Treatment of lumbar spinal stenosis (LSS) and outcome

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"Outcome may be improved by more careful selection of patients and by performance of an adequate surgical decompression" Deen G. et al. - Mayo Clin Proc 1995, 70, 33-36

The natural history of lumbar spinal stenosis is critical to treatment decisions, since it is unlikely that symptoms will worsen or that neurologic function will deteriorate rapidly, prophylactic treatment is not warranted; also there are no specific recommandations: see randomized prospective controlled trials of surgical vs nonsurgical treatment (1-18). Because spontaneous improvement is uncommon, watchful waiting is an unsatisfactory strategy for patients with intolerable symptoms, surgical attitude lukes like natural to alleviate pains, to improve fonctional capacity, to obtain symptoms resolution (1)(2)(4)(7)(8)(11-13)(17)(18).

The clinical coursevaries considerably: in most patients, is chronic, benign, stagnating – see also EMG changes (16), partially controllable by conservative treatment or is expected to progress slowly, with neurogenic claudication or although rare, with a cauda equine syndrome – with sensory and motor deficit, saddle anesthesia, bowel and bladder dysfunction, imposing a causal treatment of spinal canal stenosis (10)(14-16)(20). If disk prolapse tends to regress spontaneously, the causative degenerative changes associated with spinal stenosis will progress slowly (15)(21-23). In most patients (60% to 70%), the pain seems to stagnate in the medium term (5)(6); of the natural course of 31 patients with LSS over 49 months reports: unchanged symptoms in 70%, improvement, even walking capacity in 15%, worsening in 15%(5).

In patients with pronounced symptoms, a high degree of stenosis and spondylolisthesis, a progressive disease course may be assumed and surgery is consistent with clinical experience, showing several advantages in terms of disability, leg pain, backache, for symptoms recurrencies at least in the short term, most surgically treated patients would again choose surgery and quality of life at 3-6 months, remained for up to 2-4 years (1-3)(6)(7)(11-13)(17-23). There are also unclear aspects too: why there is no no difference in the outcomes of patients who underwent surgery earlier vs later in the disease; several outcome parameters are unknown: the duration of follow-up, the outcome measures, level of pain, use of analgesics, walking capacity, fluctuating evolution, medical and surgical treatments frequently interference, time for surgery (2-8)(10-14) (16-23).

Also nonsurgical management is effective: up to one third of patients treated surgically

For residents

responded to non-surgical treatment: 70% satisfactory at 6 months, 57% satisfactory at 4 yrs; it's generating a slight to moderate improvement for a time, it is advisable initial for most patients (1)(7)(8)(10). A recent publication in the New England Journal of Medicine (2), the Spine Patient Outcomes Research, 13h Trial (SPORT) from the US, supported these results in a larger group of 289 patients, in a randomized cohort and 365 patients in an observational cohort. Surgery resulted in faster and significantly better alleviation of complaints than conservative treatment. Interestingly, patients who did not have surgery also experienced a reduction in symptoms, albeit at a slower rate. However, this study showed that surgery is superior to conservative treatment in the longer term, decompression should be advocated whenever history, symptoms, findings and imaging clearly indicate its use in patients with LSS refractory to conservative treatment for at least 3 months, the patient should be informed about results. Similar results has also Malmivaara (1), but no current recommendations.

The conservative treatment are based on observations, clinical judgments; should be applied in a stepwise pathway that progresses from least invasive treatments: activity restrictions, physical therapy, analgesics, antiinflammatory medications, lumbo-sacral orthoses, to most invasive epidural or intratecal injection with corticoid products, calcitonin, peripheral vasodilators medication with a success rate of 50-65% of cases, Prostaglandin E (3)(6)(7)(10-12)(17)(23-30)(32). There are also reports, but not high-quality trials, reporting no substantial change over the course of 1 year to majority of symptomatic patients with lumbar spinal stenosis whose are managed non operatively (5)(7)(13)(19)(22)(23). Decompression is more effective than other alternative ? (8)(21)

The conservative treatment indications are (16): as initial treatment for radiculopathies cases, without significant deficits, reducing pain, augmenting walking distance; a therapeutic option to those patients who cannot be operated.

Several alternatives are deployed as a multimodal therapeutic concept:

- *physical therapy*(16)(19)(20)(23)(27) gives symptomatic relief of root or low back pain with the goals of improving strength, endurance and flexibility, significant benefit concerning: standing time, pain score, Roland disability score, walking distance; maintaining a better posterior pelvic tilt. Using a customized program several therapeutic alternatives could be used:
  - active exercises in the form of stretching to increase lumbo-pelvic muscular stabilization, distraction, manipulation and neural mobilization, encouraging lumbar flexion and flattening of the lumbar lordotic curve; also exercises performed during lumbar flexion, such as bicycling are better tolerated than walking, avoid hyperextension and side bending
  - massage, ultrasound, TENS, braces, supports, lumbar corsets - for a limited number of hours per day, to avoid atrophy of paraspinal muscles,

in patients with symptomatic spinal stenosis with pain, maintaining a posture of slight lumbar flexion; although there are no trial data to guide this decision; treadmill and ergometer training acupuncture; biofeedback; hot or cold packs; traction or chiropractic manipulation. These therapies (14) have not been compared in any randomized controlled trial and there is considerable variability among practitioners in their use.

- *for pain*: medication such as acetaminophen, non-steroidal anti-inflammatory drugs (NSAIDs), Anti-cox 2–debatable efficacy, used for short time (2)(4)(13)(23)(27-30), tolerance mediocre, although there is no clear rationale, but are strongly contraindicated in patients with a history of congestive heart failure, peptic ulcer or kidney disease; muscle relaxants – used when pain is not controlled by antalgic drugs, NSAIDs, but no proofs; also mild narcotic analgesics.

- *lumbar epidural corticosteroid injections* (24)(25-28) are justified to control severe roots symptoms on the assumption that symptoms may result from inflammation at the interface between the nerve root and the compressing tissues. Data on the efficacy of epidural injections are sparse and mixed; on low time, especially in older patients is a lack of consistent evidence of efficacy (24). In patients with predisposing conditions, such as diabetic patients and in repeated infiltrations, infections are possible, which may have severe consequences (31). No efficacy or even negative results with foraminal or even intrathecal, made blind or under fluoroscopic control (28)

-*relational causes treatement*: anxiolytic, antidepressive, relaxation, education (reassure the patient, explain)

- *long-term opioid therapy* (28) should be considered for older patients with unsatisfactory response to other medical therapies and who are not surgical candidates with the following caveats: assess for pain control and functional improvement in walking, standing, self-care activities, may generate complications: constipation and in the older patient may adversely affect cognition.

-*calcitonin* could be tried in patients with lumbar spinal stenosis administered by nasal spray to improve pain and walking tolerance, usually apparent within 4 to 6 weeks, despite double blind, randomized, placebo-controlled trial (29)(30). The calcitonin's mechanism of action is unknown: nonspecifically by raising the level of endogenous opioids - beta endorphins or by enhancing circulation to an ischemic cauda equine (22).

- *prostaglandin E* was credited by Yoshihara (32) useful in LSS treatment, based on same raising the endogenous opioids level.

The conservative treatment conclusions**:**

- conservative treatment is a therapeutic option for LSS without major risks - see NSAIDs complications
- it's acceptable for the patient
- several options could be used to those patients who cannot be operated
- it must be applied as the first treatment

The surgical treatment is not only a solution for resistant symptoms in patients

For residents

with LSS, but even useful: in cases of consistent clinical and radiological findings after adequate conservative therapeutic measures have failed for a time at least three months, to patients with realistic expectations; certified although by few evidence-based insights into the treatment options (1)(2)(4)(6-8)(12)(17)(19)(23)(33-41).

