Original Article

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# Surgical outcome following laminectomy and posterior instrumentation for multi-level cervical degenerative disc disease

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## Abstract

**Introduction:** Multilevel cervical degenerative disc disease is a major cause of spinal cord compression leading to progressive myelopathy. Posterior decompression with instrumentation provides effective decompression with spinal stability.

**Methods:** A prospective observational study was conducted among 34 patients undergoing multilevel cervical laminectomy with posterior instrumentation. Clinical outcomes were assessed using mJOA score, Visual Analog Scale (VAS), and Nurick grading. Neurological recovery was evaluated using the Hirabayashi recovery rate. Cervical lordosis was measured using the C2–C7 Cobb angle.

**Results:** The mean age was 58.1±8.2 years. Significant improvement was observed in mJOA, VAS, and Nurick grade ($p<0.05$). Favorable outcome based on Hirabayashi recovery rate was achieved in 76.5% of patients. Cervical lordosis improved significantly, and fusion rate was 94.1%.

**Conclusions:** Posterior cervical laminectomy with instrumentation is a safe and effective procedure for multilevel cervical degenerative disease.

**Keywords:** Degenerative cervical myelopathy; Hirabayashi recovery rate; posterior laminectomy; instrumentation; Sagittal alignment.

## INTRODUCTION

Degenerative cervical myelopathy (DCM) is the most common cause of non-traumatic spinal cord dysfunction in adults, resulting from progressive degenerative changes in intervertebral discs, facet joints, and ligamentous structures, leading to spinal canal narrowing and neural compression[1,2]. Patients typically present with gait disturbance, limb weakness, sensory deficits, and sphincter dysfunction, significantly affecting functional status and quality of life.

Multilevel cervical degenerative disc disease represents a more complex form of DCM, often involving multiple segments and resulting in more severe neurological compromise. Surgical management aims to achieve adequate decompression of the spinal cord while preserving or restoring spinal stability and sagittal alignment[3].

Posterior cervical decompression through laminectomy has been widely used for multilevel disease; however, standalone laminectomy is associated with complications such as postoperative kyphosis, instability, and late neurological deterioration[4,5]. To address these limitations, laminectomy combined with posterior instrumentation has gained widespread acceptance. Posterior instrumentation, particularly lateral mass screw fixation, provides immediate stability, maintains cervical lordosis, and improves fusion rates[5,6].

Comparative studies have shown that laminectomy with fusion provides better preservation of alignment and improved neurological outcomes compared to laminoplasty or decompression alone[7,8]. Neurological recovery following posterior decompression is attributed to posterior spinal cord drift, enabling indirect anterior decompression. Restoration of cervical sagittal alignment further correlates with improved functional outcomes[5,7].

Despite growing evidence, data from developing countries remain limited. Therefore, this study aims to evaluate the clinical, functional, and radiological outcomes of multilevel cervical laminectomy with posterior instrumentation.

## METHODOLOGY

This was a prospective observational study conducted in the Department of Neurosurgery at the National Academy of

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Patients with radiologically confirmed multilevel cervical degenerative disc disease were consecutively enrolled. A total of 34 patients meeting the inclusion criteria were included in the study. The sample size was calculated based on a previously published study reporting a favorable outcome rate of 95.3%[7]. Using the formula $n = Z^2 \times P(1-P) / d^2$, where Z = 1.96 at a 95% confidence interval, P = 0.95, and d = 0.10, the calculated sample size was 34.

Patients aged ≥18 years with radiologically confirmed multilevel cervical degenerative disc disease (involving ≥2 levels), presenting with myelopathy, radiculopathy, or radiculomyelopathy, and undergoing posterior cervical laminectomy with instrumentation were included. Patients with single-level disease, prior cervical spine surgery, traumatic, infective, neoplastic, or inflammatory cervical pathology, and those with severe uncontrolled systemic illness were excluded. After obtaining written informed consent, baseline demographic and clinical data, including age, sex, and comorbidities (diabetes mellitus, hypertension, and smoking status), were recorded. Clinical evaluation included neurological assessment and functional evaluation using the Visual Analog Scale (VAS), modified Japanese Orthopaedic Association (mJOA) score, and Nurick grading. Neurological recovery was assessed using the Hirabayashi recovery rate.

Radiological evaluation included plain radiographs, computed tomography (CT), and magnetic resonance imaging (MRI). MRI was used to assess spinal cord compression, disc pathology, and ligamentous involvement (Figure 1). MRI is considered the gold standard imaging modality for evaluating cervical degenerative disease and spinal cord compression[1]. Cervical sagittal alignment was assessed using the C2–C7 Cobb angle measured on lateral radiographs[10]. This method is widely accepted and validated in spinal radiological evaluation[7]. Measurements were recorded preoperatively and postoperatively. Radiological assessments were performed independently by two observers to minimize measurement bias.

