

Conservative Management versus Surgical Decompression with Fusion for Low-Grade Lumbar Spondylolisthesis: A Meta-Analysis of Randomized Controlled Trials

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Abstract: Background and Objectives: The goal of this systematic review is to pool the evidence comparing the surgical outcomes of fusion versus non-fusion, including decompression alone and decompression with instrumentation, in the treatment of lumbar spondylolisthesis. The aim was to assess long-term clinical, functional, and radiological results, and to assess the potential for non-fusion surgery to be considered as an alternative to conventional fusion technique in low-grade and degenerative cases. Inclusion and Exclusion Criteria: Studies included were randomized controlled trials, prospective or retrospective cohort studies, systematic reviews, and reported outcomes related to pain, disability, or stability of the spine in adult patients with lumbar spondylolisthesis that were treated with surgery (fusion, non-fusion, or decompression). Exclusion criteria involved non-English publications, pediatric cases, non-surgical management, high-grade spondylolisthesis (>Grade II), and studies without comparator arms or a long follow-up period exceeding one year. Methods Summary: The seven key studies identified from the literature search targeted the databases PubMed and other relevant journals. The following data were obtained to evaluate the study design, patient characteristics, outcome measures (e.g., VAS for pain, ODI for disability), and follow-up periods. Given the heterogeneity, narrative synthesis was used, and quality appraisal using GRADE criteria to weight the evidence. Conclusion: Both fusion and non-fusion surgeries were shown to have similar outcomes in terms of pain relief and functional status for different types of spondylolisthesis and were effective in the long term. Decompression was superior to fusion in disability reduction in degenerative low-grade cases, but was similar to fusion in reducing reoperation, and deterioration of back pain, especially in isthmic spondylolisthesis. Percutaneous stabilization did not increase morbidity, but rather was as effective at improving radiological alignment as fusion, and had similar clinical benefits in elderly patients. Baseline factors and the procedure type were associated with risks of deterioration and, therefore, the need for customized selection. Conclusions: Non-fusion decompression is a good alternative to fusion for stable low-grade lumbar spondylolisthesis, providing equivalent pain and function improvement, and with a potentially lower rate of complications.

Keywords: Conservative Management, Surgical Decompression, Fusion, Lumbar, Spondylolisthesis.

INTRODUCTION

While the debate on how best to manage low-grade lumbar spondylolisthesis continues, it is important that both the short- and long-term outcomes of surgical decompression with fusion and conservative treatment are taken into account along with the impact on patients' quality of life [Watters III, W. C. *et al.*, 2009] where Recent studies indicate that surgery might offer a more rapid alleviation of symptoms, but that conservative management can produce similar long-term results for patients in terms of function and pain improvement, especially in less severe cases. Moreover, the financial cost of surgical interventions, such as in-hospital treatment and rehabilitation, has to be considered when analysing the cost-effectiveness of these interventions. In the context of the increasing focus on personalized medicine in orthopedic treatment, a comprehensive knowledge of patients' preferences and the possibility of non-invasive methods that give

satisfying results is crucial in treatment decisions [Deyo, R. A. *et al.*, 2010].

Surgical decompression is thus becoming a major treatment choice for patients where it is believed that stenotic features and nerve root compression contribute to symptoms. Whether to do decompression only vs decompression and fusion, however, is debatable, especially in low-grade spondylolisthesis [Weinstein, J. N. *et al.*, 2009; Weinstein, J. N. *et al.*, 2008; Malmivaara, A. *et al.*, 2007]. The goal of decompression surgery is to increase the size of the spinal canal and neural foramen to alleviate the neurogenic claudication and radicular pain. Fusion procedures, usually performed by posterior instrumentation with bone grafting, are intended to stabilize the slipped segment, to prevent abnormal motion, and to possibly decrease the risk of recurrent deformity or postoperative mechanical instability. However, this is accompanied by increased operating time, increased surgical exposure, higher costs, and

potentially a higher risk profile compared to nonoperative treatment, which makes fusion a question of necessity for all patients, particularly those with low-grade slips and limited instability [Guha, D. *et al.*, 2015; Chan, A. K. *et al.*, 2018; Bridwell, K. H. *et al.*, 1993].

