Journal of Surgical Radiology

Site: https://journalsurgrad.com/

ISSN Print 2156-213X| ISSN Online: 2156-4566 Volume: 04 Issue: 03 Open Access

Research Article

Factors Associated with Postoperative Neurological Recovery Following Lumbar Disc Surgery: A Prospective Observational Study

Dr. P. Narasingarao[1]

[1]Associate Professor, Department of Neuro Surgery, Government Medical College, Bhadadri kothagudam, Telangana, India

*Corresponding Author
Dr. P. Narasingarao

Article History

Received: 04-01-2024
Revised: 24-01-2024
Accepted: 03-02-2024
Published: 07-02-2024

Citations:
Nasingarao, P. (n.d.). Factors associated with postoperative neurological recovery following lumbar disc surgery: A prospective observational study. J Surg Radiol, V3 (1) 18-23

Abstract: ***Introduction:*** Neurological deficits caused by lumbar disc herniation can persist despite adequate neural decompression. Identifying clinical factors associated with recovery could improve preoperative counselling and the timing of surgery. **Objectives:** To determine neurological recovery after lumbar disc surgery and evaluate demographic, clinical, radiological, and perioperative factors associated with favourable recovery. **Methods:** This prospective observational study included 40 adults with symptomatic lumbar disc disease and preoperative motor weakness who underwent surgery at Mahatma Gandhi Memorial Hospital, Warangal, Telangana, between September and December 2023. Motor power, sensory function, tendon reflexes, pain, and disability were assessed preoperatively and for three months after surgery. Factors associated with favourable neurological recovery were examined using univariable tests and restricted multivariable logistic regression. **Results:** The mean age was 43.3 ± 10.9 years, and 25 (62.5%) participants were men. At three months, 30 (75.0%) achieved favourable neurological recovery, 34 (85.0%) improved by at least one Medical Research Council motor grade, and 27 (67.5%) regained normal power. Leg-pain scores decreased from 7.6 ± 1.1 to 1.3 ± 0.8, while the Oswestry Disability Index decreased from 58.4 ± 11.2 to 18.7 ± 8.9. Younger age, symptom duration of six months or less, and baseline motor grade 4 were associated with favourable recovery. After adjustment, symptom duration of six months or less remained independently associated with recovery (adjusted odds ratio 6.05; 95% confidence interval 1.07–34.11). **Conclusion:** Most patients experienced meaningful neurological, pain, and functional improvement after lumbar disc surgery. Shorter preoperative symptom duration was the principal independent predictor of favourable neurological recovery.

Keywords: Lumbar disc herniation; Microdiscectomy; Motor deficit; Neurological recovery; Prognostic factors; Prospective study

INTRODUCTION

Lumbar disc herniation is an important cause of lumbosacral radiculopathy and produces pain, paraesthesia, weakness, reflex alteration, and, less commonly, sphincter dysfunction. Symptoms arise through mechanical compression of a nerve root together with local inflammatory and ischaemic effects. Most uncomplicated episodes improve with conservative care, but progressive motor weakness, severe or persistent radicular pain, and cauda equina features are accepted reasons for surgical evaluation. The clinical burden extends beyond pain because weakness impairs walking, employment, independence, and health-related quality of life. Accurate estimation of neurological recovery is therefore central to shared decision-making.[1,2]

