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# Important controversies in lumbar spine surgery: which patients benefit from lumbar spinal fusion and who should be fused? Literature review

**F. Urian[1], G. Iacob[1,3], A.V. Ciurea[2,3]**

[1] University Emergency Hospital Bucharest, Neurosurgical Department II, ROMANIA
[2] Neurosurgical Department, "Sanador" Clinical Hospital, Bucharest, ROMANIA
[3] Professor of Neurosurgery, "Carol Davila" University School of Medicine, Bucharest, ROMANIA

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lumbar spinal fusion, surgical outcomes, conservatory & surgical treatment, instability, spondylolisthesis, lumbar spinal stenosis, Oswestry disability index

## ABSTRACT

Considering the rising tendency in the application of lumbar spine devices, a rigorous selection of candidates for lumbar spinal fusion must follow the benefit of the patient in terms of a better outcome than classical techniques or conservatory treatment. We pulled essential information from scientific sources regarding the clinical results of patients who underwent fusion surgery to sift patients who do better from fusion.

We found out that imagistic proof of instability such as spondylolisthesis associated with lumbar spinal stenosis and refractory pain takes the most from spinal fusion procedures. Oswestry disability index improvement along with restoring the function and reduction of pain remained the postoperative desires of a successful fusion. Clinical amelioration with bracing test prior to intervention was a predictor of better results after fusion. Exclusion criteria like psychiatric disorders and prior lumbar spine surgery were highlighted since studies demonstrated that they are bad predictors of outcome in spinal fusion surgery.

Laminectomy was nowhere implemented in the literature as to be urgently fused since only about 20% of patients manifest instability after this classical procedure. Iatrogenic segmental instability after laminectomy, radiologically proven should be a candidate for spinal fusion. These procedures have high costs and high rates of complications putting the patient's functional status and quality of life at uncertainty since there is still a lot of debate in this area of spinal neurosurgery.

Motto: "Outcome may be improved by more careful selection of patients and by performance of an adequate surgical decompression" (Deen Jr, 1995)

## INTRODUCTION

"Which patients should be fused?" remains a big controversy. Lumbar surgical interventions for disc herniation, lumbar stenosis, with or without scoliosis, spondylolisthesis are more frequent, especially for

Corresponding author:
**Iacob Gabriel**

Professor. University Emergency Hospital of Bucharest.
Chief of Neurosurgical Department II, Bucharest, Romania

gbrl_cb@yahoo.com



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older patients, who request for a bigger autonomy (2-4). For several patients, on the medium and long term outcome, evolution may be complicated by postsurgical instability after extensive multilevel surgery, osteoporosis; the more rapid progression of degenerative changes, the suboptimal decompression of the contralateral side because of the impaired view of the target area and a slower postoperative rehabilitation may accentuate compression, especially to older patients, affecting their request autonomy (1)(5).

