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AO Spine Clinical Practice Recommendations: When to Operate in Lumbar Disc Herniation

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Abstract

Study Design: Literature review with consensus clinical recommendations. **Objective:** To review key studies on surgical vs. non-operative treatment for lumbar disc herniation (LDH) and present recommendations for how the practicing clinician should use this evidence. **Methods:** Two randomized controlled trials (RCTs), two RCTs with concomitant observational cohorts, one prospective study, and one retrospective study were summarized, methodologically assessed, and assigned an

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expert clinical recommendation. **Results:** Kim et al. demonstrated that selected surgical candidates who prefer to avoid surgery can achieve similar long-term outcomes with non-surgical management, although with slower recovery. Lurie et al. demonstrated surgical superiority in as-treated analyses across pain and disability up to 8 years, but substantial crossover limited intention-to-treat findings. Peul et al. showed that early surgery versus prolonged conservative management yields equivalent 1-year outcomes, with the primary benefit of faster pain relief. Bailey et al. demonstrated that for persistent sciatica (4-12 months), microdiscectomy outperforms conservative care at 6 months. Petr et al. found that in the case of acute motor deficit, surgery within 48 hours yields faster neurological recovery. Thomé et al. identified 3 days as the critical cutoff for complete recovery in moderate-to-severe deficits, with 8 days applicable for mild deficits. **Conclusions:** The evidence suggests that, for patients without motor deficits, symptom duration, severity, and patient preference should drive treatment selection, with increasing benefit of surgery as symptom duration grows. For patients with motor deficits, decompression within 3 days should be the goal for moderate-to-severe paresis to maximize the likelihood of complete neurological recovery.

Keywords
lumbar disc herniation, sciatica, discectomy, surgical timing, motor deficit, conservative treatment, radiculopathy, neurological recovery

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methodological quality and the expert opinion from a diverse panel of key opinion leaders, they formulate recommendations on whether the evidence should be integrated into clinical practice.

The purpose of this article series is to serve as a knowledge translation tool to help busy clinicians efficiently interpret evidence and apply it to make their practice and patients better.

Introduction

Lumbar disc herniation (LDH) is one of the most common causes of low back and leg pain worldwide and represents the leading indication for lumbar spine surgery. The clinical spectrum of LDH ranges from self-limiting low back pain (LBP) or sciatica that resolves with conservative management to acute radicular motor deficits possibly resulting in permanent neurological impairment.[1] Between these extremes lies a broad and heterogeneous patient population in whom the optimal treatment strategy, including the optimal timing of that strategy, remains the subject of ongoing debate.[2]

The timing of surgical intervention is a fundamental consideration across all clinical presentations of LDH; however, its implications differ profoundly depending on the clinical scenario. In patients presenting with subacute sciatica and absent or very mild motor deficit, timing is typically considered on the scale of weeks to months. In contrast, in cases of acute foot drop, it becomes a matter of hours to days.[3] A coherent clinical framework that integrates the evidence on surgical versus non-operative management must therefore be organized around this temporal dimension, rather than simply comparing surgical and non-surgical outcomes in aggregate.

The AO Spine Knowledge Forum Degenerative selected 6 key articles that, together, map the full spectrum of surgical timing decisions in LDH, from the role of continued conservative management in patients who decline recommended surgery, to the critical urgent time window that determines whether patients with motor deficits will recover full neurological function. This review presents these studies in order of increasing surgical urgency, synthesizes their methodological strengths and limitations, and provides expert clinical recommendations to guide practicing clinicians across the full range of clinical presentations. Rather than just comparing surgery versus conservative care, this article aims at providing a clinically actionable framework based on clinical urgency to improve the outcomes of LDH patients with different symptom severity.

Methods

The Steering Committee of the AO Spine Knowledge Forum Degenerative selected 6 key articles addressing surgical versus nonoperative treatment for LDH and the timing of surgical intervention. These included 2 randomized controlled trials (RCTs), 2 RCTs with concomitant observational cohorts, 1 prospective study, and 1 retrospective study. Articles were chosen based on the quality of evidence, recency, and clinical relevance. Each article was summarized and appraised by a working group of 2 to 4 Knowledge Forum members. Summaries were consolidated by the responsible authors and reviewed by the Steering Committee members. All members reviewed the final manuscript. Articles are presented in order of increasing surgical urgency, from scenarios in which deferral of surgery is appropriate to those requiring urgent surgical care. Clinical recommendations were formulated using a modified GRADE approach and graded as either strong or conditional, with evidence quality rated as high, moderate, low, or very low. Consensus was obtained through virtual review and agreement on the summaries.

Kim CH, Choi Y, Chung CK, Kim KJ, Shin DA, Park YK, Kwon WK, Yang SH, Lee CH, Park SB, Kim ES, Hong H, Cho Y.

Nonsurgical Treatment Outcomes for Surgical Candidates with Lumbar Disc Herniation: A Comprehensive Cohort Study. Scientific Reports, 2021.

Clinical Rationale: Despite surgery being widely recommended for patients with LDH who meet surgical indications, many patients either defer or decline surgery. Understanding the real-world outcomes of structured nonsurgical management in these surgical candidates is essential to support shared decision-making and optimize patient selection for operative treatment.

Timing paradigm: surgery deferred or avoided by patient preference.

