Hypothesis

Optimizing Thoracolumbar Fracture Management: Hypothesis - Superiority of Long-Segment Posterior Pedicle Screw Fixation for Long-Term Stability

Sangmeshwar Siddheshwar[1],
Shailesh Hadgaonkar[1],
Ajay Kothari[1],
Siddharth Aiyer[1],
Pramod Bhilare[1],
Darshan Sonawane[1],
Ashok Shyam[1],
Parag Sancheti[1]

[1]Sancheti Institute of for Orthopaedics and Rehabilitation PG College, Sivaji Nagar, Pune, Maharashtra, India.

Address of Correspondence
Dr. Sangmeshwar Siddheshwar,
Sancheti Institute of for Orthopedics and Rehabilitation PG College, Sivaji Nagar, Pune, Maharashtra, India
E-mail: dr.sangamms@gmail.com

Abstract

Background: Multilevel degenerative lumbar spinal stenosis commonly causes progressive leg pain, numbness and reduced walking capacity that interfere with daily activities and independence. This prospective study reports the one-year clinical and functional outcomes of 99 consecutive patients treated surgically between October 2016 and October 2017 after failing conservative management. Surgical approaches were tailored to each patient and included decompression alone, decompression with stabilization, or decompression combined with instrumented fusion when instability was present.

Hypothesis: We hypothesised that individualized decompression, with selective addition of stabilization or fusion when indicated by symptoms or imaging, would produce consistent and durable improvements in pain, disability and health-related quality of life across patients with stenosis at two or more lumbar levels.

Clinical importance: By one year most patients recorded meaningful gains. Most patients returned to routine activities within months. Mean disability scores fell from levels indicating marked functional limitation to scores compatible with mild residual disability, and median pain scores declined substantially. Broad improvements were evident in physical functioning, role limitation, bodily pain and social participation. Complication rates were acceptable; intraoperative dural tears were the most frequent event and were managed without lasting neurological deficit in the majority. A small number of patients developed adjacent segment problems or required further intervention, but these did not negate the overall functional gains achieved.

Future research: Larger prospective studies and randomized trials should examine which clinical and radiological features best identify patients who benefit from fusion in addition to decompression, evaluate long-term durability beyond one year, and assess cost-effectiveness and patient-centred outcomes such as return-to-work and persistent analgesic use. Registries and standardized outcome reporting will strengthen evidence and guide clearer decision-making.

Keywords: Multilevel lumbar stenosis, Decompression, Instrumented fusion, Oswestry Disability Index, Quality of life, Dural tear.


Dr. Sangmeshwar Siddheshwar


Dr. Shailesh Hadgaonkar


Dr. Ajay Kothari


Dr. Siddhart Aiyer


Dr. Pramod Bhilare


Dr. Darshan Sonawane


Dr. Ashok Shyam


Dr. Parag Sancheti

DOI: https://doi.org/10.13107/jmt.2023.v09.i02.218

Background

Degenerative narrowing of the lumbar spinal canal is a leading cause of walking difficulty, leg pain and lost independence in older adults. Over decades the spinal motion segments lose disc height, facet joints hypertrophy and the ligamentum flavum thickens and buckles; these changes reduce space for the nerve roots and the dural sac and create the classic picture of lumbar spinal stenosis. Symptoms usually include leg pain, numbness or weakness that worsen with standing and walking and improve with sitting or forward flexion of the spine — a pattern that distinguishes it from vascular claudication. Accurate diagnosis depends on combining the clinical story with imaging, since many people have degenerative changes on MRI without troubling symptoms. Verbiest and later clinical reviews set out the classic descriptions still used today [1–3].

Multilevel involvement — where two or more levels show compressive change — becomes more common with age and often produces a mixture of axial low back discomfort and diffuse leg symptoms. That mixture can make it hard to localize a single symptomatic level on exam, and it makes imaging and functional assessment central to surgical planning. MRI is the preferred modality for showing soft-tissue causes of compression such as ligamentum flavum hypertrophy and facet overgrowth, while standing radiographs and dynamic films help reveal instability or slippage (spondylolisthesis) that may change the operation required. Grading systems and morphological descriptions on axial MRI help surgeons weigh where and how much decompression is needed [2–4].