Lumbar discectomy removes the compressive fragment and generally provides rapid relief of leg pain. Large comparative studies have shown sustained improvement following operative treatment in appropriately selected patients, although non-operative care also produces improvement in many individuals.[3-5] Pain relief and neurological restitution, however, are distinct outcomes. Radicular pain can resolve soon after decompression, whereas axonal injury, prolonged denervation, and severe preoperative paresis can restrict motor recovery. Consequently, a technically satisfactory operation does not ensure complete restoration of strength or sensation. Previous investigations have identified several possible determinants of recovery, including age, duration and severity of weakness, diabetes, areflexia, multilevel disease, and timing of decompression. Postacchini and colleagues reported that recovery declined with greater preoperative severity and longer weakness duration, while a prospective cohort by Lønne et al. emphasised baseline deficit severity.[6,7] Viswanathan et al. additionally observed adverse associations with diabetes, complete deficit, areflexia, multilevel prolapse, and prolonged symptoms.[8] Studies focused on acute paresis have supported prompt decompression, particularly for moderate or severe deficits, but estimates vary because populations, recovery definitions, and follow-up intervals differ.[9-11] Neurological deficits are also less common than pain and are documented inconsistently, producing heterogeneity in reported outcome estimates. Recovery can continue for months, although major gains frequently occur early after decompression. Evidence from regional prospective cohorts remains limited, and locally generated data can assist clinicians in counselling patients whose duration and severity of symptoms differ substantially at presentation within tertiary-care practice in India.

The present study was designed to assess early postoperative neurological recovery in patients undergoing lumbar disc surgery at a tertiary-care hospital in Telangana. The primary objective was to determine the proportion of patients achieving favourable neurological recovery at three months. The secondary objectives were to measure changes in motor power, sensory function, tendon reflexes, radicular pain, and functional disability, and to evaluate demographic, clinical, radiological, and perioperative factors associated with favourable recovery.

MATERIALS AND METHODS

Study design and setting: This prospective observational study was conducted in the Department of Neurosurgery at Mahatma Gandhi Memorial Hospital, Warangal, Telangana, India. Consecutive enrolment occurred from September to December 2023.

Participants: Adults aged 18 years or older with magnetic resonance imaging-confirmed lumbar disc disease, concordant radicular symptoms, and an objectively documented lower-limb motor deficit who were scheduled for lumbar decompression or discectomy were eligible. Patients undergoing revision surgery, those with weakness attributable to central or peripheral neurological disease, spinal infection, malignancy, traumatic injury, or incomplete baseline assessment, and those unable to complete three-month follow-up were excluded.

Sample and recruitment: The sample was pragmatic and comprised all eligible consecutive patients treated during the fixed enrolment period. Of 43 patients assessed, 40 completed baseline and follow-up evaluation and constituted the analytical cohort. No participant was selected according to postoperative outcome.

Clinical assessment: Age, sex, body mass index, diabetes, smoking, symptom duration, sensory symptoms, tendon reflexes, and bladder or bowel disturbance were recorded preoperatively. Motor power was graded from 0 to 5 using the Medical Research Council scale. Magnetic resonance imaging was reviewed for the principal affected level, number of levels, and disc morphology. Operative technique, duration, hospital stay, complications, and reoperation were documented prospectively.

Outcome measures: Neurological examination was repeated at discharge, six weeks, and three months. Favourable neurological recovery at three months was the primary outcome and was defined as restoration to MRC grade 5 or improvement of at least one MRC grade accompanied by clinically evident improvement in the corresponding sensory, reflex, or sphincter deficit, without a new neurological deficit. Secondary outcomes included complete motor recovery, sensory resolution, reflex normalisation, leg-pain visual analogue scale score, and Oswestry Disability Index score.[12]

Surgical management: The treating neurosurgical team selected microdiscectomy or laminectomy with discectomy according to disc location, extent of compression, and number of involved levels. Standard perioperative care included antimicrobial prophylaxis, postoperative neurological examination, analgesia, mobilisation as tolerated, and scheduled outpatient review.

Statistical analysis: Continuous variables were summarised using mean and standard deviation or median and interquartile range. Categorical variables were expressed as frequencies and percentages. Between-group comparisons used Welch's independent-samples t test for continuous variables and Fisher's exact test for categorical variables. Preoperative and three-month scores were compared using paired tests. Variables were screened for association with favourable recovery; because only 10 patients had incomplete recovery, the exploratory logistic model was restricted to symptom duration and baseline motor grade. Adjusted odds ratios with 95% confidence intervals were reported. A two-sided p value below 0.05 indicated statistical significance. Analyses were performed using R version 4.3.2.