Study Summary

This prospective multicenter comprehensive cohort study (CCS) incorporated both randomized and observational cohorts, allowing patients who declined randomization to self-select their treatment pathway, with crossover between cohorts permitted at any time. A total of 128 patients were analyzed in a planned interim analysis: 71 in the nonsurgical cohort and 57 in the surgical cohort. Nonsurgical treatment was individualized by pain and rehabilitation physicians and could include

physiotherapy, medications, manual therapy, injections, and percutaneous adhesiolysis. Surgical treatment consisted of standard open microscopic or full endoscopic lumbar discectomy. Patient-reported outcomes, including the Visual Analogue Scale (VAS) for back (VAS-B) and leg pain (VAS-L), Korean Oswestry Disability Index (K-ODI), EuroQol-5D (EQ-5D), EQ-VAS, and Short Form (SF)-36 domains, were assessed at baseline and at 1, 3, 6, 12, and 24 months.

All outcomes improved significantly in both cohorts over 24 months ($P < 0.05$). At 1 month, the surgical cohort demonstrated significantly greater improvement in VAS-B ($P = 0.002$) and VAS-L ($P = 0.01$). However, from 3 months onward, no significant between-group differences were observed for any patient-reported outcome ($P > 0.01$). Approximately half of the patients initially allocated to surgery (51%) crossed over to nonsurgical care, and 27% of those assigned to nonsurgical care eventually opted for surgery, reflecting the degree to which treatment preferences diverged from recommendations in this population.

Methodological Review

The CCS design is an innovative approach to pragmatic clinical research that accommodates patient preference while generating prospective comparative data. The use of a web-based randomization system across participating hospitals, independent data safety monitoring, validated outcome instruments at multiple time points, and follow-up to 24 months are notable strengths.

However, several major limitations constrain interpretation. Nonsurgical treatment was individualized rather than standardized, making it difficult to attribute outcomes to specific interventions. The high crossover rates in both directions fundamentally compromised group independence. The interim analysis included only 128 of 169 consented patients, with attrition to approximately 70–77% at 24 months. The unique patient population (surgical candidates seeking second opinions) limits generalizability to standard clinical practice. The study does not clarify which patient subgroups benefit most from early surgery versus continued conservative management, which would be of greatest clinical utility. We find the quality of evidence to be Low.

Recommendation Regarding Impact on Clinical Practice

In adults with single-level symptomatic LDH after 6 weeks of active nonsurgical care who prefer to avoid surgery, we conditionally recommend a structured trial of continued nonsurgical management (low-quality evidence). Patients should be counseled that pain relief is generally slower with nonsurgical treatment than after surgery, but that patient-reported outcomes may converge at longer-term follow-up. This approach is not appropriate for patients with major neurological deficits (motor deficit $\leq$3/5 according to the Medical Research Council [MRC]), cauda equina syndrome, or radiographic instability, who should be referred for prompt surgical evaluation.

Lurie JD, Tosteson TD, Tosteson ANA, Zhao W, Morgan TS, Abdu WA, Herkowitz H, Weinstein JN.

Surgical Versus Nonoperative Treatment for Lumbar Disc Herniation: Eight-Year Results for the Spine Patient Outcomes Research Trial (SPORT). Spine, 2014.

Clinical Rationale: Although previous studies suggested that surgery provides faster symptom relief for LDH compared to conservative treatments, the durability of these benefits remained uncertain. Long-term comparative data were needed to determine whether the advantages of surgical treatment persist over time compared with nonoperative care.

Timing paradigm: surgery within weeks to months, outcomes tracked over 8 years.

Study Summary

SPORT is one of the largest and longest-running surgical trials in spine care, comprising concurrent prospective randomized ($n = 501$) and observational cohorts ($n = 743$) conducted at 13 spine clinics across 11 US states. Eligible patients had imaging-confirmed LDH with persistent radicular symptoms for at least 6 weeks and were considered surgical candidates. The surgical intervention was standard open discectomy; the nonoperative comparator was individualized usual care. Primary outcomes, SF-36 Bodily Pain (BP), Physical Function (PF), and Oswestry Disability Index (ODI), were assessed at 6 weeks, 3 months, 6 months, and annually for 8 years.

In the intention-to-treat analysis of the randomized cohort, all measures favored surgery, but the primary outcomes did not reach statistical significance, largely due to high crossover: approximately 49% of patients assigned to nonoperative care ultimately received surgery, and roughly 40% of those assigned to surgery did not adhere to their assignment. Secondary outcomes included sciatica bothersomeness, satisfaction with symptoms, and self-rated improvement, were significantly greater with surgery in the intention-to-treat analysis (all $P \leq 0.013$). The as-treated analysis, which adjusted for crossover,

demonstrated clinically meaningful and statistically significant surgical advantages sustained over 8 years: BP +10.9 (95% confidence interval [CI] 7.7–14), PF +10.6 (95% CI 7.7–13.5), and ODI −11.3 (95% CI −13.6 to −9.1). Neither group showed meaningful deterioration from years 4 to 8, and the nonoperative group also demonstrated substantial improvement over time. Reoperation occurred in approximately 15% of surgical patients at 8 years.

Methodological Review

SPORT's principal strengths include its multisite design, large, combined enrollment, exceptional follow-up duration, and the use of both intention-to-treat and as-treated frameworks. The as-treated analysis employs a time-varying treatment covariate with updated baseline covariates at the point of surgical crossover. It adjusts for baseline predictors of both crossover and attrition, representing a methodologically rigorous approach to nonadherence.