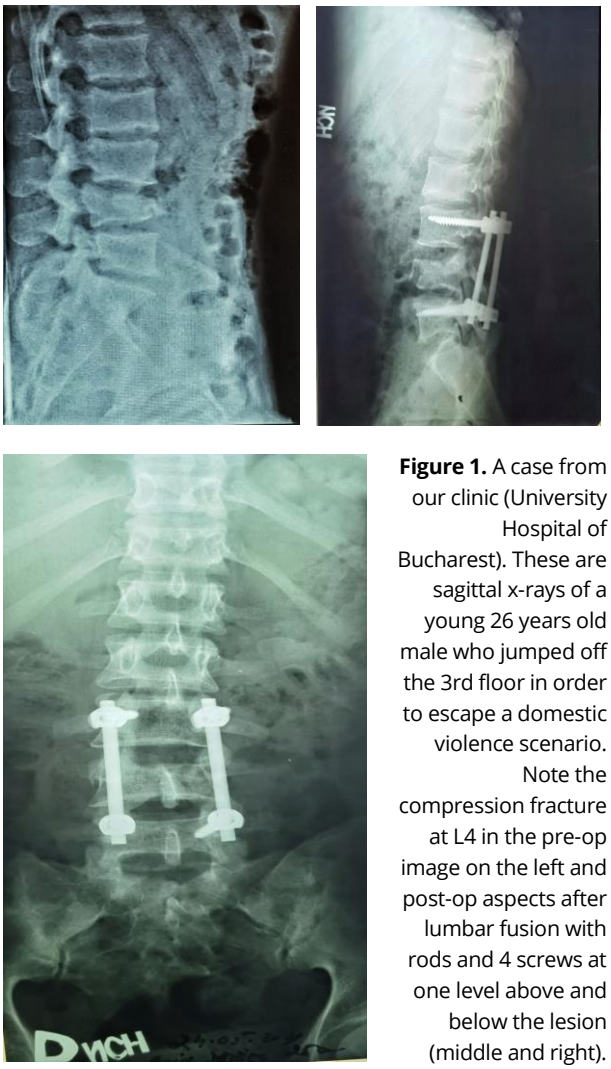

**Figure 1.** A case from our clinic (University Hospital of Bucharest). These are sagittal x-rays of a young 26 years old male who jumped off the 3rd floor in order to escape a domestic violence scenario. Note the compression fracture at L4 in the pre-op image on the left and post-op aspects after lumbar fusion with rods and 4 screws at one level above and below the lesion (middle and right).

## Material and methods

Radiological and clinical pictures of instability are key features in stratifying patients who gain the most from fusion procedures. Spinal spondylodesis is suitable for deformities and instability but lacking proof of effectiveness in primary disc herniation and lumbar spinal stenosis without instability (3).

Spondylolisthesis represents the classical x-ray feature of spinal instability (6)(7). A meta-analysis made in 2017 on 302620 patients with LIF demonstrated a major clinical improvement of individuals who were fused, while the complications and reintervention risk compared with simple decompression limited the benefits brought by spinal fusion in lumbar stenosis with RR of 1,17 for CI of 95% - 1,06-1,28 compared with spondylolisthesis RR 0,75 for CI 95% - 0,70-0,80 (8).

| Authors and Year | Class of evidence | Summary |
|---|---|---|
| SPORT – 2007 2009 & 2018 | II | Randomized (n=304) and observational (n=303) spondilolysthesis surgical vs. conservatory. Fusion offered a better outcome after 2, 4, and 8 years of follow-up. |
| Ghogawala et. al. – 2016 | I | 66 patients with spondylolisthesis grade I. Simple decompression vs. decompression and LIF. Fusion improved the quality of life (4 years follow-up) |
| Chou et al. – 2009 | II | A systematic review of 24 articles on fusion vs. conservatory for L LBP and spondilolysthesis Surgery was equivalent to intense PM&R |

**Table 1.** Lumbar fusion in spinal canal stenosis with spondylolisthesis, modified after (9).

Lumbar back pain is common, unfortunately it's a vague symptom and determining what patients benefit from fusion surgery can be delicate. About 20% of patients with LBP are unable to work (10). A detailed clinical exam and PHI are essential in determining patients who have bigger chances of recovery after spinal fusion.

Multiple studies have demonstrated improvement after fusion in patients with lumbar stenosis and spondylolisthesis (tab.1). A multi-centered randomized study with a 2 year follow-up on 294 subjects with chronic LBP and imagistic evidence of lumbo-sacral degeneration found that all surgical fusion procedures used reduced pain, Oswestry score (tab.1) and improved function (10). Exclusion criteria were: radiologically proven

radicular compression, history of surgical intervention on lumbar spine and those with psychiatric disorders in treatment. All patients were refractory to conservatory treatment. Another randomized study conducted in 2003 on 64 patients with DDD and LBP for more than 1 year demonstrated improvement of ODI score similar to cognitive therapy and exercises (11).

While patients with mild spondylolisthesis do well from postero-lateral fusion with no instrumentation, degenerative disc disease gains the most from postero-lateral fusion with instrumentation, therefore type of surgical treatment should be in relation with the diagnosis (12). A common outcome predictor of fusion in everyday practice is bracing test. Important alleviation of pain after using a TLSO indicates a good outcome for lumbar spinal fusion vs. conservatory treatment. This test has value only in patients with chronic low back pain with no prior spine surgery (5).

| | |
|---|---|
| 0%-20% minimum disability | Activities of daily living are performed normally. No special treatment is required |
| 21%-40% moderate disability | Patient has pain when standing, sitting or lifting weights.<br>Normal activities are still performed well<br>Conservatory treatment is nedeed. |
| 41%-60% severe disability | Daily activities are affected as pain is increasing and becoming constant |
| 61%-80% infirmity | Daily activities are interrupted<br>Surgical intervention is mandatory |
| 81%-100% "stuck in bed" | Patient lies in bed all day or dissimulates |

**Table 2.** Interpretation of Oswestry disability index after filling a special questionnaire, modified after (4).

## Discussions

Numerous descriptions regarding the stability of spinal column have been made still no defining consensus was reached. According to White-Panjabi (13)(14): instability means a loss of spine's ability to maintain under physiological conditions it's normal anatomical relationships at risk causing signs of irritation spinal cord/nerve root, pain or crippling deformities and to Louis (15) spinal stability is the cohesion of vertebral structures in all physiological positions. In contrast, spinal instability it's an important cause of lumbar back pain and important disability.