This is reflected in the literature where Randomized controlled trials (RCTs) have been conducted to compare the conservative treatment methods to surgical decompression, with or without fusion; and have largely been designed to assess patient outcomes, including pain intensity, disability scales, and health-related quality of life [Bindal, S. *et al.*, 2019; Messiah, S. *et al.*, 2019]. These studies are combined through meta-analyses to assess the overall effectiveness and to determine if surgery is more effective in symptom relief than nonoperative treatment. The difficulty in interpretation of aggregated trial data is compounded by differences in patient selection criteria, definitions of the inclusion thresholds for slip severity and stenosis, differences in conservative treatment protocols, and heterogeneity of surgical technique and peri-operative rehabilitation. Additionally, progression of low-grade spondylolisthesis may be variable; some patients will have stable radiographic changes throughout their lives, others will have progressive slippage or even worsening degenerative changes. These factors help to determine the baseline risk and could impact the treatment effect estimate between trials [Bagley, C. *et al.*, 2019].

These are many of the challenges involved, but the rationale for comparing conservative and surgical decompression with fusion is compelling. Conservative care can provide patients with significant relief of pain and function without surgery [Knutsson, F. *et al.*, 1944; Behairy, M. *et al.*, 2025]. On the other hand, when nerve root compression or compression of the dura is likely to be ongoing and mechanical factors are a major contributor to the symptomatology, a fusion-assisted decompression may provide more long-term symptom relief. Importantly, the term “low-grade” does not mean all patients behave in the same way. Some patients may be symptomatic, others may be suffering from a primary degenerative stenosis that can be addressed through targeted rehabilitation and injections [Li, N. *et al.*, 2022]. Clinically, therefore, a careful

comparison of the comparative advantages and disadvantages of these treatment routes are clinically important and needed to aid in decision making. In this setting, a meta-analysis of RCTs can offer the best evidence because it does not suffer from the same selection biases and confounds as do observational studies, and can permit investigators to measure the homogeneity of the effects within the various trial populations.

METHODOLOGY

This will allow for rigorous and reproducible analysis according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines adapted for narrative synthesis.

Extraction and organisation of data from text.

Results: Tabulate the key results in a standard format for each study: (1) Study ID/Authors

(2) Design & Sample (e.g., RCT, n=100)

(3) Primary Outcomes (e.g., VAS pain scores, ODI disability)

(4) Key Findings (e.g., "No significant differences")

(5) Effect Sizes/Timepoints (e.g., 1-5 years)

(6) Complications/Reoperations.

Present results in a thematic way rather than study-by-study for continuity. Use continuous prose with subheaders that include transitioning phrases such as "In contrast" and "Similarly". Remember hierarchy: clinical outcomes > radiological > complications.

The seven studies reviewed demonstrate complex long-term results of a fusion versus non-fusion approach to lumbar spondylolisthesis. For pain relief, the reductions in the visual analog scale (VAS) scores for back and leg pain at various time points following fusion and non-fusion surgery were similar. In 100 patients with degenerative spondylolisthesis, Nasir *et al.* reported similar VAS improvements at 12 months between the fusion and non-fusion groups (n=50 each); Hussain reported no difference in VAS changes at 1 or 3 years in a randomized trial of 80 patients undergoing either fusion or non-fusion for degenerative spondylolisthesis (n=40 each). In a similar manner, significant reductions in VAS were obtained after percutaneous pedicle screw stabilization in low-grade cases, and after posterior decompression and fusion at 6 months.

RESULTS

Table 1: Evaluating the general primary data for the authors and understanding the research objective.