The principal limitation is the extraordinary degree of crossover, which severely undermines the intention-to-treat analysis of the randomized cohort. Only 63% of initial enrollees provided data at 8 years; patients lost to follow-up were somewhat more symptomatic, suggesting modest overestimation of long-term outcomes in both groups, though the comparative treatment effect appears unbiased. The nonoperative comparator was "usual care" without a pre-specified protocol, introducing heterogeneity in the control arm while reliably simulating real-world scenarios. We find the quality of evidence to be Moderate.

Recommendation Regarding Impact on Clinical Practice

In patients with symptomatic, imaging-confirmed LDH with persistent radicular symptoms, we conditionally recommend surgical discectomy to achieve greater and more durable improvement in pain, physical function, and self-rated recovery compared to nonoperative care (moderate-quality evidence). Conservative treatment also yields substantial improvement and should be considered for patients with lower surgical risk tolerance or milder disability. These findings support a shared decision-making approach in which treatment choice is guided by symptom severity, patient preference, and risk tolerance.

Peul WC, van Houwelingen HC, van den Hout WB, Brand R, Eekhof JAH, Tans JTJ, Thomeer RTWM, Koes BW. Surgery versus Prolonged Conservative Treatment for Sciatica. The New England Journal of Medicine, 2007.

Clinical Rationale: Many patients with LDH improve spontaneously, yet delayed surgery may prolong pain and disability. High-quality evidence was lacking regarding whether early surgical intervention offers meaningful advantages over an initial strategy of prolonged conservative management.

Timing paradigm: early surgery within 2 weeks versus conservative management for up to 6 months.

Study Summary

This multicenter, prospective RCT enrolled 283 patients with severe sciatica lasting 6 to 12 weeks due to magnetic resonance imaging (MRI)-confirmed LDH. Patients were randomly assigned to early surgery (microdiscectomy targeted within approximately 2 weeks of randomization) or to prolonged conservative treatment for an additional 6 months, with surgical crossover permitted if symptoms persisted or worsened. The primary outcomes were functional disability assessed by the Roland Morris Disability Questionnaire, leg pain intensity on a 100-mm VAS, and perceived recovery on a 7-point Likert scale, evaluated at 2, 4, 8, 12, 26, 38, and 52 weeks.

Of 141 patients assigned to early surgery, 125 (89%) underwent microdiscectomy at a median of 1.9 weeks. In the conservative arm, 55 of 142 (39%) crossed over to surgery at a median of 14.6 weeks due to intractable pain. There was no significant overall difference in disability scores at 1 year ($P = 0.13$). However, early surgery provided significantly faster relief of leg pain ($P < 0.001$) and a higher rate of perceived recovery (hazard ratio 1.97, 95% CI 1.72–2.22, $P < 0.001$), with a median time to recovery of 4.0 weeks (95% CI 3.7–4.4) versus 12.1 weeks (95% CI 9.5–14.9) in the conservative group. By 52 weeks, both groups had achieved similar recovery rates of approximately 95%.

Methodological Review

This well-conducted multicenter RCT used computer-generated permuted-block randomization stratified by center, with allocation concealment through opaque envelopes. Baseline characteristics were well-balanced. The intention-to-treat analysis was appropriately applied, and a comprehensive battery of validated outcome instruments was used with frequent assessment time points. The sample size was adequately powered for the primary functional outcome.

Key limitations include the inherently unblinded design, unavoidable in surgical trials, which introduces performance and detection bias, particularly for subjective outcomes such as pain and perceived recovery. The 39% crossover rate in the conservative group attenuates true between-group differences in the intention-to-treat analysis. The conservative care protocol, while pragmatic, was supported by research nurses providing additional monitoring not available in routine clinical practice. The study exclusively evaluated standard microdiscectomy without comparison to minimally invasive or endoscopic techniques. We find the quality of evidence to be High.

Recommendation Regarding Impact on Clinical Practice

Patient preference and tolerance for symptom burden remain the fundamental decision criteria in the management of LDH causing sciatica. In patients accepting surgery and seeking faster recovery and relief of leg pain, we conditionally recommend early (<2 weeks) surgery (high-quality evidence).

Bailey CS, Rasoulinejad P, Taylor D, Sequeira K, Miller T, Watson J, Rosedale R, Bailey SI, Gurr KR, Siddiqi F, Glennie A, Urquhart JC.

Surgery versus Conservative Care for Persistent Sciatica Lasting 4 to 12 Months. The New England Journal of Medicine, 2020.

Clinical rationale: While previous trials demonstrated benefits of surgery for acute sciatica due to LDH, evidence was lacking for patients with persistent symptoms lasting several months. This study aimed to determine whether microdiscectomy provides superior outcomes compared with continued conservative care in patients with prolonged sciatica.

Timing paradigm: surgery within 3 weeks versus conservative management for patients with chronic sciatica.

Study Summary

This single-center prospective RCT compared microdiscectomy with standardized nonsurgical care in patients with unilateral sciatica of 4 to 12 months duration caused by posterolateral LDH at L4–L5 or L5–S1. Between February 2010 and August 2016, 128 patients were randomized 1:1; 64 to early surgery and 64 to nonsurgical care. Nonsurgical treatment was standardized and included education, oral analgesics, active physiotherapy, and epidural glucocorticoid injections. Patients in the surgical group underwent microdiscectomy using open or minimally invasive approaches at a median of 3.1 weeks after randomization. The primary outcome was leg-pain intensity on a VAS (0–10) at 6 months; secondary outcomes included ODI and SF-36 scores.

