likelihood of patients having other comorbidities is high. The mix of comorbidities in the elderly patient and their effect on the individual's health status must be appreciated. For example, advanced DJD and/or osteopenia or Paget's disease may severely limit the kind of positioning and therapeutic stretching and strengthening exercises that are tolerable and therapeutic for the patient. Testing quadriceps muscle length may not be tolerable in the typical

¹⁷ Sengupta DK and Herkowitz HN, Orthop Clin N Am, 34:281-295,2003



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prone position. Other modifications in the physical examination, test positions or exercise prescriptions may be needed due to intolerance to positioning. Cardiac and pulmonary measures (respiratory rate, heart rate, perceived exertion scale) may be required if patient's tolerance to very basic functioning is low due to a mix of lumbar stenosis and other medical diagnoses. Patient's with diabetes or vascular disease effecting peripheral circulation in addition to confirmed diagnosis of lumbar spinal stenosis require close (REG>>>> closer ...Ethan concerned re litigation) monitoring and progression of treatment in order to establish a home program that is effective and tolerable.

Treatment Planning / Interventions

Established Pathway ___ Yes, see attached. No

Established Protocol ___ Yes, see attached. No

Interventions most commonly used for this case type/diagnosis.

This section is intended to capture the most commonly used interventions for this case type/diagnosis. It is not intended to be either inclusive or exclusive of appropriate interventions.

1. **Joint Protection Techniques:** Body mechanics for transfers, lifting and carrying methods, positioning techniques, posture awareness and cues for maintaining pelvis in neutral, pacing and planning activities, modifications of activities, use of assistive device(s).
2. **Therapeutic exercises:** A progressive therapeutic exercise program with flexion bias, stretching of identified tight muscles; lumbar and lower extremity stabilization exercise techniques; strengthening of any identified muscle weaknesses; postural reeducation, conditioning activities (recumbent bike, stationary bike, walking program, treadmill use), return to recreational sport activities (for example, swimming with use of modified stokes to avoid trunk extension).
3. **Transfer and gait training:** Balance, safety, pacing of cadence and planning for distance tolerated. Appropriate use of any assistive device(s). Consider the use of 1 or 2 canes or a rolling walker for patients who require an assistive device(s). Some patients may benefit from a specialized walker with a seat option. Consider adjusting the height of the assistive device just slightly lower than usual to help patient achieve the postural correction needed for symptom management.
4. **Manual therapy** – Soft tissue and joint mobilization techniques to improve patient's level of symptoms and/or mobility.
5. **Lumbar traction** - May be appropriate if general lumbar hypomobility and patient unable to effectively apply lower trunk stretching techniques.

Frequency & Duration: 6-8 treatments to achieved identified short term goals over an 8 week period. Patients with lower tolerance levels may require more intensive intervention.



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Patient / family education: Diagnosis and related basic anatomy, why trunk extension and axial loading may be aggravating symptoms, joint protection techniques including posture awareness, activity modifications, body mechanics, proper positioning and stretching techniques, use of assistive device(s) and heat/cold, relaxation techniques or massage.

Recommendations and referrals to other providers:

1. Occupational therapy- especially for ADL and additional training in joint protection methods if pain symptoms, loss of function and health status limit patient's independence and ease of function. Discuss with referring physician and explain your recommendations to patient.
2. Calcitonin treatment¹⁸- a peptide hormone which reduces skeletal blood flow has been successfully used in the treatment of patients with Paget's disease who also had spinal stenosis.. It is presumed that by reducing venous blood from the vertebral body into the extradural plexus that there will be more space for the neural elements. No randomized controlled studies of this treatment currently exist. Discuss with referring physician.
3. Weight reduction program which would decrease the strain of lumbar lordosis Encourage patient to discuss with referring physician before attempting weight loss program.
4. A lumbar orthotic with rigid panel support may help some patients, especially those with little abdominal strength, to assist in awareness of pelvic positioning with upright activity or to act as a comfort measure. Discuss with referring physician before suggesting to patient/family.
5. Additional support system/ counseling if patient having difficulty coping with the loss of independence and need to modify activity level. Discuss with referring physician.
6. Physiatry or Pain management consult- epidural injection. Per primary physician referral
7. Surgery consult-per primary physician referral

Re-evaluation / assessment

Standard Time Frame: 30 days

Other Possible Triggers: Worsening symptoms despite adhering to recommendations.