Surgical treatment in LSS means (33)(34)(38)(40-55):

-a functional surgery – never operate pictures with the aim to alleviate symptoms, to normalize daily life activities, improving functional capacity, achieving a good quality of life

-difficult surgery – most aged patients, with chronic illness; there are still 20% unsatisfactory results

-experience - surgical treatment should be applied to each patient, with a perfect correspondence between neuro-radiological and clinical findings

There are several points to consider into the preoperative planning (33)(50)(51)(56):

- medical status & physiologic age of the patient
- clinical and morphologic aspects, associated pathology – it's rational to consider a disturbed balance between the capacity of the spinal canal and its contents at the time of presentation must be responsible for the insidious onset of neurogenic claudication; also is usually symptomatic at a particular side & motion segment/s rather than affecting bilateral multiple radiological involved levels; careful evaluation of all available data proved that the number of nerve roots requiring decompression is often less than what appears in radiological studies alone
- the timing for surgery has not been clearly decided. Data comparing the outcomes of patients who underwent surgery earlier vs later in the disease suggest no difference in outcome
- is there deformity/instability too ?, the suggested decompression technique alone may lead to segmental instability ?
- a fusion technique should be performed to all cases ? – see loss of mobility of the operated segment, possible adjacent segment decompensation or unless instability is present pre-op; for older patients ability to fuse may be compromised, also fixation may not be adequate
- the proposed surgical procedure should be correlated with long-term results relating especially to modern techniques, which are still often lacking
- should this operation to be the "last surgery"?
- it's also art of surgery– adequacy for enlarged lumbar spinal canal - it's a balance between doing too much and not doing enough: suppressing the conflict between the lumbar spinal canal with disco-ligamentous structures and the content represented by the dural sac and radicular nerves, decompressing the neural foramina, eliminating pressure

on the spinal nerve roots, without generating spinal instability, never prophylactic

In the absence of randomized prospective controlled trials of surgical vs nonsurgical treatment several ideas should be underlined (1)(2)(4)(11)(12)(16)(19)(20)(23)(33)(34)(39)(41) (50)(54)(56):

-stenotic symptoms improved significantly more often in surgically treated patients; there is an advantage at least in the short term than in conservatively treated patients

-most surgically treated patients would again choose surgery; no difference in outcomes of patients who underwent surgery earlier vs later in the disease; but over 10 years outcome was most favorable with surgery

-however, up to one third of patients treated non surgically also do well and an initial non-surgical approach was advisable for most patients

The aims of surgical techniques (50)(51)(53)(54) in degenerative lumbar spinal stenosis should be critical evaluated since the aims of the procedure are clearly explained in the written consent, especially to old-aged patients:

- ✓ *to restore functional capacity* acting on neuro-vascular compression, with no or limiting complaints: neurogenic claudication + mono or multi roots resting or in efforts pain; subjective neurologic signs + neurologic deficit during walking, to improve leg and low back symptoms, to increase the pain - free walking distance
- ✓ *to achieve a good quality of life using a technique for* "maximum effect with minimum trauma": minimize tissue disruption, decompress the lumbar channel and the roots, avoid to destabilize, no stabilization, no instrumentation, minimize time of surgery and length of hospital stay, minimize post operative morbidity, avoiding complications, to permit a rapid patient mobilization, almost addressability is for old, fragile patients think to an unique surgical procedure

It's better to inform the patient, that surgical treatment has *no action* on (33)(51)(54):

- focal or diffuse low back pain and/or stiffness
- "degenerative" illness
- no patient will be completely free of complaints
- no patient will have a new lumbar spine after the operation

Surgical indications are depending on case to case evaluation (37)(38-41)(50):

-general indications related to age - without a priori contraindications, co-morbidities, surgeon experience which predicts failure of conservative therapy or patients intolerant to conservative therapy, younger age and somatic co-morbidity were independently associated with life dissatisfaction

-specific indications related to: degree of stenosis, MRI findings, with evidence of good correlation between severity of symptoms, radiological concordance and surgical outcome and poor correlation between degree of stenosis with degree of symptoms; degree of

For residents

disability (ODI, Pain Analog Scales, walking distance, daily life activities), degree of instability and associated neurological deficit, surgical option and the timing for surgery individualized on patient request.

Establishing indications, there are several situations (50)(54):

- ✓ *Incidental finding of LSS* and those with no limitation of life style; not bothered by symptoms (mild):
- explanation of findings, reassurance and "watchful waiting"
- treat any co-morbidities or other conditions contributing to symptoms of stenosis
- treat low back pain with NSAID's (selective cox2 inhibitors)
- ✓ *Symptomatic LSS*: patients with cauda equine syndrome (52) *should be operated on emergency* – rare cases
- ✓ *Symptomatic LSS* with persistent or worsening symptoms of neurogenic claudication and/or radiculopathy (reduced walking distance but can manage daily activities with medication) despite conservative therapy for at least 3 months, with minimal co-morbidities, radiologically demonstrated severe stenosis - the best patients to benefit from surgery. Also in cases with recurrent symptoms (56) proofed clinically and radiologically of: residual stenosis at operative site due to inadequate first surgery, stenosis at adjacent levels to surgical site, new herniated disc, epidural and arachnoidal adhesions, instability and/or spondylolisthesis following first surgery, in the absence of demonstrated stenosis, further investigations are warranted: contrast studies, EMG and NCS. For symptomatic LSS evidence in the literature is poor for correlating degree of stenosis with degree of symptoms, but there is a good correlation between severity of symptoms and surgical outcome (34). Because the timing for surgery has not been clearly decided (50), option for early surgical management is based, in selected patients, on surgeon experience who predicts failure of conservative therapy, to those patients failing or intolerant to conservative therapy or patients with associated instability and neurological deficit.
- ✓ *Symptomatic LSS* in patients with co-morbidities that increase surgical risk (46)
- severe medical conditions (severe pulmonary disease or unstable cardiac status)
- morbid obesity, diabetic
- severe osteoporosis
- extremely advanced age: treat with conservative measures, use adaptive techniques for restoring mobility, utilize rehabilitation services

  Such patients should be treated with conservative measures, adaptive techniques for restoring mobility, utilize rehabilitation services

- ✓ *Patients with LSS candidates for instrumentation and fusion* (35)(36)(48): pre-existing spondylolisthesis, instability; if proposed operation may compromise spinal integrity (about 5% laminectomies - in most series ended up requiring stabilization) a consent should be obtained.

LSS surgical tactic strategy should respond to 5 problems (33)(43)(45)(48-51):

1. should we decompress ?

Yes, in a majority of cases

No in cases with instability; hypermobility may accentuate compression – it's better to stabilise without decompression

2. what kind of surgery should be done ? Micro or Macro ?

It's better to choose *the best operative technique*, *avoid reintervention*, *never preventive*. The operative technique should minimize tissue disruption (smaller incisions, less tissue trauma), minimal blood loss, minimize time of surgery, length of hospital stay, post operative morbidity, with earlier return to activities and work; easier operative approach in obese patients. It should be used local or regional anesthesia combined with conscious sedation, less postoperative pain medication is required.

What to do in the meantime - requirements: continue with current best practice - surgical expertise and experience for patient selection & for surgical skills, inform patients of surgical choices and availability of resources and facilities in institution - informed consent

3. which roots should be decompressed ?