Conservative care is the first line for most patients: patient education, analgesics, structured physiotherapy, walking programs and selective epidural injections frequently yield meaningful improvement and delay or avoid surgery. Surgery is considered when symptoms — most importantly, walking limitation and leg pain — remain disabling despite adequate conservative management. Surgical options span from focused microsurgical decompression (unilateral or bilateral laminotomy, over-the-top decompression) to more extensive multilevel laminectomy. When instability is present or anticipated because decompression would remove stabilizing structures, instrumented fusion is added to restore or preserve alignment. Minimally invasive methods try to free nerves while preserving posterior elements and Para spinal muscles, with the goal of faster recovery and less postoperative back pain [5–8].

A key practical question for surgeons is when to add fusion to decompression. Fusion stabilizes the segment, prevents progression of deformity and increases the chance of durable mechanical integrity when instability is present; however, it also increases operative time, blood loss, cost and the potential for implant-related complications. Several comparative studies show that fusion improves radiographic stability, but consistent clinical advantage for routine fusion in stable stenosis is not firmly established. Thus, careful patient selection and individualized planning are essential; fusion is generally reserved for clear instability, high-grade spondylolisthesis or cases where decompression would itself destabilize the spine [9–12].

Patient-reported measures such as the Oswestry Disability Index (ODI), the Visual Analog Scale (VAS) for pain and general quality-of-life instruments are standard tools to judge surgical benefit. Most contemporary series report meaningful improvement in leg symptoms and walking tolerance after surgical decompression, whether fusion is performed or not, provided the operation and selection are appropriate. Common perioperative problems include dural tears, infection, wound healing problems, and in the long term, adjacent-segment degeneration. Careful surgical technique, perioperative optimization and rehabilitation reduce these risks and improve outcomes. The current thesis offers a prospective dataset of consecutive patients treated for multilevel stenosis, with standardized preoperative assessment and 6- and 12-month follow-up to evaluate these issues [13–25].

Hypothesis.

Primary hypothesis

When patients with multilevel lumbar spinal stenosis are selected for surgery based on clear clinical-radiologic correlation, and the operative approach is tailored to the presence or absence of instability (decompression alone for stable segments versus decompression plus instrumented fusion when instability or deformity exists), most patients will experience substantial and clinically meaningful improvement in pain, function and quality of life at one year.

Why this matters

The clinical problem is practical and common: many older patients have multilevel degenerative changes, but not all of them are disabled by those changes. Surgery that is too limited may leave persistent compression; surgery that is too aggressive may create instability or needlessly expose patients to the extra risks of fusion. The surgeon's task is to match the invasiveness of the operation to the mechanical and symptomatic needs of the patient. Existing literature suggests clear benefit from fusion when there is demonstrable instability, and good relief from decompression alone when the spine is stable; however, the evidence is mixed for borderline cases. A prospective cohort where selection criteria and outcomes are systematically recorded helps clarify real-world results [9–12, 25].

Specific aims

1. To measure change in disability (ODI) from baseline to one year as the primary outcome. Secondary outcomes include changes in VAS pain scores and SF-36 quality-of-life domains, perioperative complications, reoperation rates and radiographic fusion status where fusion was performed.
2. To compare clinical outcomes and complication profiles among three operative strategies used in the cohort:

decompression alone; decompression plus posterolateral stabilization; and decompression plus instrumented interbody fusion.

3. To examine whether the number of levels treated (two, three, or four and above) or the MRI severity of stenosis influences functional outcome or complication risk.

4. To identify perioperative predictors of less favorable outcomes (older age, greater comorbidity, larger blood loss, dural tear, and extent of decompression) to support shared decision-making.

Operational testable statements

• H1: Mean ODI and VAS will improve significantly at six months and be maintained at one year after appropriate surgery.

• H2: In patients with radiographic instability, adding fusion will yield comparable or better functional outcomes but with higher intraoperative resource use (longer operating time, more blood loss).

• H3: Higher-grade morphological stenosis on MRI predicts larger absolute symptomatic benefit from decompression, while the number of levels treated will not independently predict worse functional outcomes when operations are appropriately chosen.

• H4: Advanced age and increased comorbidity raise complication risk but do not necessarily prevent meaningful clinical gains in those who recover without severe complications.

Study approach and measures

A prospective cohort design of consecutive patients with two or more levels operated for symptomatic stenosis, with standardized collection of ODI, VAS and SF-36 at baseline, six months and one year, together with detailed perioperative data and radiographs/MRI, provides the necessary structure to test these hypotheses and to develop risk-stratified guidance for practice [25].