Of 64 patients assigned to surgery, 56 underwent the procedure, and 7 cancelled due to symptom improvement. In the nonsurgical arm, 22 (34%) eventually crossed over to surgery at a median of 11 months. At 6 months, VAS leg pain was significantly lower in the surgical group (2.8 ± 0.4 vs 5.2 ± 0.4; adjusted mean difference 2.4, 95% CI 1.4–3.4, $P < 0.001$). Secondary outcome measures were consistent with the primary finding. At 12 months, the surgical group demonstrated superior ODI (22.9 vs 34.7), SF-36 Physical Component Scale (PCS) (42.8 vs 34.1), Mental Component Scale (MCS) (48.1 vs 42.3), and VAS LBP (3.2 vs 5.1). Surgery-related adverse events occurred in 6% of the surgical group. Satisfaction with treatment at 6 months was 92% in the surgical group versus 71% in the nonsurgical group.

Methodological Review

This trial addresses a previously underrepresented population: patients with chronic sciatica lasting 4 to 12 months, for whom prior RCT evidence was scarce. Strengths include prospective computer-generated randomization in a 1:1 ratio, a clearly defined patient population with imaging-confirmed posterolateral LDH, a standardized nonsurgical care protocol, and an intention-to-treat analysis with a clearly prespecified primary endpoint. The prolonged wait time inherent to the Canadian healthcare system reduced early crossover, with 97% of nonsurgical patients remaining under conservative care at 6 months.

Important limitations include the single-center design, which constrains external validity. The highly selective enrollment (128 of 790 screened patients) limits generalizability to the broader population with chronic sciatica. Up to 20% of data for the primary outcome were missing at 6 months, requiring multiple imputation. The open-label design introduces potential expectation bias for subjective pain outcomes. Secondary outcomes lacked adjustment for multiple comparisons and should be interpreted as exploratory. The surgical approach was not standardized (open versus minimally invasive), and no subgroup analyses were performed by symptom duration within the 4–12-month window. We find the quality of evidence to be High.

Recommendation Regarding Impact on Clinical Practice

Within the context of patient preference, for patients with persistent sciatica of 4 to 12 months duration caused by LDH who have not improved with conservative care, we conditionally recommend surgical discectomy (high-quality evidence).

Petr O, Glodny B, Brawanski K, Kerschbaumer J, Freyschlag C, Pinggera D, Rehwald R, Hartmann S, Ortler M, Thomé C.

Immediate versus Delayed Surgical Treatment of Lumbar Disc Herniation for Acute Motor Deficits: The Impact of Surgical Timing on Functional Outcome. Spine, 2019.

Clinical Rationale: Motor deficits are a common manifestation of LDH, yet the optimal timing of surgical decompression remains controversial. While early surgery is known to improve outcomes in cauda equina syndrome, evidence supporting urgent intervention for isolated motor deficits is limited and inconclusive.

Timing paradigm: surgical decompression within 48 hours versus delayed intervention for acute motor deficit.

Study Summary

This single-center retrospective cohort study with prospectively collected data evaluated the impact of surgical timing on neurological recovery in 330 patients with acute motor deficits caused by LDH, treated with microdiscectomy between January 2013 and December 2015. All patients had MRI- or computed tomography (CT)-confirmed LDH with an accompanying acute motor deficit and underwent urgent surgery regardless of paresis severity. Patients were stratified by duration of motor deficit prior to surgery: Group I ($\leq$48 hours, n = 126) and Group II (>48 hours, n = 204). Motor function was assessed through manual muscle testing (MMT) and graded according to the MRC scale at admission and at discharge, 6 weeks, and 12 weeks postoperatively. Outcomes also included sensory deficits and residual sciatica assessed by patient report.

Group I demonstrated significantly faster recovery of moderate and severe motor deficits (MRC 0–3) at discharge and at 6- and 12-week follow-up ($P \leq 0.001$ for all). Body mass index (BMI), preoperative MRC grade, and surgical timing within 48 hours were identified as independent predictors of motor recovery across all follow-up time points. Among patients with severe paresis (MRC 0–2), complete remission at 3 months was 96.2% in the early surgery group versus 64.0% in the delayed group ($P = 0.001$), with 20% of patients from the latter showing no recovery at all. No significant difference in recovery was observed for mild motor deficits (MRC 4). Sensory deficits recovered significantly faster in Group I at 6 weeks ($P = 0.003$) and 3 months ($P = 0.045$). Surgical complication rates were similar between groups (11.1% vs 14.2%, $P = 0.549$), and the mean hospital stay was 6 days in both groups.

Methodological Review

Key strengths include a relatively large consecutive series with prospectively collected outcome data, use of a validated motor grading scale (MRC) with a predefined grouping by time to surgery, and an appropriate statistical approach employing mixed linear and logistic regression models to account for surgeon-related clustering effects and to identify independent predictors of recovery.

Substantial limitations must be acknowledged. The retrospective, non-randomized design introduces selection bias and limits causal inference. The 48-hour threshold was adopted without explicit evidence-based justification, and the unequal group sizes may reflect differences in underlying care pathways rather than a true controlled comparison. Inter-rater reliability for MRC grading was not reported, and radicular pain was not systematically quantified using standardized scales, introducing the possibility that pain-related weakness confounded motor grading. Important clinical confounders, including disc morphology, presence and severity of spinal stenosis, disc calcification, surgeon experience, and motor assessment consistency were not addressed. Follow-up was limited to 12 weeks, restricting assessment of long-term neurological outcomes. Despite its methodological limitations, this study provides directional evidence supporting urgent surgical decompression for patients with LDH presenting with acute moderate-to-severe radicular motor deficits. We find the quality of evidence to be Low.