Electrophysiological testing correlated to through neurological examination is more accurate than radiological evaluation alone in choosing the roots to be decompressed. In practice we deal with several situations:

-*central lumbar canal stenosis* even with unilateral radiculopathy, during walking or effort –

decompress all roots

-*lateral recess stenosis bilateral* with unilateral radiculopathy, at one level - decompress both roots

-*lateral recess stenosis multilevel*, with unilateral radiculopathy – radical fenestration and foraminotomy technique, decompressing only the symptomatic side & level

-*foraminal stenosis* - decompress affected root

4. stabilisation is needed ? There are several aims to respect:

-*treat a dynamic component*- patients with severe symptoms and radiographic evidence of excessive motion, greater than 4 mm translation or 10° of rotation, who fail to respond to a trial of nonsurgical treatment

- *prevent a postoperatory instability*

Stabilization is needed for: confirmed preoperative instability, extent of bone resection, articular processes orientation, spinal static condition

5. what type of stabilisation should be used?

- preoperatory instability, see also articular processes orientation - spinal static

- the extent of bone resection

Caveats: No systematic stabilization !

Stabilization should be limited !

No stabilization for lumbar associated pains !

For residents

-*Fusion* should be made to obtain a stabilization after arthrectomy, to correct a deformity, to avoid a hyper-mobility, maintaining lordosis and foraminal size

-*Arthrodesis &instrumentation*

- open - rigid stabilization systems with pedicle screw fixation
- percutaneous
- motion preservation: dynamic stabilization systems
- facet arthroplasty
- TFAS® Total Facet Arthroplasty System

- *Lumbar interspinous implants:*
- Colfex, Wallis, Diam, X-Stop

Surgical Interventions for LSS

A variety of surgical techniques can be used depending on patient selection (informed written choice and consent) surgical skills, surgeon expertise and experience, but also availability of resources and facilities in each institution (50)(54)(55)(57)(58)(60-133)

A. For lumbar spinal stenosis

1. "the gold standard technique" – microsurgery using microscope and micro instruments to realize microsurgical decompression without instrumented fusion and with segmental stabilization. Microsurgical decompression of the spinal canal or "internal laminoplasty" (50)(51)(60)(61)(66)(71)(72)(75)(76)(78)(79) (82)(129)(133) is defined as a mono or multi segmental, unilateral or bilateral internal enlargement of the central and/or lateral volume of the spinal canal, without performing a laminectomy.

Surgical Principle

The spinal canal is approached through a modified microsurgical inter-laminar route usually from the (most) symptomatic side. In cases with associated degenerative lumbar scoliosis, the approach from the convex side is preferred. The inter-laminar window is opened ipsilateral by resection of the hypertrophied yellow ligament. The insertions of the yellow ligament are resected by osteoclastic undercutting of the cranial and caudal lamina. Subarticular ipsilateral decompression is achieved by undercutting or partial resection of the medial parts of the superior facet of the infradiacent vertebra. Enlargement of the central parts of the spinal canal, controlateral decompression of the lateral recess is performed without the risk of destabilization of the motion segment by a limited and modified approach bringing in the working instruments through an "over-the top" approach which means undercutting of the laminae and resection of the ventral parts of the interspinous ligament. This approach was proposed by Poletti (73) and refined by McCulloch (75) for the treatment of lumbar disc herniations.

Micro surgery for LSS has both technical as well as clinical advantages, but also limitations; using para-spinal approach introduced by Wiltse in 1973 (63) are many advantages:

Technical advantages:

- permit bilateral decompression of the spinal canal through a unilateral approach, also the spinal nerves on both sides; from their dural sleeve exits to their entrance into the foramen
- decreased trauma to paravertebral muscles on the ipsilateral side, preserving skin vascularisation which is dependent on two networks joigned at 30 mm from midline, no

trauma to paravertebral muscles on contro-lateral side, preserve the posterior spinal elements: limiting the iatrogenic disruption of ligaments (supraspinous, interspinous), spinous processes, paraspinal muscles on the contro-lateral side as well as complete preservation of the laminae, the two thirds of the facet joint on the ipsilateral side and more than 75% of the facet joint of the contro-lateral side

-avoids iatrogenic multifidus denervation, devascularization, atrophy - if approach are median, diminishing low back pain about to this muscle which is a key position

-allows decompression, pedicle fixation under visual control (no need fluoro), TLIF, ELIF, PLF

-offer direct access to articular process, entry point of pedicle fixation, transverse process and sacral alar

- decreased operative blood loss even in multi segmental approaches

Clinical advantages result from the technical advantages:

-decrease postoperative pain & infection rate, minimize rates of developing de novo postoperative changes in spinal alignment - segmental motion is similar to the intact spine, avoiding iatrogenic « instability »

-decrease hospital stay & duration for rehabilitation, increase patient satisfaction and confort, quicker return to normal activities

-early mobilization by decreased trauma to paravertebral muscles; important argue to decrease postoperative complications: such as deep venous thrombosis, urinary tract infection or pneumonia due to prolonged immobilization; especially in aged patients >70 years, without stability operation indication

- reduce surgical morbidity in a frequently high-risk patient group.

Reported success rates of surgery vary considerably in uncontrolled trials (50), but data from long-term studies are lacking. Over the past several years, minimally invasive surgical techniques have been introduced that use smaller incisions and more limited removal of the laminae and facet joints to achieve decompression. Early results from small observational studies are promising (51)

Limitations:

- longer surgery: 45 to 60 min per level

-an insufficient exposure lead to intempestive manipulation of the thecal sac and cauda equina, generating temporary and/or permanent neurological deficits

- unfavorable clinical outcomes by inadequate decompression, especially of the controlateral side

-radiation exposure

-dural tear

-learning curve

Before micro surgery for LSS, the patient must sign the informed consent on the risks of microsurgical mono or multilevel approaches to the lumbar spinal canal: nerve root, cauda equina and/or conus medullaris lesions with postoperative neurological deficits, inclusive bladder and bowel dysfunction; dural tears with menigocele and/or CSF fistulas, postoperative epidural hematoma, meningitis, spondylodiscitis with epidural abscess, compressive epidural scarring with permanent sciatica or even neurological deficits, segmental instability, chronic low back pain

For residents

and radicular symptoms ("failed back surgery syndrome") requiring stabilizing surgical procedures.

Micro surgery for LSS indications:

-symptomatic LSS patients, congenital or acquired, with spinal claudication, stiffness of low back pain, loss of lumbar lordosis, uni or bilateral crural symptoms, with or without vertebral body translations

-proof of neuroradiology of a narrowing of the central and/or lateral spinal canal, in relation to the topography of the affected lumbar nerve roots: dynamic MRI, myelo-CT, saccoradiculography (measurement of the sagittal and/or transverse diameter of the spinal canal are not helpful for the indication for surgery, since it is not the absolute width of the spinal canal). For a differential diagnosis, see peripheral radiculopathy: electromyograms – EMG (80), nerve conduction studies or somato-sensory-evoked potentials (SSE) are useful to rule out other diagnosis.

-decompression without stabilization is performed in all patients without radiological signs of vertebral body translation, in patients without low back pain despite vertebral body translation or degenerative scoliosis, in patients older than 75 years, with severe osteoporosis and multi segmental pathology

-decompression with segmental stabilization (usually posterior–anterior 270° fusion or TLIF) is performed in patients exhibiting grade I or higher type spondylolisthesis on rest or functional X-rays with significant low back pain, as well as in patients with unstable lumbar degenerative scoliosis.