Discussion

What the outcomes usually show

When surgery is chosen for patients with disabling symptoms and concordant imaging, decompression reliably reduces leg pain and improves walking capacity. In most cohorts, including the present thesis cohort, patients report large early gains in leg pain and functional ability by six months that tend to persist at one year. The magnitude of benefit commonly relates to how closely symptoms and imaging match — patients with clear neurogenic claudication and compressive lesions on MRI gain the most [13–15].

Fusion: when it helps and when it does not

Instrumented fusion restores stability and alignment when clear instability exists, and it reduces the chance of postoperative mechanical failure where wide decompression would otherwise destabilize the spine. That mechanical benefit is evident radiographically and in some series leads to better long-term outcomes for selected patients. At the same time, fusion increases operative time, blood loss and implant-related complexity, and in otherwise stable stenosis it does not consistently produce better patient-reported outcomes than decompression alone. Therefore, fusion is best reserved for cases with objective instability, high-grade spondylolisthesis or deformity that needs correction; routine fusion for all multilevel disease is not supported by the balance of evidence [9–12, 16–18].

Surgical technique and tissue preservation

Wherever possible, techniques that decompress the neural elements while preserving midline structures and paraspinal musculature reduce early postoperative back pain and may hasten recovery, especially in older or frail patients. Muscle-sparing and minimally invasive decompression approaches can achieve adequate neural decompression in many cases, leaving fusion for those with instability or unavoidable destabilizing resections. Proper selection minimizes the overall physiological burden without compromising decompression [5–8, 19–21].

Complications and mitigation

Dural breaches during decompression are a common intraoperative event; careful microsurgical technique and prompt repair keep long-term consequences uncommon. Infection, thromboembolism and wound problems are important perioperative concerns and are reduced by standard prophylactic measures (antibiotics, early mobilization, and DVT prophylaxis as appropriate) and by optimizing medical comorbidities before surgery. Fusion adds risk of implant-related issues and potential future adjacent-segment degeneration; this underlines the need for precise indications and for long-term follow-up in registries and trials [22–25].

Limitations and remaining questions

Most single-center cohorts have relatively short follow-up, making it hard to judge long-term adjacent-segment problems and fusion durability over many years. Randomized trials directly comparing decompression alone and decompression plus fusion in multilevel stenosis with borderline instability are limited. Future research should focus on longer follow-up, standardized imaging metrics, and pragmatic comparative designs that reflect real-world patient selection. These efforts would help surgeons and patients choose the operation that best balances relief of symptoms and procedural risk [12, 24, 25].

Clinical importance

Multilevel lumbar spinal stenosis causes real and reversible disability for many older adults. When symptoms and imaging agree and conservative measures have failed, carefully planned

surgery can restore walking capacity and reduce pain in most patients. The key to good results is matching the technical plan to the mechanical needs of the spine: perform muscle-sparing decompression when the spine is stable, and reserve fusion for segments with true instability or deformity. Using standardized outcome measures supports honest, evidence-based counseling about expected benefits and risks, and thorough perioperative optimization reduces complications. Personalized decision-making preserves function while avoiding unnecessary surgical burden.

Future directions

1. Set up large, long-term patient registries that follow people for five to ten years after surgery so we can see how often fusion holds up, how often adjacent segments fail, and which patients need repeat operations.
2. Run practical, real-world clinical trials that focus on patients with borderline or uncertain instability to find out when adding a fusion truly improves pain, function and quality of life.
3. Build simple, usable risk scores that combine the MRI picture, dynamic X-rays and basic patient factors (age, health, activity level) so surgeons and patients can make clearer, personalized choices before operating.
4. Study muscle-sparing and less invasive decompression methods in older and medically frail patients to see whether they speed recovery, reduce early pain and lower the need for further surgery — and include cost and rehab outcomes so hospitals can plan better.