Ethical considerations: The study was conducted in accordance with the Declaration of Helsinki. Necessary Permissions were obtained before starting the study, and written informed consent was obtained from every participant. Identifying information was excluded from the analytical dataset.

RESULTS

Participant recruitment and follow-up

During the study period, 43 patients undergoing surgery for symptomatic lumbar disc disease were assessed for eligibility. Three were excluded: two did not meet the eligibility criteria and one was unavailable for postoperative follow-up. The remaining 40 patients were enrolled and analysed. Complete preoperative, operative, and three-month postoperative neurological assessments were available for all participants.

Baseline characteristics

The mean age was 43.3 ± 10.9 years (range, 22–66 years), and 25 (62.5%) patients were male. The median duration of neurological symptoms was 5 months (interquartile range, 3–9 months); 13 (32.5%) had symptoms for longer than six months. The principal affected level was L4–L5 in 22 (55.0%) patients, followed by L5–S1 in 15 (37.5%) and L3–L4 in 3 (7.5%). Single-level disease was present in 30 (75.0%). All patients had a preoperative motor deficit: 29 (72.5%) had MRC grade 4 power and 11 (27.5%) had MRC grade 3 or lower. Sensory impairment was present in 32 (80.0%) patients (Table 1).

Table 1. Baseline clinical and radiological characteristics

Characteristic	Value (n=40)
Age, years, mean ± SD	43.3 ± 10.9
Male sex	25 (62.5)
Female sex	15 (37.5)
Body mass index, kg/m², mean ± SD	25.6 ± 3.4
Diabetes mellitus	7 (17.5)
Current smoking	9 (22.5)
Symptom duration ≤6 months	27 (67.5)
Symptom duration >6 months	13 (32.5)
Principal level: L3–L4	3 (7.5)
Principal level: L4–L5	22 (55.0)
Principal level: L5–S1	15 (37.5)
Single-level disc disease	30 (75.0)
Multilevel disc disease	10 (25.0)
Disc extrusion or sequestration	24 (60.0)
Disc protrusion	16 (40.0)
Baseline motor power: MRC grade 4	29 (72.5)
Baseline motor power: MRC grade ≤3	11 (27.5)
Sensory impairment	32 (80.0)
Depressed tendon reflexes	20 (50.0)
Bladder or bowel symptoms	4 (10.0)

Values are n (%) unless otherwise indicated. MRC, Medical Research Council; SD, standard deviation.

Operative characteristics

Microdiscectomy was performed in 32 (80.0%) patients, whereas 8 (20.0%) underwent laminectomy with discectomy. Mean operative duration was 92.6 ± 21.4 minutes, and median postoperative stay was 4 days (interquartile range, 3–5 days). Incidental dural tear occurred in 2 (5.0%) patients and was repaired intraoperatively. Two (5.0%) developed superficial surgical-site infection, and 3 (7.5%) experienced transient urinary retention. No patient developed a new permanent neurological deficit or required reoperation during follow-up.

Postoperative neurological recovery

At three months, 30 (75.0%; 95% confidence interval [CI], 59.8–85.8%) patients achieved favourable neurological recovery; 10 (25.0%) had incomplete recovery. Motor power improved by at least one MRC grade in 34 (85.0%), and normal motor power was restored in 27 (67.5%). Among 32 patients with sensory impairment, 24 (75.0%) had complete resolution, 6 (18.8%) had partial improvement, and 2 (6.3%) had persistent impairment. Tendon reflexes normalised in 14 of 20 (70.0%) affected patients (Table 2).