Discharge Planning

Commonly expected outcomes at discharge: Independence in home program of body mechanics, joint protection, pain management with conservative measures, a routine stretching and strengthening program and independence in walking with or without an assistive device(s)

¹⁸ Porter, Richard. Spinal Stenosis and Neurogenic Claudication. Spine: 21:2046-2052. Sept 1996.



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75 Francis St., Boston, Massachusetts 02115

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Patient's discharge instructions: Continue prescribed home program. Be diligent in use of joint protection techniques.

Developed: Janice McInnes PT, MPH 01/2005

Reviewed: Ethan Jerome, PT,
Reg Wilcox, PT, MS, DPT



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Bibliography / Reference List

Arbit, E and Pannullo, S. "Lumbar Stenosis: A Clinical Review". *Clinical Orthop and Related Research*. Vol 1, No. 384, 137-143, March, 2001.

Aronaldi CC, Brodsky AE, Cauchoix J, et al. "Lumbar Spinal Stenosis and Nerve Root Entrapment Syndromes: Definition and Classification". *Clin Orthop* 115:4-5, 1976.

Bogle Thorban, LD and Newton, RA. "Use of the Berg Balance Test To Predict Falls in Elderly Persons". *Physical Therapy*. Vol.76, 1996, 576-583.

Bodack, M, and Monteiro, M. "Therapeutic Exercise in the Treatment of Patients With Lumbar Spinal Stenosis". *Clinical Orthopaedics and Related Research*, Vol. 1, No. 384, 114-152, March, 2001.

Gibson JNA, Waddell G and Grant IC. "Surgery for Degenerative Lumbar Spondylosis". *The Cochrane Database of Systematic Reviews*. Vol. 4, 2004.

Johnson KE, Rosen I, Uden A. "The Natural Course of Lumbar Spinal Stenosis" *Clin Orthop* 279: 82-82, 1992

Katz JN, Dalgas M, Stucki G et al. "Degenerative Lumbar Spinal Stenosis-Diagnostic Value of the History and Physical Examination" *Arthritis and Rheumatism*. Vol 38, No. 9, 1236-1241 September, 1995.

McKenzie, R and May, S. The Lumbar Spine: Mechanical Diagnosis and Therapy. Spinal Publications New Zealand Ltd. Vol.1, 2003.

Podsiadlo, D, Richardson S. The timed "Up & Go": A test of basic functional mobility for frail elderly persons. *J Am Geriatric Soc* 1991, 39:142-148.

Panjabi MM, Takata K, Goel VK. "Kinematics of the Lumbar Intervertebral Foramen". *Spine* 8:348-357, 1983.

Porter, Richard. "Spinal Stenosis and Neurogenic Claudication". Lippincott-Raven Publishers. *Spine*. 21:2046-2052, September, 1996.

Saidoff, David C. and McDonough, Andrew L. Critical Pathways in Therapeutic Intervention: Extremities and Spine. Mosby. St. Louis, MO. 2002, Chapter 57, 884-910.

Schonstrom N., Linhahl, S, Willen J, and Hansson T. "Dynamic Changes in the Dimensions of the Lumbar Spinal Canal: An Experimental Study in Vitro". *Journal of Orthopaedic Research*. Raven Press,LTD. New York. 7:115-121, 1989.



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Simotas, Alexander C. “Nonoperative Treatment for Lumbar Spinal Stenosis”. *Clinical Orthopaedics and Related Research*. Vol. 1(384):153-161, March, 2001.

Tenitti, ME. Performance Oriented Assessment of Mobility Problems in Elderly Patients. *JAGS*; 1986, 34:119-126.

Turner JA, Ersek M, Herron L et al. “Surgery for Lumbar Spinal Stenosis- Attempted Meta-analysis of the Literature”. *Spine*. 17:1-8, 1992.