Micro surgery for LSS contraindications: unstable angina pectoris, severe arterial hypertension, severe respiratory insufficiency

Micro surgery for LSS - surgical technique (60)

Preoperative planning is based on:

-clinical

-neuroradiologic studies:

-X-rays of the lumbar spine using AP and lateral views

-for instability functional X-rays in flexion and extension to reveal a degenerative scoliosis, segmental rotational or translational instability

-MRI - the imaging technique of choice, using standard facilities: the thickness of the yellow ligament, its extension underneath the adjacent laminae as well as the thickness of the lamina itself; the size and topography of the neural structures at the level of compression as well as above and below to avoid damage during decompression; the epidural fat distribution which may lead to enter the spinal canal through a more medial posterior route where more epidural fat protecting the thecal sac especially in a extremely narrow lumbar canal; the shape of the spinal canal (round, oval, trefoil) and estimate whether it is mainly soft tissue (yellow ligament, joint capsule, intervertebral disc) or bone (superior facet, lamina, osteophytes) which leads to a compression of neural structures, preserving the bony structures as much as possible or dynamic facilities to discover instability

-CT scan/post-myelographic CT-scan

-electrophysiologic studies especially in a multilevel stenosis: EMG, NCV, somatosensory-evoked potentials (SSE)

The operation is performed under general anesthesia, requiring arterial blood pressure monitoring, central venous line, the introduction of a urinary catheter. If a multilevel decompressions is intended, blood collection for retransfusion or blood transfusions are nedded. The patient should be positioned as similar for lumbar micro discectomy in a prone "Mecca" position, restricting head rotation, padding the eyes, forehead and nose; also protecting shoulders, brachial plexus, ulnar nerve, the knees with as many gel cushions or pads as are needed. The level(s) which have to be approached for microsurgical decompression are localized. The skin incision is centered exactly over the lumbar segment of interest. For two or more adjacent levels the skin incision is enlarged; for nonadjacent levels two separate skin incisions are recommended. After the interlaminar space is approached a new intraoperative reperage is performed and under microscope, fascia is opened in a semicircular manner, leaving the medial parts attached to the supraspinous ligament and the lamina. The paravertebral muscles are retracted after subperiosteal elevation. Retraction does not extend beyond the lateral border of the facet joint in order to avoid disruption of segmental innervation. The laminae of the adjacent vertebrae are exposed, the interlaminar window is cleaned of soft tissue, the speculum-retractor is inserted, the interspinous ligament is exposed, verifying that the visual axis toward the midline is not obstructed by a hypertrophied or dysplastic spinous process.

Microsurgical ipsilateral decompression is started with the removal of the inferior parts of the cephalic lamina, using a high-speed burr. Laminotomy is extended laterally and caudally. Depending on the size ofthe inferior facet, its medial aspect is removed until the medial parts of the superior facet can be identified. The yellow ligament is removed with rongeurs including the ventral parts of the interspinous ligament. Adhesions of the dura to the yellow ligament are gently dissected from medial to lateral. After removal of the yellow ligament and its insertion underneath the lamina in most of the cases the central portion of the spinal canal is already decompressed. However, if there is still narrowing by a hypertrophied lamina, undercutting has to be continued in cranial and caudal directions. "Subarticular" decompression can be the most difficult part of the operation. Usually there is no space between the lateral parts of the thecal sac, the nerve root and the superior facet. With a blunt micro dissector, the neural structures are gently mobilized from the yellow ligament, the lateral recess is opened with a 1.5 or 2 mm Kerrison rongeur, proceed first in a caudal direction, minimizing the risk of dural laceration or nerve injury. Decompression continue along the nerve until the medial border of the pedicle can be visualized and completed until the inferior border of the exiting nerve root can be identified or palpated with the blunt nerve hook. In cases with pronounced narrowing of the intervertebral space there is often impingement of the exiting nerve root by the tip of the superior facet. This tip can now be removed with a rongeur thus achieving a complete decompression of the exiting nerve root in the foramen.

For residents

Microsurgical controlateral decompression is realized tilting the table and adjusting the microscope to give an oblique view into the spinal canal. The ventral parts of the interspinous ligament, sometimes even ventral parts of the base of the spinous process should be resected, also the transition zone into the fibers of the contralateral yellow ligament are resected; the yellow ligament of the contralateral side are resected. It is necessary to continue undercutting of the supra and infradjacent lamina to increase the spinal canal volume as well as to have a free visual axis toward the controlateral recess and foramen entrance. Decompression is facilitated if the medial border of the controlateral inferior pedicle is identified by minimum retraction of the thecal sac. Then decompression by subarticular undercutting as well as by undercutting of the supradjacent lamina can be accomplished using a blunt dissector, a nerve hook or a metal sucker probe to temporarily retract the dura. At the end of the procedure the surgical field is irrigated with saline solution, hemostasis is achieved with small amounts of bone wax for the bone surface, avoiding to place into the spinal canal Gelfoam, Surgicel; fascia and the skin are closed with absorbable sutures. For the lumbar lateral recess stenosis a bilateral lateral recess decompression via subarticular fenestrations (57) is a less invasive technique, which enables to decompress the neural structures while preserving as much of the bony structures and ligamentum flavum as preferred. These technique will lead to early mobilization of patients without impending instability, less postoperative pain and immobility, minimal epidural fibrosis, providing an easier reoperation of the same area if required.

2. endoscopic: not superior to "gold standard"(51)(54)(61)(62)(65-70).The micro endoscopic decompression technique used in spinal lumbar stenosis is a less invasive form of surgery, based on the micro endoscopic discectomy as developed by Foley and Smith in 1996 (70). Using this method, it is possible to address problems on the controlateral side in addition to those on the ipsilateral side. Therefore there is no valid evidence from randomized controlled trials on the effectiveness of transforaminal endoscopic surgery for lumbar stenosis (67):

- comprehensive systematic literature review
- no randomized controlled trials, seven observational studies.
- studies were of poor methodological quality
- heterogeneous regarding patient selection, indications, operation techniques, follow-up period and outcome measures.
- re-operation rate varied from 0 to 20%.

The micro endoscopic decompression technique is characterized by several advantages:

-require local or regional anesthesia combined with conscious sedation

-a small skin incision, useful even for two neighboring segments approach

-less invasion of paraspinal muscle because the paraspinal muscle is not detached from the lamina, less tissue trauma, a small dead space

-affords a safe procedure, minimizes resection

of the pathologic compression tissues
-the ipsilateral approach and controlateral endoscopic decompression can be performed under the midline posterior structures the same as microsurgical decompression or even more easier tilting the tubular retractor about 20° to 30° medially
-damaged areas inaccessible by direct vision can be reach by an endoscope angled at 25°; it's possible to see the compressed nerve root directly under the hypertrophied superior facet
-minimal blood loss
-less postoperative pain medication
-earlier return to activities and work
-easier operative approach in obese patients
-excellent clinical outcome and patient satisfaction in most cases
The micro endoscopic decompression technique disadvantages:
-demanding technique, a steep learning curve; for LSS should be applied only after mastering the endoscopic procedure for lumbar disc herniation
-the field of view through the endoscope is limited, which makes it difficult to appreciate the amount of bony resection that has been performed
Indications:
-initially for lateral recess stenosis, because the inter laminar space is relatively wide
-for moderate central canal stenosis
The micro endoscopic decompression technique in LSS:
-after radiologic control, tubular retractor is inserted and a minimal skin incision is performed
-different types of endoscopes angulations are used
-using a curved chisel, the inferior part of the ipsilateral lamina and the medial side of the inferior facet is cut, the remnants of lamina are removed with Kerrison rongeurs
-the ligamentum flavum is cut transversely, with a sheathed knife blade and removed piece by piece with the Kerrison rongeur
- the tubular retractor is moved to the medial side through and beneath the interspinous ligament controlateral; the ligamentum flavum and medial facet are removed by using the Kerrison rongeur - always oriented away from the nerve root during the decompression procedure, exposing the dural tube, ipsi and controlateral nerve roots, which could be retracted, using the Penfield retractor
- using a curved chisel the additional medial facet are removed
-also a small chip of shaved lamina could be removed by the use of a pituitary rongeur
-hemostasis is realized using a bipolar coagulator, bone wax.