Recommendation Regarding Impact on Clinical Practice

We conditionally recommend that patients with paresis should be evaluated and imaged on an emergency basis, with a surgical goal of decompression within 48 hours of symptom onset for those with moderate-to-severe (MRC 0-3) weakness (low-quality evidence). Mild paresis (MRC 4) appears to have a more favorable natural history. It may not require the same

degree of urgency, though close observation and prompt reassessment is warranted if weakness fails to improve. Surgeons should note that the contribution of radicular pain to apparent motor weakness should be assessed: adequate analgesia prior to definitive neurological examination may clarify the true severity of the deficit.

Thomé C, Kögl N, Grassner L, Vo AK, Kramer JLK, Petr O.

Motor Recovery Depends on Timing of Surgery in Patients with Lumbar Disk Herniation. Neurosurgery, 2022.

Clinical Rationale: Although delayed surgery is generally discouraged in patients affected by LDH with significant motor weakness, clear recommendations regarding the urgency of surgical decompression are lacking. This study sought to determine whether a critical time threshold exists beyond which motor recovery is compromised.

Timing paradigm: surgical decompression within 3 days (severe/moderate deficit) or 8 days (mild deficit).

Study Summary

This investigator-initiated, prospective observational study followed 390 consecutive patients with LDH-associated motor deficits who underwent microdiscectomy between January 2013 and December 2015, with a minimum follow-up of 12 months (mean 43.4 ± 19.7 months). Motor function was graded using the MRC scale at multiple perioperative and postoperative time points. The primary outcome was the slope of motor recovery, derived using linear mixed-effects modeling across all available data per subject, reflecting both the rate and total extent of functional improvement over time. Unbiased recursive partitioning conditional inference tree (URP-CTREE) analysis was applied to identify optimal surgical timing thresholds from the data without imposing a priori assumptions.

Preoperative motor deficit severity (MRC ≤2/5) was the strongest predictor of outcome ($P < 0.001$). URP-CTREE identified 3 days as the critical timing threshold for both severe ($P = 0.022$) and moderate/mild deficits ($P < 0.001$). At final follow-up, 90.5% of patients operated within 3 days achieved full muscle strength (MRC 5/5) compared to only 36% of those operated after 3 days. For patients with severe preoperative weakness (MRC ≤2/5), 61% achieved complete recovery with early surgery versus 0% with delayed intervention. A separate sensitivity analysis in patients with mild deficits (MRC 4/5) identified a more permissive cutoff of 8 days, with greater than 90% full recovery when operated within this window, decreasing substantially beyond this threshold. The number needed to treat to prevent incomplete recovery was fewer than 2 for moderate-to-severe deficits treated within 3 days.

Methodological Review

This study carries important methodological strengths. The large sample size (390 consecutive patients), near-complete follow-up rate (99.7%), and prospective outcome assessment across a long follow-up period (up to 5 years) minimize attrition and recall bias. The application of URP-CTREE is a notable methodological advance, providing a data-driven, unbiased approach to threshold identification that avoids the limitations of arbitrarily chosen cutoffs used in prior studies. The use of a recovery slope as the primary outcome, incorporating all longitudinal MRC measurements rather than a single time-point assessment, is statistically more robust and clinically more informative. The strong correlation between 3-month motor strength and outcome ($r = 0.96$) further validates the early time points as prognostically meaningful.

Limitations include the observational design with no randomization and no nonoperative control group, restricting interpretation to surgically treated patients only. Patients were not prospectively assigned to early or delayed surgery; timing was largely determined by extramural factors (time to presentation and operating room availability), which may introduce confounding. Inter-rater reliability of MRC grading was not assessed, and the contribution of radicular pain to apparent motor weakness was not systematically controlled for. The single-center setting and high proportion of tertiary referrals may limit generalizability to lower-acuity settings. Surgical complication rates were not reported in detail, which is an important omission when advocating for expedited intervention. We find the quality of evidence to be Moderate.

Recommendation Regarding Impact on Clinical Practice

We conditionally recommend surgical decompression within 3 days of symptom onset for patients with LDH and moderate-to-severe motor deficits (MRC ≤3/5) to maximize the likelihood of complete neurological recovery. For patients with mild but functionally significant motor weakness (MRC 4/5), we conditionally recommend surgical intervention within 8 days of onset (moderate-quality evidence). Clinicians should systematically assess whether apparent motor weakness reflects true neurological deficit or pain inhibition, ensuring adequate analgesia before definitive strength testing.

Discussion

The six studies reviewed here, ordered along a continuum of surgical urgency, reveal a coherent and clinically actionable evidence base for decision-making in LDH. In the context of patient preference, rather than simply questioning whether surgery is better than conservative management, this framework asks a more precise and practically useful question: given the clinical presentation, how urgently is surgery needed, and what is lost by waiting?

At one end of the spectrum, Kim et al.4[4] demonstrated that in motivated surgical candidates who strongly prefer to avoid immediate surgery, a monitored extension of conservative management can yield similar long-term outcomes compared to surgery, although with slower early recovery. This finding supports the legitimacy of shared decision-making and patient autonomy in cases without neurological deficits, aligning with the broad principle that LDH has a favorable natural history in most patients. However, the extreme crossover rates and low evidence quality in this study limit its generalizability and underscore the importance of appropriate patient selection. Unequivocally, this approach is not applicable to patients with motor deficits or red-flag features.