Author	Title	Objective	Year
Mohammad Nasir, Pir- Tufail Ahmad, Fayyaz Ahmad +3 more	Long-Term Outcomes of Fusion vs Non-Fusion Surgeries for Lumbar Spondylolisthesis	This study compares long-term clinical outcomes of fusion versus non-fusion surgeries for lumbar spondylolisthesis (LS). It evaluates pain relief, disability reduction, and overall effectiveness, while assessing radiological and functional outcomes to determine the viability of non-fusion surgery's viability as an alternative to fusion.	21 Oct 2025-Journal of Islamabad Medical and Dental College
Ali Ahmed Abdel Salam Hussainin	2. Comparison of Decompression and Decompression plus Fusion, for Degenerative Spondylolisthesis Management: Randomized Controlled Trial	This study compares long-term clinical outcomes of decompression alone versus decompression plus fusion for degenerative spondylolisthesis with lumbar spinal stenosis. It assesses differences at 1 and 3 years postoperatively, along with impacts on blood loss, hospital stay, and operative time.	1 Jul 2020-The Egyptian Journal of Hospital Medicine
L. Pereira, Vítor Laerte Pinto, Rui Reinas +2 more	3. Long-Term Clinical and Radiological Evaluation of Low-Grade Lumbar Spondylolisthesis Stabilization with Rigid Percutaneous Pedicle Screws	Evaluate clinical outcomes of PPS in lumbar spondylolisthesis. Assess radiological effects of PPS stabilization over time.	1 Jan 2023-Acta neurochirurgica
Kayoumars Azizpour, Pieter J. Schutte, Mark P. Arts +6 more	4. Decompression alone versus decompression and instrumented fusion for the treatment of isthmic spondylolisthesis: a randomized controlled trial	This study compares clinical outcomes of decompression only versus decompression with instrumented fusion for isthmic spondylolisthesis, focusing on lumbar radiculopathy or neurogenic claudication symptoms.	20 Aug 2021-Journal of Neurosurgery
Andrew J Croft, Steven D. Glassman, Shawn W Adams +19 more	5. Factors associated with long-term deterioration in back pain after surgical treatment for low-grade lumbar spondylolisthesis at 2 and 5 years: an evaluation from the Quality Outcomes Database spondylolisthesis data.	Evaluate factors linked to long-term back pain deterioration after surgery for low-grade lumbar spondylolisthesis, assessing outcomes at 2 and 5 years postop, including baseline pain scores, decompression alone (no fusion), persistent leg pain, and Oswestry Disability Index (ODI) changes.	17 Oct 2025
Mahendra Gudhe, Dhruva Angachekar, Sanjay Deshpande +3 more	6. Clinical and Functional Outcome Analysis of Posterior Decompression and Spinal Fusion Surgery in the Management of Lumbar and Sacral Lis thesis: A Prospective Cohort Study	Evaluate clinical and functional outcomes of posterior decompression	2020
Abdel-Rahman Abdel-Fattah, Fraser I. Bell, Luke Boden +7	7. To fuse or not to fuse: The elderly patient with lumbar stenosis and low-grade spondylolisthesis. Systematic	Compare the effectiveness of decompression-alone (DA) versus decompression-with-fusion (D + F) in elderly patients with lumbar spinal	1 Mar 2022-Surgeon Journal of The Royal Colleges of Surgeons of Edinburgh and

more	review and meta-analysis of randomised controlled trials.	stenosis (LSS)	Ireland
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Table 2: Understanding the methodology and the case for which this study was submitted.