3. conventional

Several techniques have been used, depending the LSS topography: central stenosis, lateral stenosis and mixed stenosis.

- *for central stenosis* there are (33)(39)(43)(49-51)(55)(56)(83)(87)(95-97)(98)(99)(105) (108)(109)(111):

-laminectomy with bilateral foraminotomy (yellow ligament removal, inferior facetectomy, respecting isthm, discectomy if needed, it could be made in block or by fragmentation = "the recalibration" – "the windows technique"

For residents

Laminectomy is still considered to be the treatment of choice in degenerative spinal stenosis without instability, used for adequate and safe decompression of lumbar stenosis, with highly significant reduction of symptoms and disability and improved health-related quality of life. Laminectomy is the traditional standard operation in lumbar spinal stenosis decompression, to remove the roof of the spinal canal. If no preoperative instability, laminectomy does not require fusion or fixation; only about 5% laminectomies (in most series) ended up requiring stabilization, if facet and discal anatomy is compromised.

For congenital central spinal stenosis wide laminectomies are indicated because that narrowing of the spinal canal not only affects the interlaminar interval but also the sublaminar space in multiple segments. In a meta analysis, the success rate of this procedure has been shown to be 92.2% fair to excellent result (Finneson + Cooper Criteria), 9.8% complications, including 6.8% durotomies, 11.2% re-operation rate (re-stenosis, instability, complications)(76) Nerve compression is usually limited to the height of the intervertebral space in the area of the hypertrophied joint facets and the ligamentum flavum. Removing long sections is therefore not necessary, which has – aided by enormously increasing numbers of surgical procedures – resulted in the development of newer, less invasive techniques.

-unilateral and bilateral laminotomy „recalibrage“ means lumbar decompression by partial removal of laminae. There are several techniques variants: unilateral hemilaminotomy (66) (one or several levels), partial decompressive lamino-arthrectomy uni/bilateral, hemilaminotomy + arthrectomy with ligamentectomy & recess decompression (87-90).

There are several alternatives to laminectomies:

The “port-hole”technique is a surgical procedure for spinal stenosis developed by Dr. Kleeman in 1992 (88); instead of performing a laminectomy and removing the spinous processes, the spinal canal was decompressed through openings or “port holes” that left the spinal structures intact.

Weiner et al. (100) used a procedure for lumbar decompression, with unilateral periosteal dissection of multifidus, to minimise denervation and subsequent atrophy. A modified Weiner technique is ”the hinge osteotomy technique” applied by El-Abed K. et al. (101)(107); a safe unilateral approach for multi-level lumbar stenosis, allowing wide decompression of lumbar spine with significant symptom and functional improvement and no iatrogenic spinal instability

”The hinge osteotomy technique” incorporate: unilateral subperiostal muscle dissection with osteotomy of the of the base of the spinous processes of the involved segments, just superficial to their junction with the lamina, bilateral complete laminectomies avoiding over-resection of the facet joints (less than 30%) and complete resection of the ligamentum flavum thereby providing excellent exposure, preserving the integrity of the posterior elements, while maintaining posterior column stability

A variant of bilateral laminotomies are "the transspinous median sublaminar decompression" which means bilateral laminotomies, with unilateral periosteal dissection of multifidus, to minimise denervation and subsequent atrophy, osteotomy of the spinous processes of the involved segments, just superficial to their junction with the lamina - Weiner procedure, (111)

In most outcome parameters, bilateral laminotomies was associated with a significant benefit and thus constitutes a promising treatment alternative.

-radical fenestration (93)

As an alternative to laminectomy, interlaminar fenestration techniques have become established that spare the midline structures and thus the dorsal tension band, decompressing the nerve roots, by resecting the ligamentum flavum and parts of the medial facet joint; exceptionally disc removal. Encouraging results have been shown for bilateral fenestration and unilateral fenestration with undercutting controlateral decompression.

-foraminotomy (50)(51)(133) means radicular nerve decompression by classic or minimal invasive decompression technique removing ligamentum flavum, partial inferior arthrectomy. It can be associated with discectomy

-open door expansive lumbar laminoplasty is another decompressive lumbar spinal canal technique without impairement of instability (50)(51)

Today's conventional technique should provides excellent exposure, a safe approach even for multiple level stenosis, maintaining posterior column stability. This techniques are generally based on:

-clinical evaluation, inclusive:

-leg pain validation VAS (0-10),

-Self-Reported Functional Status based on Likert scale (SRFS: pain interference with normal work:1 not at all - 5 extremely)

-Likert Symptom-Specific Well-Being Score (SSWBS: 1 very dissatisfied - 5 very satisfied)

-Likert General Well-Being Score (GWBS - how would you rate your quality of life? 1 very bad - 5 very good)

-Oswestry Disability Index for leg pain (ODI)

-radiologic evaluation, lumbar spine CT and RM, standardised lumbo-sacral X-rays along with lateral flexion and extension radiographs – defining spinal instability as sagittal plane translation of 3 mm or more - White and Panjabi (1990) Clinical bio-mechnics of Spine (cited by 54); performed preop, at 6 months and 3 years post op to demonstrate evidence of progressive segmental instability.

-operation is made under general anesthesia, using magnifying loops

-the patient is placed in prone position, midline incision is made, after radiological level confirmation.

-periosteal multifidus muscle dissection is carried out unilaterally

-the electric pen burr is used to delineate the base of spinous process

-the integrity of the posterior elements: the spinous process, interspinous/supraspinous

For residents

ligaments, and facet capsules are preserved
-surgical retractors are spread to hinge the spinous process(es) off the midline
-the spinal canal, the foraminal zones and nerve root canals are decompressed after bilateral laminectomies and complete excision of ligamentum flavum, as completely as possible, avoiding over-resection of the facet joints - less than 30%
-fat pad is laid on the dura to avoid subsequent fibrosis
-supraspinous ligament is sutured to dorso-lumbar fascia
-drain is used
In general conventional open posterior lumbar approach and laminectomy generate tendon disruption, muscle devascularisation, atrophy, denervation, dysfunction, dysconfort, crusch injury; also produces the greatest changes in segmental motion during flexion, extension, left and right axial rotation. (85)(86)(92)(95-99)(102)(105)(106)

- *for lateral stenosis*: (81)

In lateral lumbar spinal canal stenosis, radiculopathy is well recognized as expression a spinal nerve entrapment in the three zones: entrance zone, mid zone and exit zone.
For entrance zone stenosis the most common causeis hypertrophic osteoarthritis of the facet joint, particularly involving the superior articular process. The appropriate surgical decompression technique are medial fatectomy, ranging from one-third to one-half.
For mid zone stenosis localized facet degeneration under the pars interarticularis where the ligamentum flavum is attached are due by osteophyte formation, periarticular calcification, articular narrowing of the joint space, subchondral erosion and fibro-cartilaginous hypertrophy at a spondylolytic defect. The surgical techniques focused on the symptomatic stenotic side have common hallmark of medial fatectomy, careful excision and curettage under the pars interarticularis; osteophytes trimming along the superior margins of the superior articular process and along the lateral margins of the corresponding inferior articular process or even laminectomy with total fatectomy.