The SPORT trial,[5] with its 8-year follow-up, provides the most durable longitudinal evidence on surgery versus conservative management in the broader LDH population. The as-treated analysis, the most clinically informative analytic approach in the context of high crossover, demonstrates that surgical benefit is not only statistically significant but clinically meaningful across all primary outcomes, and that it persists without degradation from years 4 to 8. This is reassuring evidence against concerns that surgery merely accelerates recovery without conferring long-term advantage. Importantly, the nonoperative group also improves substantially, reinforcing that conservative management is a viable strategy for appropriately selected patients.

Peul et al.[6] address the timing question most directly for acute sciatica, demonstrating that the 1-year endpoint is equivalent whether surgery is performed within 2 weeks or after up to 6 months of conservative management. The critical clinical insight from this study is not that surgery and conservative care are equivalent, but rather that the choice carries meaningful implications for the patient's experience in the intervening months. For patients who can tolerate their symptoms and prefer to avoid surgery, waiting is not harmful to their ultimate outcome. For those with intolerable leg pain or willing to minimize the time to recovery, early surgery offers substantially faster pain relief.

Bailey et al.[7] extend this framework to the chronic sciatica population (a group previously underrepresented in surgical trials) and demonstrate a clear and sustained benefit of surgery over conservative care at 6 and 12 months. This study challenges any assumption that prolonged conservative management is appropriate for all patients regardless of symptom duration. When sciatica persists beyond 4 months, the evidence suggests that continued conservative care is associated with significantly inferior outcomes compared to surgery, and clinicians should lower their threshold for surgical referral in this group.

The final two studies shift the clinical framework from a question of timing relative to symptom duration to one of neurological urgency. Petr et al.[8] and Thomé et al.[9] both examine LDH in the context of acute motor deficit, and their convergent findings are significant: time to surgery is a critical, potentially modifiable determinant of whether patients regain full neurological function. Petr et al.[8] identify 48 hours as an important threshold using a clinically pragmatic grouping, while Thomé et al.,[9] using a data-driven URP-CTREE approach that avoids a priori threshold assumptions, narrow this to 3 days, with a number (of patients) needed to treat of fewer than 2 for moderate-to-severe deficits. The difference in complete recovery rates between early and delayed surgery in the Thomé study (>90% versus 36%) is among the most clinically consequential findings in the LDH literature. Although substantiated by a strong methodology, the convergent findings of these studies may partially stem from overlapping cohorts, since they have been performed at the same institution along similar timelines, thus prompting cautious interpretation.

Together, these two studies make a compelling case that LDH presenting with moderate-to-severe motor deficit should be managed on an emergency basis, comparable to cauda equina syndrome. The most clinically relevant factor is not only the interval from symptom onset to surgery, but each component of the pathway: onset to first clinical contact, recognition and documentation of weakness, imaging acquisition, specialist assessment, interhospital transfer (if needed), and access to the operating room. Potential barriers include misidentification of MRC grade (which remains subjective in nature), misclassification of pain-inhibited weakness, limited MRI availability, transfer or specialist referral delays, and the absence of protected emergency operating room access. Ideally, institutions treating LDH should establish a clear pathway encompassing rapid imaging, repeat motor examination, same-day surgical consultation, and urgent operative scheduling. Out of these contexts, it would be instrumental to promote the adoption of standardized fast-track protocols for direct specialist consultation, prompt imaging, and urgent transfer to referral centres. Indeed, a key practical implication is that delays often arise outside the surgical setting, particularly within primary care, emergency medicine, or diagnostic radiology, thereby highlighting the need for broader clinical awareness of the time-sensitive nature of radicular motor deficits.

Table 1. Summary of the evidence-based clinical framework for decision-making in LDH, organised according to symptom duration, neurological status, and urgency of surgical intervention. The framework highlights the transition from elective decision-making in patients without neurological deficits to time-critical surgical urgency in the presence of motor weakness

Clinical Scenario	Symptom Duration	Neurological Status	Key Evidence	Recommendation	Strength of Evidence
Patient prefers to avoid surgery (surgical candidate)	≥6 weeks	No motor deficit	Kim et al.[4]	Conditional: continuation of nonoperative care may be offered; slower early recovery expected, but similar long-term outcomes possible	Low
Acute/subacute sciatica	6–12 weeks	No motor deficit	Peul et al.[6]	Conditional: either early surgery or continued conservative care is reasonable; surgery provides faster pain relief but similar 1-year outcomes	High
Persistent (chronic) sciatica	4–12 months	No motor deficit	Bailey et al.[7]	Conditional: discectomy should be offered, as it results in superior pain and functional outcomes compared to continued conservative care	High
General LDH population (long-term outcomes)	≥6 weeks	No major deficit	Lurie et al.[5]	Conditional: surgery provides greater and more durable improvement in pain and function; nonoperative care also improves outcomes; shared decision-making is essential	Moderate
Acute motor deficit (mild weakness)	Days (≤8 days)	MRC 4/5	Thomé et al.[9]	Conditional: early surgical decompression within approximately 8 days is associated with a high likelihood of full recovery; close monitoring is required	Moderate
Acute motor deficit (moderate–severe weakness)	Hours–days (≤3 days ideal; ≤48h preferred)	MRC ≤3/5	Petr et al.,[8] Thomé et al.[9]	Conditional: urgent surgical decompression should be prioritised; earlier surgery is strongly associated with improved neurological recovery	Low–Moderate

Abbreviations: LDH = lumbar disc herniation; MRC = Medical Research Council.

The reviewed studies together with relative scenarios and considerations are summarized in Table 1. To facilitate knowledge translation, Figure 1 integrates the reviewed evidence into a ready-to-use clinical decision algorithm.