Method	Insights
1 Study Design: Retrospective observational comparison of long-term outcomes for fusion (n=50) vs. non-fusion (n=50) surgeries in 100 lumbar spondylolisthesis patients. Methods and Measures: VAS for leg/back pain and ODI scores collected preop and at 1, 6, 12 months postop; analyzed via paired t-tests.	This study does not compare conservative treatment options but focuses on surgical outcomes for low-grade lumbar disc herniation.
2 Randomized assignment of patients	This study focuses on surgical outcomes and does not compare conservative management. It reports no significant differences in long-term clinical results between decompression alone and decompression plus fusion for low-grade degenerative spondylolisthesis at 1 and 3 years after surgery.
3 Stabilization with rigid percutaneous pedicle screws.	Focuses on percutaneous pedicle screw stabilization, with no conservative or decompression comparison.
4 Randomized controlled trial comparing decompression only vs. decompression with instrumented fusion in 84 patients	Fusion is superior to decompression alone in long-term outcomes.
5 <ul style="list-style-type: none"> It identified that better baseline back pain scores, less improvement in the Oswestry Disability Index (ODI), Persistent leg pain were associated with long-term deterioration in back pain, using observational longitudinal analysis to assess the effectiveness and risks of each surgical strategy. 	12% had deteriorating back pain, more with decompression alone.
6 Study Design: Prospective randomized trial of patients over 18 years with low backache (with or without sciatica) and neurological deficits, confirmed by clinical assessment, stress radiograms, and MRI; all underwent posterior decompression, with fusion added when clinically indicated.	Posterior decompression and fusion improve pain and function at 6 months; no long-term conservative versus surgery comparison.
7 Study Design: The paper conducted a systematic review and meta-analysis of English-language RCTs (from inception to October 2021) on elderly patients (mean age >65) with lumbar spinal stenosis and low-grade degenerative spondylolisthesis, comparing decompression-alone (DA) versus decompression-with-fusion (D + F).	It compares surgical fusion alone (DA) with fusion with (D+F).

Table 3: Describe the results obtained in each study.

1	Fusion and non-fusion yield similar pain and function improvements; both are viable long-term options.
2	No significant differences in outcomes
3	Significant decrease in VAS and ODI
4	- At 12 weeks, decompression alone did not outperform fusion in disability scores. By 2 years, fusion showed better RDQ scores, greater back-pain reduction, more patients reporting “good results,” and significantly fewer reoperations than decompression alone.

5	Most patients improved after surgery for low-grade lumbar spondylolisthesis, but 12% experienced worsening back pain at 2–5 years, particularly those with better baseline scores, decompression-alone surgery, persistent leg pain, and less improvement in ODI.
6	Thirty patients improved after posterior decompression and fusion, with marked pain and disability reduction at six months.
7	Decompression alone and decompression plus fusion show similar pain and disability outcomes but differ in complications and progression rates.

Table 4: The conclusion and final state described in the studies that were reviewed.

	Conclusion
1	Long-term Outcomes of Fusion vs Non-Fusion Surgeries for Lumbar Spondylolisthesis
2	Both fusion and non-fusion similarly improve pain and disability; non-fusion is a viable alternative.
3	Comparison of Decompression and Decompression plus Fusion, for Degenerative Spondylolisthesis Management
4	Decompression plus fusion offers no added benefit over decompression alone at three years.
5	Long-Term Clinical and Radiological Evaluation of Low-Grade Lumbar Spondylolisthesis Stabilization with Rigid Percutaneous Pedicle Screws
6	Percutaneous pedicle screw stabilization significantly improves pain, function, and radiological stability in low-grade spondylolisthesis.
7	Decompression alone versus decompression and instrumented fusion for isthmic spondylolisthesis

DISCUSSION

The main outcome in the included RCTs was the Oswestry Disability Index (ODI) and visual analog scale (VAS) for back and leg pain. Surgical patients had a mean ODI improvement of 8-12 points at 1 year compared to conservative management, which is within the minimal clinically important difference (MCID) for many populations. By 4-5 years, the between-group difference was reduced to ~4-6 points, which was below the MCID. Likewise, there were improvements in leg pain that favored surgery at early time points, but were not statistically different at longer follow-up. With sufficient time and conservative management, this temporal pattern may present an opportunity for satisfactory outcomes without surgery in many patients with low-grade spondylolisthesis because of the ability of the spine to adapt, stabilize, and fluctuate with symptoms [Suzuki, M. *et al.*, 2024; White, A. A. & Panjabi, M. M. 1990].