Diagnosing spinal instability can be challenging. Use of imaging like X-rays in flexion-extension and side-bending, standardised lumbo-sacral X-rays along with lateral flexion and extension radiographs – defining spinal instability as sagittal plane translation of 4 mm or more (13)(14), fluoroscopy, MRI(standard and dynamic) and CT scans can provide useful information. Dynamic X-rays in flexion and extension should not be replaced by MRI and CT scans in the assessment of spinal instability (16). Radiological documentation of instability should be performed preop, at 6 months and 3 years post op to demonstrate evidence of progressive segmental instability (2).

Instability could be responsible for stenosis; it could be associated with LSS symptomatic with intermittent mechanical pain; iatrogenic with symptomatic instability or without clinical signs (17)(18).

Spondylolisthesis, lumbar scoliosis may generate instability (19-21), 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 postop listhesis (22-24). 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 (25).

Spiking if stabilisation is needed, even if is better to stabilise without decompression, there are several aims to respect (2)(26):

- *treat a dynamic component* - patients with severe symptoms and radiographic evidence of excessive motion, greater than 4 mm translation or 10$^{o}$ of rotation, who fail to respond to a trial of nonsurgical treatment;
- *prevent postoperatory instability* - stabilization is needed for confirmed preoperatory instability, large resections and abnormal articular orientation;
- *fusion* should be made to obtain a stabilization after arthrectomy, to correct a deformity, to avoid

a hypermobility, maintaining lordosis and foraminal size;
- *arthrodesis & instrumentation* there are several options: open - rigid stabilization systems with pedicle screw fixation, percutaneously, motion preservation: dynamic stabilization systems, facet arthroplasty - TFAS® Total Facet Arthroplasty System;
- *lumbar interspinous implants:* - Colfex, Wallis, Diam, X-Stop, a.s.o.

Current guidelines reject stabilization by default on the basis of an extensive literature search (2)(23)(24). Even after a laminectomy only 20% of cases need a fusion procedure (22). The reactive degenerative changes obviously prevent manifest segmental instability, even after decompression if more of 50-66% of articular process or isthmus are conserved, without discal space violation (25). There are several surgical alternatives (27-32):

- *Open:* bone deposition, iliac bone graft, instrumentation rigid or dynamic with pedicular screws, inserted with the help of a spinal navigation system, interbody cages;
- *Microscopic;*
- *Percutaneously;*
- *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 can't 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 is 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 hypertrophy and variations in the shape of the inferior surface of the spinous process.

*Combined LSS with degenerative spondylolisthesis 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 (33). 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 (2).

*Combined LSS with degenerative listhesis and posterior arthrosis at one or several levels.* From the surgical point of view decompression in LSS may affect isthmus and generate iatrogenic instability because of arthrectomy, especially in a LSS with degenerative listhesis and posterior arthrosis. We should treat only the instable level (25). Several complications could be seen: overlying stenosis (by recurrence of a degenerative spondylolisthesis, hypertrophic flavum ligaments), disassembly of osteosynthesis by fracture instrumentation on a short and medium term, as a sign of pseudarthrosis.

## Conclusions

Interbody lumbar fusion indication should be established on imagistic proof of instability and substantiated by perpetual clinical suffering refractory to conservatory methods. It's already demonstrated that large laminectomies should be avoided, lumbar decompression with fusion, at the symptomatic level should be made if medical treatment fails.

There is still a lot of work to do in this field of research since there is a lack of randomized studies that compare surgical outcomes with natural history of lumbar pathologies, classical techniques and conservatory measures.

On the other hand, there are some encouraging positive results of surgical fusion in patients with lumbar spine instability and associated degeneration, as a promising alternative detrimental to conservatory treatment, although psychiatric background and prior history of lumbar surgery should rise the alarm of surgeon, since the latter

were proved to be negative predictors of outcome in spinal fusion.

## Abbreviations

CI Confidence interval
CT Computed tomography
DDD Degenerative disk disease
LBP Low Back Pain
LSS Lumbar Spinal Stenosis
LIF Lumbar Interbody Fusion
MRI Magnetic Resonance Imaging
ODI Oswestry Disability Index
PHI Personal History of Illness
PM&R Physical Medicine and Rehabilitation
RR Relative Risk
TLSO Thoracic Lumbar Sacral Orthosis

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## Conflicts of interest

The authors declare no conflict of interest.

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