For exit zone stenosis the main causes are: hypertrophic osteoarthritis changes of the facet joints with subluxation and osteophytic ridge formation along the superior margin of the disc. The suggested technique are foramen approach from the interlaminar space below the level of the root.
It's to be remarked in congenital lateral recess stenosis a trefoil-shaped, the nerve root is entrapped under the superior articular facet by facet hypertrophies or by disk bulging, disk margin enlarges because of endplate spur. Surgical management consists of decompressing the nerve root emerging from the thecal sac along its entire course in the radicular canal with laminotomy and medial facetectomy. If lumbar disc herniation accompanies the pathology, removal of disc material is needed additionally.
There is also a second form with an angled shape of the recess by progressive facet, endplate and disk margin changes with subsequent pinch of the nerve root. If early facet hypertrophy occurs, an acquired trefoil-shaped canal ensues.

-for mixed stenosis:

laminectomy + partial artrectomy; the Wiltse

approach (63) with foraminotomy for isolated foraminal stenosis

4. fusion:

Current guidelines reject stabilization by default on the basis of an extensive literature search (33)(34)(48)(51)(54-56)(58)(113-127). Even after a laminectomy only 20% of cases need a fusion procedure (58). The reactive degenerative changes obviously prevent manifest segmental instability, even after decompression if more of 50-66% of articulary or isthme are conserved, without discal space violation (56)

After White-Panjabi (cited by 54): instability means a loss of spine 's ability to maintain under physiological conditions its normal anatomical relationships at risk causing signs of irritation spinal cord/nerve root, pain or crippling deformities ". Instability could be responsible of stenosis; it could be associated with LSS symptomatic – with intermittent mechanical pains; iatrogene with symptomatic instability or without clinical signs (50)(51)(54)(55)(133).

Spondylolisthesis, scoliosis may generate instability; also after decompression, the possibility of segmental instability should always be considered. Fusion procedures, especially those involving instrumentation, are associated with increases in cost and complications, are used for pre-op, intraoperative instability or postoperatory listhesis (58). Still there are several debatable aspects - subject of controversy: the criteria of instability, the spondylolisthesis or scoliosis grade, what kind of stabilization should be used with or without motion preservation, minimally or invasive intervention, the approach used: posterior, anterior or "circumferential", instrumentation increases the fusion rate ?, implant failures and adjacent joints degeneration (56).

There are several surgical alternatives (50)(51)(113-128)(131)(133)(135):

-open: bone deposition, iliac bone graft, instrumentation rigid or dynamic with pedicular screws, inserted with the help of a spinal navigation system, inter body cages

-microscopy

-percutaneous

-facet arthroplasty

-interspinous spacers (X-STOP, DIAM, COFLEX, HELIFIX) with 45% improvements after two years, an intermediate option between conservative and surgical treatment - "does not burn bridges", for patients with mild symptoms, to those that cannot undergo or refuse more extensive surgery, as a temporary solution, "addressing the problem within the canal without entering the canal". Interspinous spacers advantages are: disc not removed, no pedicles used, opening of foramens, unloading of the posterior part of the disc, of the facets. There are also less risk of significant complications, no direct manipulation adjacent to the neural structures; the risk of neurological deficit (paralysis; dural tears; etc) decrease to a minimum. Such interspinous spacers can't be used in the following anatomic variants: markedly decreased interspinous distance (kissing spine–like), with concomitant facet joint hypertrophy, a posterior V-shaped interspinous area, limited accessibility of the space between the base and the tip of the spinous process because of facet joint

For residents

hypertrophy and variations in the shape of the inferior surface of the spinous process.

The technique used for microsurgical decompression with instrumented fusion are based on the same principles (113)(114):

-preoperative planning includes the acquisition of CT-scan, MRI data for intra operative navigation

- general anesthesia: with the introduction of a central venous line, to perform arterial blood pressure monitoring, as well as the introduction of a urinary catheter, blood transfusion are not usually necessary.

- patient positioning: in a prone, comfortable position, on a soft foam frame, on a radiolucent table; respecting the protection of neural structures and the skin. The hips and knees are slightly flexed (20–30°) and the anterior iliac crest is padded in order to avoid pressure on the lateral femoral cutaneous nerve.

- screw insertion with the help of an intra operative navigation system or under fluoroscopic control

-insertion of mono or multi segmental internal fixation system

-reduction and reconstruction of normal curvature

-microsurgical decompression (see above)

-drain insertion and wound closure.

-wound drains are inserted underneath the fascia without applying suction.

- wound closure.

Several complications could appear (38)(54)(56)(59)(60)(61)(95)(137):

- dural tears leading to a pseudomeningocele or even CSF fistulas are the most common complications
- nerve roots lacerations (the nerve roots could be vulnerable by chronic compression for years in LSS; by temporary direct compression of the cauda equina roots during decompression of the controlateral side; also the arterial supply may be diminished by other concomitant diseases: diabetic microangiopathy, microangiopathy due to arterial hypertension, etc.)
- segmental instability
- destabilization of the adjacent segment
- arachnoiditis
- epidural scar formation
- epidural hematoma
- complications secondary to positioning, especially postoperative blindness or corneal lesions after pressure on the eyes - higher as compared to microsurgical discectomy, since microsurgical decompression requires longer operating times
- deep venous thrombosis
- upper respiratory tract infection
- urinary tract infection
- superficial wound infection

B. Lumbar Stenosis + Aggravating Factors (55)(56)(133)

There are several situations which should be discussed:

1.*Co-existing multiple disk prolapses or single level disk prolapsed with a multistage lumbar*

spinal stenosis, without scoliosis: - more common there is a single or two level prolapsed discs with LSS; the patient may present lombalgia, intermittent radicular claudication (walking perimeter, the caddie sign), isolated radicular pain, sciatic pain or cural nevralgia: for such cases medical treatment should be tried, in case of failure surgical attitude with LSS decompression plus disk surgery

2.*Combined LSS with degenerative listhesis and posterior arthrosis at one or several levels*. In such cases it's more frequent lateral LSS associated with disc hernia. Spondylolisthesis in itself is not an indication, except if there is > 4 mm translation in sagittal plane and 10° angulation flexion/extension

For such cases foraminal decompression, discectomy and fusion to all affected levels should be made (50)(132). It is uncertain whether instrumentation: use of pedicle screws or metal cages help to fuse adjacent vertebrae or biologic agents - bone morphogenetic protein should be used to enhance osseous fusion (50).

3.Combined LSS with scoliosis

Scoliosis and LSS can be explained in two ways: spinal deformation induce LSS or by arthrosis, massive joint hypertrophy may generate LSS and degradation of scoliosis. Saccoradiculography, dynamic MRI, EOS system osteodensitometry, electromyogramme are particularly useful examinations of reference for assessing instability and to measure the extent of curvature (54).

LSS with scoliosis with a small radius of curvature: decompression should not be associated with fusion.