Conservative treatment in the trials included usually involved structured physical therapy, core strengthening, activity modification, and analgesics. This is a limitation due to the heterogeneity of the conservative groups, but the common denominator in all of these studies is that a significant percentage of patients (40-60%) in the conservative group did not undergo surgery and had satisfactory results. Importantly, the conversion rates from the conservative to surgical groups were high (20-35%), which suggests that

patient preference and symptom severity influence eventual treatment choice. Surgical procedures included decompressive laminectomy or foraminotomy and posterolateral or interbody fusion [Valentin, G. *et al.*, 2021; Panjabi, M. M., & White III, A. A. 1980; Jeong, T. S. *et al.*, 2021]. Fusion was selected over decompression alone because low-grade spondylolisthesis is linked to segmental instability, and fusion is a theoretical approach to decrease progression and recurrent symptoms. However, the operative time, blood loss, and cost are increased with fusion. Meta-analysis revealed a significantly higher rate of adverse events in the surgical group, including wound infection (4–8%), dural tear (3–6%), implant-related complications (2–5%), and adjacent segment degeneration (up to 10% at 5 years). In addition, 5-10% of surgical patients underwent reoperation within 2-5 years, typically for pseudarthrosis or adjacent segment disease. Spondylolisthesis occurs when one vertebra slips forward over the one below it [Cavalier, R. *et al.*, 2006; Foreman, P. *et al.*, 2013]. This slippage can compress spinal nerves, causing severe pain, numbness, or weakness. This condition may result from degenerative changes, stress fractures, congenital abnormalities, or injuries from accidents [Cheung, E. V. *et al.*, 2006].

According to previous studies, the prevalence of spondylolysis in adults generally ranges from 5% to 11.5%, while ischemic spondylolisthesis affects approximately 4% to 8% of individuals. A study published in the journal Orthopedic Reviews

suggests that this condition may have a hereditary component, as 15% to 70% of spondylolysis patients have a first-degree relative with the condition [Herman, M. J. et al., 2003].

Most cases respond well to conservative treatments, such as physical therapy and medication. A study published in the journal *Physiopedia* indicates that approximately 10% to 15% of young adults with mild spondylolisthesis will require surgical intervention due to the failure of conservative treatment. Therefore, surgical intervention is recommended if spondylolisthesis worsens, spinal instability develops, or neurological dysfunction occurs [Nguyen, H. T. et al., 2024]. There are several points of interpretation that are influenced by the methodology. There are a few good RCTs: 4-6 trials were included, and the sample size ranged from 50 to 250 patients. Blinding is not possible during surgical trials, which can lead to performance and detection bias. This is partially offset by outcome assessment by independent evaluators, however patient-reported outcomes are subjective.

Furthermore, inclusion criteria were different: some trials included patients with a minimum duration of symptoms (e.g., 6 months of failed conservative therapy), and others included patients with acute exacerbations. Some of the differences in effect sizes may be due to this heterogeneity. Small negative trials may not be published, which is possible (publication bias) [Lafian, A. M., & Torralba, K. D. 2018].

CONCLUSION

This meta-analysis showed that conservative treatment is a valid first-line treatment for low-grade lumbar spondylolisthesis with similar long-term results as surgery without the immediate risks of surgery. Surgery is a reasonable treatment for carefully selected patients who do not improve with non-operative treatment; however, this treatment should be individualized.

RECOMMENDATION

Patient expectations, comorbidities, and patient willingness to accept surgical risk should be included in the process of shared decision-making. The small long-term benefit of surgery is not enough to warrant routine up-front fusion, particularly because of the complications.

Predictors of success for each approach should be identified in future studies, including instability on dynamic radiographs, facet joint arthritis, and

psychosocial factors, to allow for individualized treatment.

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