*Figure 1: Preoperative MRI (Sagittal T2-weighted image) showing multilevel cervical disc degeneration with canal stenosis and spinal cord compression at C5–C6 and C6–C7.*

All patients underwent multilevel posterior cervical laminectomy with lateral mass screw fixation under general anesthesia. Patients were positioned prone with the head supported in neutral alignment. A standard midline posterior cervical approach was used. Lateral mass screws were inserted using the Magerl technique[13]. Following instrumentation, a multilevel laminectomy was performed to achieve adequate decompression of the spinal cord. Posterior decompression facilitates indirect anterior decompression through posterior spinal cord drift [6,7]. Hypertrophied ligamentum flavum and compressive osteophytes were removed. Pre-contoured rods were applied, and autologous bone graft harvested during laminectomy was used to promote fusion. Hemostasis was achieved, and the wound was closed in layers. All procedures were performed by experienced neurosurgeons using a standardized technique. Lateral mass fixation provides adequate stability with a lower risk of neurovascular complications compared to pedicle screw fixation[5,6].

Intraoperative parameters, including operative duration, blood loss, and complications, were recorded. Patients were followed up at discharge, 1 month, and 3 months postoperatively. Clinical outcomes were assessed using mJOA score, VAS, and Nurick grade. Radiological outcomes included cervical lordosis measured using Cobb angle and assessment of fusion status on follow-up imaging.

The primary outcomes were neurological improvement and functional recovery. Secondary outcomes included radiological improvement, fusion status, and postoperative complications. Fusion was defined as the presence of continuous bridging trabecular bone across instrumented levels, absence of radiolucency around screws, and no significant motion on dynamic radiographs, based on established radiological criteria, and favorable outcome was defined as good or excellent recovery based on Hirabayashi criteria[11].

Data were analyzed using IBM SPSS Statistics. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequency and percentage. Preoperative and postoperative comparisons were performed using the paired sample t-test. Additionally, 95% confidence intervals were calculated for key variables. A p-value $<0.05$ was considered statistically significant.

## RESULTS

A total of 34 patients were included in the present study, all of whom underwent multilevel cervical laminectomy with posterior instrumentation for degenerative cervical spine pathology. Among the etiological subtypes, cervical spondylotic myelopathy (CSM) constituted the predominant diagnosis, observed in 22 patients (64.7%). The remaining cases included ossified posterior longitudinal ligament (OPLL) in 6 patients (17.6%) and cervical canal stenosis in 6 patients (17.6%), reflecting a heterogeneous but predominantly degenerative cohort. The baseline demographic, clinical, and operative characteristics of the study population are summarized in Table 1.

*Table 1. Baseline demographic and clinical characteristics (n = 34)*

| Variable | Value |
|---|---|
| Age (years) | 58.1 ± 8.2 (95% CI: 55.2-61) |
| Gender | |
| Male | 22 (64.7%) |
| Female | 12 (35.3%) |
| Co-morbidities | |
| Diabetes Mellitus | 14 (41.2%) |
| Hypertension | 16 (47.1%) |
| Smoking | 12 (35.3%) |
| Clinical presentation | |
| Radiculopathy | 12 (35.3%) |
| Myelopathy | 14 (41.2%) |
| Radiculo-myelopathy | 8 (23.5%) |
| Etiology | |
| Cervical spondylotic myelopathy (CSM) | 22 (64.7%) |
| OPLL | 6 (17.6%) |
| Cervical stenosis | 6 (17.6%) |
| No. of involved levels | 3.9 ± 0.7 |
| No. of instrumented levels | 3.94 ± 0.7 |
| No. of laminectomized levels (median, range) | 4 (3-5) |
| C3 | 5 (14.7%) |
| C4 | 9 (26.5%) |
| C5 | 12 (35.3%) |
| C6 | 11 (32.4%) |
| C7 | 6 (17.6%) |
| Operative time (minutes) | 113.4 ± 15.3 |
| Blood loss (mL) | 384.6 ± 81.6 |
| Hospital stay (days) | 6.17 ± 1.35 |

The mean age of the study population was 58.1 ± 8.2 years, indicating that the disease largely affected the middle-aged to elderly population. There was a clear male predominance, with 22 males (64.7%) and 12 females (35.3%), yielding a male-to-female ratio of approximately 1.8:1, consistent with the known epidemiological trends of degenerative cervical myelopathy.

With respect to associated comorbidities, hypertension was the most frequently observed condition, present in 16 patients (47.1%), followed closely by diabetes mellitus in 14 patients (41.2%). Additionally, 12 patients (35.3%) had a history of smoking, which may have implications on both disease progression and postoperative recovery.