LSS with scoliosis and a big radius of curvature installed in adolescence, it's stable and has similar therapeutic strategy

LSS with scoliosis and a big radius of curvature, with rapid evolution 5-10^0 in one year generating both radiculalgia and instability can not be neglected; also in *scoliosis with rotation* and rapid evolution to 30-50^0, with arthrosis in concavity which should be decompressed and fused (55). If scoliosis affect several levels a multilevel fusion should be tried (133).

4.*Combined stenosis and facet joint cyst* should be decompressed as usual, but the major risk is a dural tear which should be avoided

5. *LSS with severe polineuropaty* with or without uni/bilateral paresis should be decompressed and fused as well, but prognosis is different and should be explained to the patient (133)

The outcome in operated lumbar spinal stenosis

Despite several published studies, a lot of aspects should be clarified:

-functional outcome valuation should be made using (107)(135): Self-reported leg pain on VAS (0-10), Self-Reported Functional Status based on Likert scale (SRFS)(pain interference with normal work:1 not at all - 5 extremely), Likert Symptom-Specific Well-Being Score(SSWBS) If you had to spend the rest of your life with the symptoms you have right now (1 very dissatisfied - 5 very satisfied), Likert General Well-Being Score (GWBS) How would you rate your quality of life? (1 very bad - 5 very good), Oswestry Disability Index (ODI) for leg pain, Dallas Pain

For residents

Questionnaire (DPQ) *Lawlis et al. Spine, 1989*, Low Back Pain Rating Scale (LBPR) *Manniche et al. Pain, 1994*, SF-36 *Ware, Spine 2000*, EQ-5D, Swiss Spinal Stenosis Stucki et al, Spine 1996, Oxford Claudication Score Makan et al, JBJS, 1998.

-time – mean follow up 24 months or more: advantage of surgery was noticeable at 3-6 months, remained for up to 2-4 years (4)(44)(128-130). Cohort studies indicate that although more than 80% of patients have some degree of symptomatic relief after surgery for spinal stenosis, 7 to 10 years later, at least one third of patients report back pain (33)(56). Patients with the most severe nerve-root compression preoperatively are the most likely to have symptomatic relief. Reoperation rates are on the order of 10 to 23% over a period of 7 to 10 years of follow-up. Systematic review are necessary to compare the effectiveness of surgery vs. conservative treatment on pain, disability, loss of quality of life (19)(38)(50)(51)(136).

739 citations reviewed, several publications studies, showed surgery better results for pain, disability and quality of life, although not for walking ability. Results were similar among patients with and without spondylolisthesis. Advantage of surgery was noticeable at 3-6 months, remained for up to 2-4 years (1-17).

32,152 operations for lumbar stenosis in the first 11 months of 2007 (137): surgical rates declined slightly from 2002-2007, rate of complex fusion procedures increased 15-fold, life-threatening complications increased 2.3% to 5.6%, rehospitalization within 30 days, 7.8% decompression and 13.0% complex fusion, medical expenses were $23,724 compared with $80,888, preoperatory predictors for post operative outcome in lumbar spinal stenosis - based on 21 prospective studies (4)(38)(43-45)(52)(56)(133), despite reported success rates of surgery vary considerably in trials:

- good preoperatory walking predict a better walking capabilities two years later
- less co-morbidities: patients with cardio-vascular co-morbidities, severe scoliosis, lumbar spine surgery history had bad prognosis; also preop. depression predict: pain, less good satisfaction, less walking capabilities
- surgery appears to lead to better outcomes if there are ongoing symptoms after three to six months of conservative treatment, in those who worsen despite conservative treatments, surgery leads to improvement in 60–70% of cases (3)(50)(51)(76)(138)(139)
- poor pre operatory indications for surgery are bad predictors for outcome
- age < 65 years good post operative outcome
- back pain predominance compared with radicular pain has bad prognosis
- pre operatory motor deficit mono-radicular and unilateral, installed less than 6 weeks has complete recovery 40%, no recovery 20%
- stenosis to one level with real compressive disc herniation, predict a better function especially on walking and pain

- insufficient decompression are a bad predictor
- an important stenosis: A-P diameter < 6 mm predict less pain to 5 years
- therefore the timing for surgery has not been clearly decided. Data comparing the outcomes of patients who underwent surgery earlier vs later in the disease suggest no difference in outcome

-overall rating of post-operatory results of operated LSS: improved – 85% better quality of life-walking distance improvement - 95%, pain improvement (VAS) - 85%, low improvement – 5%, no improvement – disability 5%, worse – very rare, mortality 0 - 3% (12)(33)(38)(56). Daily life activities are post-operatory: normal 82%, modification of life/work style - 13%, stopped working - 5% (17)(133)(140). In general surgery affords earlier and greater pain relief and improvement in functional status and that these gains begin to narrow over the course of follow-up.

-although technical errors during time were noted, they seemed to have less influence on the outcome than did appropriate selection of patients; also complication rates did not differ based on patient age or fusion. The most common complications (up to 3%) (50)(133)(136)(137) are: epidural haematoma, CSF fistula +/- pseudomeningocele, inadequate - insufficient decompression, decompression at wrong level, root trauma or avulsion, infection up to 4%, arachnoiditis, epidural fibrosis, recurrence of stenosis with reoperation rates as high as 21%, instability, pseudarthrosis, flat back syndrome, general complications such as deep venous thrombosis, pulmonary embolism, urinary infection, wound healing disturbances; also by the co-morbidity of the patients.

-if operated patients present recurrent symptoms it's mandatory to resume lumbar MRI and CT, contrast studies, EMG and NCS to demonstrate (50)(51)(133): residual stenosis at operative site due to inadequate first surgery, stenosis at adjacent levels to surgical site, new disc herniations, epidural and arachnoidal adhesions, instability and/or spondylolisthesis following first surgery

-outcome depends on surgical type of operation used; also the pathological situation (56)(133):

- *one level lumbar stenosis or a multistage lumbar spinal stenosis, without scoliosis*

There are several meta analyseses :

Turner (38) on retrospective studies reffering to surgery for lumbar spine stenosis between 1970-1993 revealed 64% satisfied people by surgery

Marjerko (cited by 56) on degenerative lumbar spondylosis between 1970-1993 find 69% satisfaction by decompression without fusion and more than 80% satisfaction if decompression was made with fusion.

Updated Cochrane review 2005 (34) several studies, for a short time, are reffering to different techniques applied, to pain symptomatology, but few informations about functional results, with limited conclusions.

Amundsen (7) on 19 patients operated of 50 patients, assert that conservatory treatment is compared with immediately post op on 4/5

For residents

patients without a significative diffference; after 10 years good surgical results in 5/11 patients, compared to 4/14 treated conservatory.

Postacchini 1993 (87) laminectomy versus staged laminotomies no difference ; Herkowitz 1991 (94), Grob 1995 (131) laminectomy with or without fusion - no difference on 139 patients during 3 years.

Fritzell Spine 2001 (cited by 56) fusion versus physiotherapy 294 patients of which 98% were reevaluated at two years; in 46% of cases surgery has good or very good results, compared with 18% good results by physiotherapy, p<0,0001.

Brox Spine 2003, Keller Spine 2004 (cited by 56) postero-lateral fusion with transpedicular screws compared with physiotherapy alone demonstrate the value of physiotherapy on avoidance beliefs, flexion, force and muscular endurrancy.