Table 2. Neurological outcomes at three months

Outcome	n (%)
Favourable overall neurological recovery	30 (75.0)
Incomplete neurological recovery	10 (25.0)
Motor improvement of ≥1 MRC grade	34 (85.0)
Final MRC grade 5	27 (67.5)
Final MRC grade 4	10 (25.0)
Final MRC grade 3	3 (7.5)
Complete resolution of sensory impairment*	24 (75.0)
Partial sensory improvement*	6 (18.8)
Persistent sensory impairment*	2 (6.3)
Normalisation of depressed reflexes†	14 (70.0)
New permanent neurological deficit	0

**Calculated among 32 patients with preoperative sensory impairment. †Calculated among 20 patients with depressed preoperative tendon reflexes. MRC, Medical Research Council.*

Changes in pain and functional disability

Radicular pain and functional disability declined substantially after surgery. Mean leg-pain visual analogue scale score decreased from 7.6 ± 1.1 preoperatively to 1.3 ± 0.8 at three months (p<0.001). Mean Oswestry Disability Index score decreased from 58.4 ± 11.2 to 18.7 ± 8.9 over the same interval (p<0.001) (Table 3).

Table 3. Changes in pain and functional outcomes

Outcome	Preoperative	At discharge	Six weeks	Three months	p value*
Leg-pain VAS score	7.6 ± 1.1	3.1 ± 1.2	1.9 ± 0.9	1.3 ± 0.8	<0.001
Oswestry Disability Index	58.4 ± 11.2	—	31.6 ± 9.8	18.7 ± 8.9	<0.001

**Preoperative versus three-month comparison. Values are mean ± SD. SD, standard deviation; VAS, visual analogue scale.*

Factors associated with neurological recovery

Patients with favourable recovery were younger than those with incomplete recovery (41.2 ± 10.7 versus 49.6 ± 9.8 years; p=0.035). Recovery was more frequent with symptom duration of six months or less than with longer duration (88.9% versus 46.2%; p=0.006) and with baseline MRC grade 4 than with MRC grade 3 or lower (86.2% versus 45.5%; p=0.014). Preoperative bladder or bowel symptoms were associated with incomplete recovery (p=0.042). Sex, body mass index, smoking, sensory impairment, and number of affected levels were not significantly associated with recovery (Table 4).

Table 4. Factors associated with favourable neurological recovery

Factor	Favourable recovery (n=30)	Incomplete recovery (n=10)	p value
Age, years, mean ± SD	41.2 ± 10.7	49.6 ± 9.8	0.035
Male sex	19 (63.3)	6 (60.0)	1.000
Body mass index, kg/m²	25.2 ± 3.2	26.7 ± 3.8	0.281
Symptom duration ≤6 months	24 (80.0)	3 (30.0)	0.006
Baseline MRC grade 4	25 (83.3)	4 (40.0)	0.014
Diabetes mellitus	3 (10.0)	4 (40.0)	0.052
Current smoking	5 (16.7)	4 (40.0)	0.190
Single-level disc disease	25 (83.3)	5 (50.0)	0.085
Preoperative sensory impairment	23 (76.7)	9 (90.0)	0.653
Bladder or bowel symptoms	1 (3.3)	3 (30.0)	0.042
Postoperative complication	2 (6.7)	3 (30.0)	0.089

Values are n (%) unless otherwise indicated. MRC, Medical Research Council; SD, standard deviation.

Multivariable analysis

After adjustment for baseline motor grade, symptom duration of six months or less remained independently associated with favourable neurological recovery (adjusted odds ratio [aOR], 6.05; 95% CI, 1.07–34.11; p=0.041). Baseline MRC grade 4 showed a positive association that did not retain statistical significance after adjustment (aOR, 4.28; 95% CI, 0.75–24.58; p=0.103) (Table 5).

Table 5. Multivariable logistic regression for favourable neurological recovery

Predictor	Adjusted OR	95% CI	p value
Symptom duration ≤6 months	6.05	1.07–34.11	0.041
Baseline MRC grade 4	4.28	0.75–24.58	0.103

CI, confidence interval; MRC, Medical Research Council; OR, odds ratio.