Several important caveats apply across this body of evidence. First, the applicability of these recommendations to minimally invasive and endoscopic discectomy requires a distinction between the indication and timing of surgery and the operative approach used to achieve decompression. The proposed timing thresholds are driven by the natural history of nerve root compression and should therefore be considered approach-agnostic. Nevertheless, the evidence base is predominantly derived from standard open or microscopic discectomy. In their studies, Kim et al.[4] included full-endoscopic discectomy and Bailey et al.[7] reported both open and minimally invasive procedures, but neither study was designed to compare surgical approaches or to test an interaction between technique and timing. By further reducing surgical invasiveness, endoscopic discectomy has been shown to improve early postoperative outcomes, including reduced pain within the first 6 months and more rapid patient mobilization, while maintaining complication rates and long-term outcomes comparable to those of conventional approaches.[10] These advantages may enhance patient acceptance of the surgical burden and potentially increase the proportion of patients opting for operative management. Nonetheless, in patients with an acute motor deficit, the preferred technique should be the one that can provide prompt, complete, and reproducible decompression without additional delay. Endoscopic or tubular approaches are reasonable when the surgeon is experienced, the anatomy is suitable, and the required equipment and operating-room support are immediately available; conventional microscopic or open discectomy should be favored whenever an alternative strategy could delay or compromise decompression. At present, current evidence is insufficient to recommend one approach over another for neurological recovery in time-critical LDH.

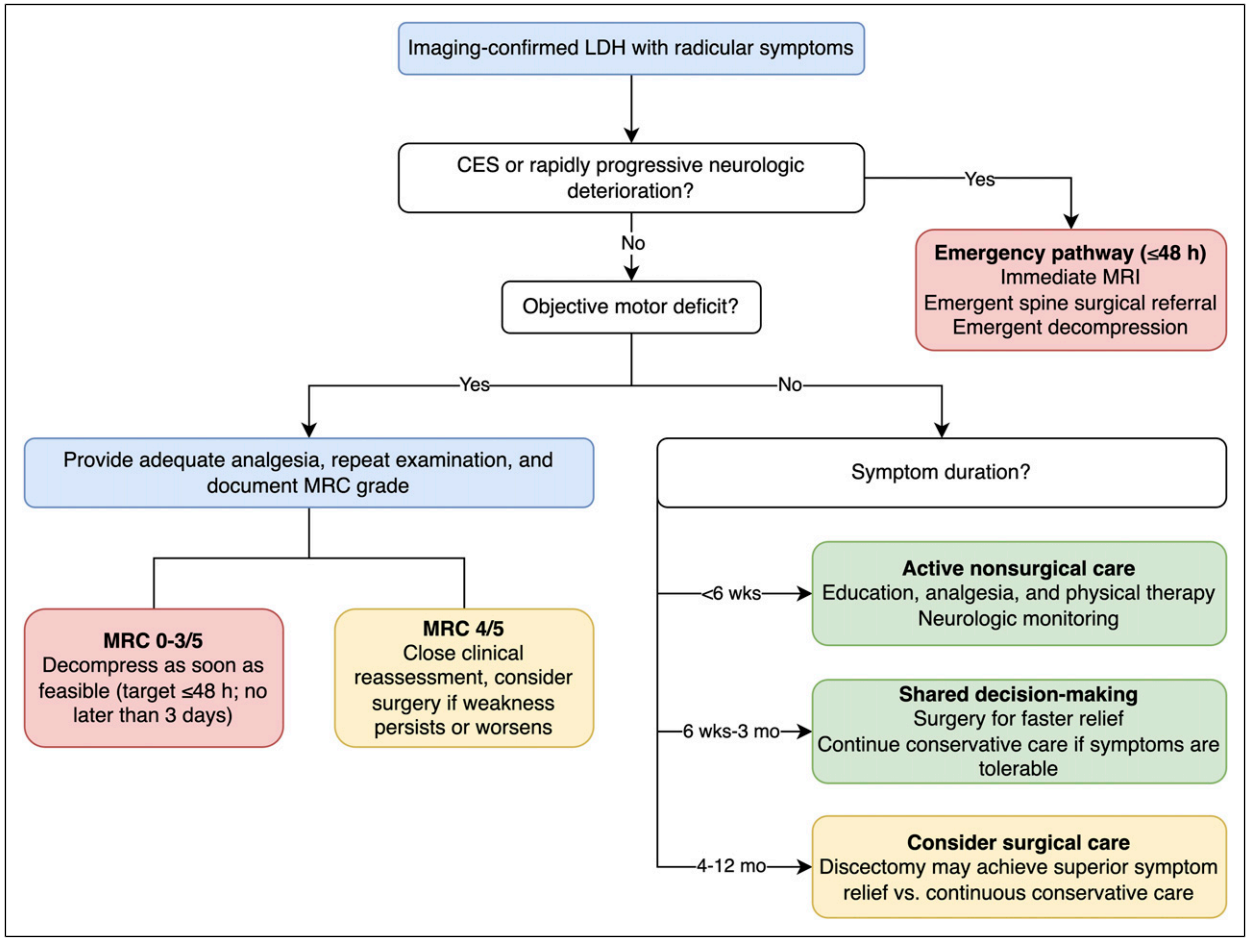


Figure 1. Clinical decision algorithm for LDH according to neurological urgency and symptom duration. The timing thresholds are conditional recommendations derived from the reviewed evidence and should not supersede immediate decompression for CES or rapidly progressive neurological deterioration. Abbreviations: CES; cauda equina syndrome; LDH, lumbar disc herniation; MRC, Medical Research Council; MRI, magnetic resonance imaging

Second, the contribution of radicular pain to apparent motor weakness is frequently underappreciated: adequate analgesia before neurological examination is essential to avoid overestimating the severity of a deficit and thus the urgency of intervention.