Another 3 studies with IDET without encouraging results ; also studies McAfee Spine 2003, Zigler J.Spin Disord 2003, Geisler J Neurosurg 2004 (cited by 56) reffering to disc prothesis no superiority versus simple fusion

Cochrane updated review 2005 (34) Surgery for degenerative lumbar spondylosis

Conclusion: few controlled trials, most retrospective, few are interested about symptoms.

Zucherman (120) made a prospective multicentric randomised study on 191 patients during 15 months; patients were >50 years with sciatalgic predominance, with or without lombalgia, intermitent claudication, surgical treatment consist in laminectomy with spacer versus medical traitement – at least one epidural infiltration before the study and 1-4 infiltration during study. At 2 years for operated patients 45% amelioration on severity score versus 7% in control groupe p<0,001); 56 of 93 operated patients has significant amelioration compared with 15 of 81 medically treated patients with a satisfaction index of 73% versus 36%. He foud that predictive factors were influenced by comorbidities.

Conclusion: the first precise study on methodological aspects is a plea to proof surgical treatment superiority versus conservatory in intermitent radicular claudication.

Atlas (4) published in Spine 2005 a prospective study on 10 years on 105/148 patients of which 97 are survivors; inclusion criteria: LSS on clinical argues, half of the patients with a radiculalgia monitorised at 3, 6, 12 months, after that annually. He found surgery superiority for radiculalgia 67% versus 41% p=0,04; satsfaction 42% versus 28% p=0,24; 23% of patients have a second spinal operation and 39% of medically treated patients were operated too.

Duquesnoy & Assaker (56)(62) on 168 operated cases:

Excellents results : retourn to anteriorly life condition, good results: good waking, retourn to professional activities, medium results: persistent invalidity, bad results: no amelioration.

124 patients	at 2 months	at 2 years
excellent results	68%	21%
good results	33%	41%
medium results	17%	19,5%
bad results	12%	18,5%

On intermittent claudication: excellents results in 47% of cases and good results in only 28% of cases; reffering on radiculalgia: excellents results in only 26% of cases; good results in 44% of cases.

For an operated multistage lumbar spinal stenosis, without scoliosis, without arthrodesis, walking troubles may be generated by (56):

- iterative stenosis (rare, by osseous aposition, Forestier illness)
- insufficient decompression to only symptomatic level, lateral partial decompression especially by incomplete lateral flavum ligament resection
- iatrogene instability (articulary resection, even isthm rupture may generate radiculalgia)
- concomitant cervical canal stenosis (if walking troubles are persistent, correlated with profound sensibility troubles)
- coxartrosis could be concomitant with LSS. Surgical indication for spinal decompression should be made on clinics and dynamic MRI or saculography.

In conclusion: for a multistage lumbar spinal stenosis, without scoliosis, surgery even to oldest patients has proved his efficacy in intermittent medullar claudication and radiculalgia on one or several levels, decompressing LSS, also performing discectomies, fusions techniques; **the patients should be inform that lombalgia is not treated**.

- *Combined LSS with degenerative listhesis and posterior arthrosis at one or several levels*

For surgical point of vue decompressing roots in a LSS may affect isthm, may generate iatrogene instability because of arthrectomy, especially in a LSS with degenerative listhesis and posterior arthrosis. We should treat only the instable level (56).

Several complication could be seen : overlying stenosis (by recurrence of a degenerative spondylolisthesis, hypertrophic flavum ligaments), disassembly of osteosynthesis by fracture instrumentation short and medium term as a sign of pseudarthrosis.

In conclusion: large laminectomies should be avoided, lumbar decompression with fusion, at the symptomatic level should be made if medical traitement fails.

- *Combined LSS with scoliosis* may be generated by two mechanisms:

-deformation generate stenosis – see stable scoliosis since adolescence

-degeneration induce a hypertrophic articular process with LSS - evolutive scoliosis with severe torsion

Always deformation should be evaluated, severe scoliosis should be operated (55)(133)

- if deformation is responsible for LSS the reduction arthrodesis treats claudication
- if the deformation is not the cause of LSS - rahisynthesis is imperative to avoid iatrogenic instability after decompression laminectomy

For old patients with severe ostheoporosis, LSS with scoliosis may generate complications:

For residents

-fails of rahisynthesis 15-20% especially in the lumbo-sacral area

-overlying osteoporothic fracture or settlement may be seen in 10-15% of cases, imposing : arthrodesis extension, vertebroplasty

- disorder sagittal echilibre should be corrected by subtraction osteotomy

A Scoliosis Research Society (SRS) database: 10.329 patients with LSS, treated with either decompression alone (64%) or decompression with concomitant fusion (36%) between 2004 – 2007 (140): complications (7.0%), including 13 deaths (0.1%); complication rates did not differ based on patient age or fusion.

In conclusion in LSS with scoliosis: limited surgical indication; indisputably effective surgery in intermittent claudication root and radicular pain, but surgical indications are on demand; surgery measuring if the predominant low back pain or joint pain; preeminence of the clinic on neuro-radiologic data; no proved superiority of multistage laminectomy compared to one level laminectomy, adjusted to the demand, with rahisynthesis

Final conclusions

- Initial management in LSS should be non-surgical unless very severe; also conservative treatment is able to give satisfactory results even for 10 years. It's important to survey scoliosis after climax, to use a lombostat.
- Clinical argues for surgical traitement: severe lumbar stenosis with waking perimeter limited, radicular pain and claudication, to a patient in good health condition, without comorbidities - clinical findings are prevalent compared with neuro radiological data.
- Surgical interventions are more frequent corresponding to increasing number of older patients and to their request for a bigger autonomy
- LSS surgery is a functional one, balance bony and soft tissue decompression while maintaining spinal stability, surgical interventions have to be tailored and rigourous applied to the unique pathological situation in the persistently symptomatic patient; explored by MRI, dynamic flexion and extension x-rays, EMG (electrophysiological testing correlated to thorough neurological examination is more accurate than radiological evaluation alone in choosing the roots to be decompressed)
- Adaptation of the surgical strategy according to the therapeutic objectives, constraints and physiological analysis of imbalances: never preventive, minimize tissue damage minimally invasive decompressive technique and/or fusion technique, clearly precised in the informed consent who correspond with patients expectations.
- Selective decompression only at the neurological responsible level improved neurogenic intermittent claudication in the majority of patients, - un operated radiological

stenotic levels or previously borderline stenotic level rarely became symptomatic in later follow up

- There is still a lack of evidence - based data regarding the different surgical techniques for lumbar spinal decompression, this explains why the success rate of decompression for LSS ranges from 57% to 95%; microsurgical decompression is useful in pain decrease and analgesic consumption, but also in functional improvement
- Surgery for LSS is efficacy for short and medium term; compared with medical treatment; for short time, surgery is better, nearly 80% of patients enjoyed excellent results: less pain and better functional status than those who had non operative treatment.
- Randomized trials are required to produce better guidelines for minimally invasive procedures, avoiding more extensive surgery
- The outcome after surgical decompression of LSS could be influenced by general complications such as deep venous thrombosis, pulmonary embolism, urinary infection, wound healing disturbances; also by the co-morbidity of the patients. Each additional decade could increase the ASA score and could worsen the postoperative result of the patients in their 60s to 90s. Most aggravating factors do not really make outcome worse; in particular degenerative spondylolisthesis and disk prolapses do not affect outcome.

The medium and long term outcome may be complicated by postsurgical instability after extensive multilevel surgery, osteoporosis; the more rapid progression of degenerative changes, the suboptimal decompression of the contro-lateral side because of the impaired view of the target area and a slower postoperative rehabilitation.

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