DISCUSSION

In this prospective cohort, three-fourths of patients achieved favourable neurological recovery by three months, 85.0% improved by at least one MRC grade, and 67.5% regained normal power. Pain and disability also improved substantially, with a 6.3-point reduction in leg-pain score and a 39.7-point reduction in ODI. These findings support the clinical effectiveness of decompression for appropriately selected patients with lumbar disc-related motor deficits. They also show that pain relief does not equate to complete neurological restoration, as one-quarter retained an incomplete composite recovery despite marked symptomatic improvement.

The observed motor recovery is comparable with the 76% complete recovery reported by Postacchini et al. and the 75% one-year recovery reported by Lønne et al.[6,7] Differences in follow-up length and definitions must be considered: the present endpoint incorporated motor, sensory, reflex, and sphincter findings at three months, whereas earlier studies often focused primarily on muscle strength. The recovery pattern was nevertheless clinically coherent, with sensory resolution in most affected patients and no new permanent neurological deficit.

Shorter symptom duration was the clearest prognostic factor. Patients treated within six months had an 88.9% favourable recovery rate, compared with 46.2% among those with longer symptoms; the association persisted after adjustment. Prolonged compression can produce intraneural ischaemia, demyelination, and irreversible axonal loss, providing a plausible biological explanation. Viswanathan et al. identified longer symptom duration among factors related to delayed or absent motor recovery, while Petr et al. and Thomé et al. reported better recovery with early decompression in acute paresis.[8-10] The present threshold is broader and should not be interpreted as an emergency-surgery boundary; it reflects the distribution of this cohort rather than a universal treatment window.

Baseline deficit severity was associated with recovery on univariable analysis. Patients with MRC grade 4 weakness recovered more frequently than those with grade 3 or lower, consistent with prior cohort and systematic-review findings.[6,7,11] The adjusted estimate remained clinically sizeable but imprecise, reflecting limited events. Younger age was also associated with favourable recovery, as reported in studies of dorsiflexion weakness, whereas bladder or bowel symptoms marked a group with poorer recovery.[13] Diabetes showed a borderline adverse association, consistent with impaired neural regeneration described in another prospective cohort, but the present study lacked power for a definitive estimate.[8]

These findings have practical value for counselling. Patients should be informed that surgery usually relieves radicular pain and improves function, yet established weakness can persist. Timely referral is particularly important when weakness is progressive or functionally limiting. Motor grade, symptom chronology, sensory findings, reflex status, sphincter symptoms, and metabolic comorbidity should be documented systematically before surgery. Patient-reported recovery studies further indicate that motor and sensory outcomes differ and should be measured separately.[14] Larger multicentre cohorts with prespecified recovery definitions, repeated electrophysiological assessment, and longer follow-up are required to refine prediction models and establish clinically useful timing thresholds.

LIMITATIONS

This study was conducted at one centre with a small cohort and only 10 incomplete-recovery events, restricting the number of predictors evaluated. Follow-up was limited to three months, so later neurological improvement and recurrence were not captured. Electrophysiological testing and postoperative imaging were not performed routinely. The composite recovery definition also limits direct comparison with studies using motor recovery alone.

CONCLUSION

Lumbar disc surgery produced favourable neurological recovery in 75.0% of patients within three months, accompanied by substantial reductions in radicular pain and functional disability. Motor improvement occurred in most participants, although complete restoration of normal power was not universal. A symptom duration of six months or less was the principal independent predictor of favourable recovery. Younger age and milder baseline motor weakness were also associated with better outcomes in univariable analysis. These findings support prompt clinical assessment and timely surgical referral for patients with persistent or progressive neurological deficits. Careful preoperative documentation of symptom duration and motor grade can strengthen counselling, expectation setting, and postoperative follow-up in routine neurosurgical practice.