Third, none of the reviewed studies specifically address the interaction between surgical timing and disc morphology, stenosis severity, or vertebral endplate changes, all of which may influence prognosis independently of timing.

While the available evidence provides a clearer outlook of the treatment outcomes in patients with LDH and absent or mild motor weakness, additional research is needed to better clarify the relationship between symptom severity and timing of surgical decompression. Prospective multicenter studies should capture the exact onset of weakness at each step of the care pathway, use repeated standardized MRC assessments with inter-rater assessment, and report neurological recovery at prespecified short- and long-term endpoints. Candidate predictors should include baseline deficit severity, pain inhibition, age, BMI, psychosocial characteristics, symptom duration, spinopelvic balance, disc level and morphology, fragment migration, canal occupancy, concomitant stenosis, and electrodiagnostic findings. Studies should also be designed to examine interactions between timing and surgical approach, including microscopic, tubular, and endoscopic techniques. Because random assignment to delayed decompression may be unethical for moderate-to-severe deficits, prospective registries and pragmatic pathway studies may be more suited to address these unanswered questions. Such studies should test whether direct-referral protocols, prompt MRI access, transfer agreements, and protected emergency operating capacity shorten time to decompression and improve neurological recovery, while also assessing feasibility, cost, and equity across different health systems.

Conclusion

LDH should be triaged according to neurological urgency rather than symptom duration alone. In patients without neurological deficits, both conservative and surgical treatment are reasonable for acute sciatica (6–12 weeks), with surgery offering faster symptom relief but similar long-term outcomes. As symptoms persist beyond 4 months, the evidence increasingly favors surgical intervention. Continued non-operative management may remain appropriate in selected surgical candidates without significant neurological impairment. In the presence of a motor deficit, surgical timing becomes critical for neurological recovery, supporting the treatment of moderate-to-severe weakness (MRC 0-3/5) as a surgical emergency. Decompression should ideally be performed within 3 days for moderate-to-severe paresis and within 8 days for mild but functionally disabling deficits. The operative approach (open, microscopic, tubular, or endoscopic) should be selected according to anatomy and local expertise, but must never delay complete nerve root decompression. Practice change therefore requires both correct clinical triage and institutional pathways that convert neurological urgency into timely access to imaging, specialist assessment, and the operating room.

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Ethical Considerations

Institutional Review Board approval was not required for this study as it did not meet the standards for human research.

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Data Availability Statement

The data generated and analyzed during this study will be made available upon reasonable request.

References

1. Fjeld OR, Grøvle L, Helgeland J, et al. Complications, reoperations, readmissions, and length of hospital stay in 34 639 surgical cases of lumbar disc herniation. *The Bone & Joint Journal*. 2019;101-B:470-477. doi:10.1302/0301-620x.101b4.Bjj-2018-1184.R1.
2. Ambrosio L, Vadalà G, de Rinaldis E, et al. Discectomy versus sequestrectomy in the treatment of lumbar disc herniation: a systematic review and meta-analysis. *The Spine Journal*. 2025;25:211-226. doi:10.1016/j.spinee.2024.09.007.

3. Kögl N, Petr O, Löscher W, et al. *Lumbar disc herniation*. Deutsches Ärzteblatt international; 2024. doi:10.3238/arztebl.m2024.0074.
4. Kim CH, Choi Y, Chung CK, et al. Nonsurgical treatment outcomes for surgical candidates with lumbar disc herniation: a comprehensive cohort study. *Sci Rep*. 2021;11:3931. doi:10.1038/s41598-021-83471-y.
5. Lurie JD, Tosteson TD, Tosteson ANA, et al. Surgical Versus Nonoperative Treatment for Lumbar Disc Herniation. *Spine*. 2014;39:3-16. doi:10.1097/brs.0000000000000088.
6. Peul WC, van Houwelingen HC, van den Hout WB, et al. Surgery versus prolonged conservative treatment for sciatica. *N Engl J Med*. 2007;356:2245-2256. doi:10.1056/NEJMoa064039.
7. Bailey CS, Rasoulinejad P, Taylor D, et al. Surgery versus Conservative Care for Persistent Sciatica Lasting 4 to 12 Months. *New England Journal of Medicine*. 2020;382:1093-1102. doi:10.1056/NEJMoa1912658.
8. Petr O, Glodny B, Brawanski K, et al. Immediate Versus Delayed Surgical Treatment of Lumbar Disc Herniation for Acute Motor Deficits. *Spine*. 2019;44:454-463. doi:10.1097/brs.0000000000002295.
9. Thomé C, Kögl N, Grassner L, Vo AK, Kramer JLK, Petr O. Motor Recovery Depends on Timing of Surgery in Patients With Lumbar Disk Herniation. *Neurosurgery*. 2022;90:347-353. doi:10.1227/neu.0000000000001825.
10. Latka K, Kozlowska K, Domisiewicz K, Klepinowski T, Latka D. Full-endoscopic lumbar spine discectomy: Are We Finally There? A Meta-Analysis of Its Effectiveness Against Non-microscopic Discectomy, Microdiscectomy and Tubular Discectomy. *The Spine Journal*. 2025;26:479-497. doi:10.1016/j.spinee.2025.02.006.