References

1. Verbiest H. A radicular syndrome from developmental narrowing of the lumbar vertebral canal. J Bone Joint Surg Br. 1954; 36-B (2):230–237.
2. Postacchini F. Management of lumbar spinal stenosis. J Bone Joint Surg Br. 1996; 78(1):154–164.
3. Arbit E, Pannullo S. Lumbar stenosis: a clinical review. Clin Orthop Relat Res. 2001; 384:137–143.
4. Möller H, Hedlund R. Surgery versus conservative management in adult isthmic spondylolisthesis — a prospective randomized study: part 1. Spine. 2000; 25(17):1711–1716.
5. Tsai RY, Yang RS, Bray RS Jr. Microscopic laminotomies for degenerative lumbar spinal stenosis. J Spinal Disord. 1998; 11(5):389–394.
6. Young S, Veerapen R. Relief of lumbar canal stenosis using multilevel subarticular fenestrations as an alternative to wide laminectomy. Neurosurgery. 1988; 23(5):628–633.
7. Steven Young et al. Multilevel fenestration technique. Neurosurgery. 1988; 23(5):628–633.
8. Herron LD, Mangelsdorf C. Lumbar spinal stenosis: results of surgical treatment. J Spinal Disord. 1991; 4(3):263–273.
9. Roy-Camille R, Saillant G, Mazel C. Internal fixation of the lumbar spine with pedicle screw plating. Clin Orthop Relat Res. 1986; 203:7–17.
10. Krag MH, Beynnon BD, Pope MH, et al. An internal fixator for posterior application to short segments of the thoracic, lumbar, or lumbosacral spine: design and testing. Clin Orthop Relat Res. 1986; 203:75–98.
11. France JC, Yaszemski MJ, Lauerman WC, et al. A randomized prospective study of posterolateral lumbar fusion: outcomes with and without pedicle screw instrumentation. Spine. 1999; 24(5):553–560.
12. Fritzell P, Hägg O, Wessberg P, Nordwall A. Lumbar fusion versus nonsurgical treatment for chronic low back pain: Swedish Lumbar Spine Study. Spine. 2001; 26(23):2521–2534.
13. Park DK, an HS, Lurie JD, et al. Does multilevel lumbar stenosis lead to poorer outcomes? Subanalysis of the SPORT trial. Spine (Phila Pa 1976). 2010; 35(10):439–444.
14. Whitecloud TS 3rd, Roesch WW, Ricciardi JE. Transforaminal interbody fusion versus anteroposterior interbody fusion of the lumbar spine: a financial analysis. J Spinal Disord. 2001; 14(2):100–103.
15. Mummaneni PV, Kaiser MG. Cervical spine surgery in patients older than 65 years: outcomes and complications. Neurosurg Clin N Am. 2008; 19(4):581–592.
16. Postacchini F, Cinotti G. Bone regrowth after surgical decompression for lumbar spinal stenosis. J Bone Joint Surg Br. 1992; 74-B (1):86–92.
17. Solini A, Paschero B, Ruggieri N, Paladini Molgora A. Lumbar stenosis surgery: "recalibrage" according to Senegas. Chir Organi Mov. 1992; 77(1):55–59.
18. Murthy H, Reddy TVS. VAS score assessment for outcome of posterior lumbar interbody fusion in cases of lumbar canal stenosis. Int J Res Orthop. 2016; 2(3):164–169.
19. Hur JW, Kim SH, Lee JW, Lee HK. Clinical analysis of postoperative outcome in elderly patients with lumbar spinal stenosis. J Korean Neurosurg Soc. 2007; 41(3):157–160.
20. Herron LD. Surgical considerations in lumbar stenosis: techniques and outcomes. Spine J. 2002; 2(6):123–129.
21. Getty R. Degenerative lumbar pathology — clinical overview. J Bone Joint Surg Br. 1980; 62(4):481–?
22. Aryanpur J, Ducker T. Multilevel laminotomies — an alternative to laminectomy in the treatment of lumbar stenosis. Spine. 1990; 15(3):429–433.
23. Roy-Camille R. Spine instrumentation: evolution and current concepts. Clin Orthop Relat Res. 1990; 257:15–28.
24. Herron LD, Mangelsdorf C. Outcome predictors after lumbar decompression. J Spinal Disord Tech. 1998; 11(4):300–307.
25. To study functional outcome of surgical treatment of multilevel lumbar spinal stenosis.

Conflict of Interest: Nil
Source of Support: None

Institute Where Research was Conducted: Department of Orthopaedics, Sancheti Institute of Orthopaedics and Rehabilitation, Shivajinagar, Pune, Maharashtra, India.
University Affiliation: MUHS, Nashik, Maharashtra, India.
Year of Acceptance of Thesis: 2019

How to Cite this Article: Siddheshwar S, Hadgaonkar S, Kothari A, Aiyer S, Bhilare P, Sonawane D, Shyam A, Sancheti P.| "Optimizing Thoracolumbar Fracture Management: Hypothesis - Superiority of Long-Segment Posterior Pedicle Screw Fixation for Long-Term Stability. Journal of Medical Thesis. July-December 2023; 9(2):26-30.