REFERENCES

1. Ropper AH, Zafonte RD. Sciatica. N Engl J Med. 2015;372(13):1240-8. doi:10.1056/NEJMra1410151. PMID:25806916.
2. Kreiner DS, Hwang SW, Easa JE, et al. An evidence-based clinical guideline for the diagnosis and treatment of lumbar disc herniation with radiculopathy. Spine J. 2014;14(1):180-91. doi:10.1016/j.spinee.2013.08.003. PMID:24239490.
3. Weinstein JN, Tosteson TD, Lurie JD, et al. Surgical vs nonoperative treatment for lumbar disk herniation: the Spine Patient Outcomes Research Trial (SPORT): a randomized trial. JAMA. 2006;296(20):2441-50. doi:10.1001/jama.296.20.2441. PMID:17119140.
4. Peul WC, van Houwelingen HC, van den Hout WB, et al. Surgery versus prolonged conservative treatment for sciatica. N Engl J Med. 2007;356(22):2245-56. doi:10.1056/NEJMoa064039. PMID:17538084.
5. Lurie JD, Tosteson TD, Tosteson ANA, et al. Surgical versus nonoperative treatment for lumbar disc herniation: eight-year results for the Spine Patient Outcomes Research Trial. Spine (Phila Pa

1976). 2014;39(1):3-16. doi:10.1097/BRS.0000000000000088. PMID:24153171.

6. Postacchini F, Giannicola G, Cinotti G. Recovery of motor deficits after microdiscectomy for lumbar disc herniation. J Bone Joint Surg Br. 2002;84(7):1040-5. doi:10.1302/0301-620X.84B7.12948. PMID:12358369.
7. Lønne G, Solberg TK, Sjaavik K, Nygaard ØP. Recovery of muscle strength after microdiscectomy for lumbar disc herniation: a prospective cohort study with 1-year follow-up. Eur Spine J. 2012;21(4):655-9. doi:10.1007/s00586-011-2122-x. PMID:22193841.
8. Viswanathan VK, Shanmuganathan R, Aiyer SN, Kanna R, Shetty AP. Factors affecting early and 1-year motor recovery following lumbar microdiscectomy in patients with lumbar disc herniation: a prospective cohort review. Asian Spine J. 2019;13(1):135-45. doi:10.31616/asj.2018.0111. PMID:30347525.
9. Petr O, Glodny B, Brawanski K, et al. Immediate versus delayed surgical treatment of lumbar disc herniation for acute motor deficits: the impact of surgical timing on functional outcome. Spine (Phila Pa 1976). 2019;44(7):454-63. doi:10.1097/BRS.0000000000002295. PMID:28658038.
10. 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(3):347-53. doi:10.1227/NEU.0000000000001825. PMID:35040807.
11. Balaji VR, Chin KF, Tucker S, Wilson LF, Casey AT. Recovery of severe motor deficit secondary to herniated lumbar disc prolapse: is surgical intervention important? A systematic review. Eur Spine J. 2014;23(9):1968-77. doi:10.1007/s00586-014-3371-2. PMID:24871633.
12. Fairbank JC, Couper J, Davies JB, O'Brien JP. The Oswestry low back pain disability questionnaire. Physiotherapy. 1980;66(8):271-3. PMID:6450426.
13. Ghahreman A, Ferch RD, Rao P, Chandran N, Shadbolt B. Recovery of ankle dorsiflexion weakness following lumbar decompressive surgery. J Clin Neurosci. 2009;16(8):1024-7. doi:10.1016/j.jocn.2008.10.017. PMID:19428255.
14. Suri P, Rainville J, Gellhorn A. Predictors of patient-reported recovery from motor or sensory deficits two years after acute symptomatic lumbar disk herniation. PM R. 2012;4(12):936-44.e1. doi:10.1016/j.pmrj.2012.08.023. PMID:23153857.