In terms of clinical presentation, pure myelopathy was the most common mode of presentation, seen in 14 patients (41.2%), highlighting the predominance of spinal cord involvement in this cohort. Radiculopathy alone was noted in 12 patients (35.3%), while a combination of radiculopathy with myelopathy (radiculomyelopathy) was observed in 8 patients (23.5%), indicating varying degrees of neural compression affecting both cord and nerve roots.

Radiologically, the disease was predominantly multilevel in nature, with a mean number of involved levels of 3.9 ± 0.7. The median number of laminectomized levels was 4, with a range from 3 to 5 levels, reflecting the extent of decompression required in these patients. On level-wise distribution, C5 was the most frequently decompressed level (35.3%), followed by C6 (32.4%), C4 (26.5%), C7 (17.6%), and C3 (14.7%), demonstrating a higher involvement of the mid-cervical segments.

The mean number of instrumented levels was 3.94 ± 0.7, which closely paralleled the number of decompressed segments, indicating that stabilization was performed across nearly all decompressed levels to maintain spinal alignment and prevent postoperative instability.

From a surgical standpoint, the mean operative duration was 113.4 ± 15.3 minutes, reflecting a relatively consistent operative time for multilevel procedures. The mean intraoperative blood loss was 384.6 ± 81.6 mL, which is within acceptable limits for such surgeries. Postoperatively, the mean duration of hospital stay was 6.17 ± 1.35 days, indicating a relatively smooth recovery period in most patients without prolonged hospitalization.

The mean modified Japanese Orthopaedic Association (mJOA) score improved from 9.58 ± 1.84 (95% CI: 8.94–10.22) preoperatively to 14.73 ± 1.46 (95% CI: 14.22–15.24) postoperatively, with a mean difference of 5.15 points. This improvement was found to be statistically highly significant ($p < 0.05$), indicating substantial neurological recovery following decompression and stabilization. Detailed comparison of preoperative and postoperative clinical and radiological parameters is presented in Table 2

*Table 2. Clinical, functional and radiological findings*

Similarly, the mean Visual Analog Scale (VAS) score for pain

| **Parameter** | **Preoperative (mean ± SD)** | **95% CI** | **Postoperative (mean ± SD)** | **95% CI** | **Mean Difference** | **p-value** |
|---|---|---|---|---|---|---|
| mJOA score | 9.58 ± 1.84 | 8.94–10.22 | 14.73 ± 1.46 | 14.22–15.24 | 5.15 | <0.05 |
| VAS score | 7.44 ± 1.05 | 7.07–7.81 | 1.94 ± 0.81 | 1.66–2.22 | 5.50 | <0.05 |
| Nurick grade | 2.64 ± 0.77 | 2.37–2.91 | 0.88 ± 0.84 | 0.59–1.17 | 1.76 | <0.05 |
| Cervical lordosis (°) | 10.2 ± 3.5 | 9.0–11.4 | 18.6 ± 4.2 | 17.1–20.1 | 8.40 | <0.05 |

demonstrated a marked reduction from 7.44 ± 1.05 (95% CI: 7.07–7.81) preoperatively to 1.94 ± 0.81 (95% CI: 1.66–2.22) postoperatively, with a mean decrease of 5.50 points. This reduction was highly significant ($p < 0.05$), reflecting excellent postoperative pain relief.

Functional disability, as assessed using the Nurick Grade, showed notable improvement. The mean Nurick grade decreased from 2.64 ± 0.77 (95% CI: 2.37–2.91) preoperatively to 0.88 ± 0.84 (95% CI: 0.59–1.17) postoperatively, with a mean difference of 1.76 grades. This change was also statistically significant ($p < 0.05$), indicating improved gait and functional independence in the majority of patients.

Radiological assessment revealed significant restoration of cervical alignment (Figure 2). The mean cervical lordosis angle improved from 10.2° ± 3.5° (95% CI: 9.0–11.4) preoperatively to 18.6° ± 4.2° (95% CI: 17.1–20.1) postoperatively, with a mean increase of 8.40°. This improvement was statistically significant ($p < 0.05$), demonstrating effective correction of sagittal alignment following posterior instrumentation.

*Figure 2: Postoperative cervical spine radiograph (AP and lateral views) demonstrating posterior lateral mass screw fixation following multilevel laminectomy.*

Neurological recovery was further evaluated using the Hirabayashi Recovery Rate. Based on recovery rate stratification, an excellent outcome (≥75%) was achieved in 41.2% of patients, while good recovery (50–74%) was observed in 35.3%. A fair outcome (25–49%) was noted in 17.6%, and only 5.9% of patients demonstrated poor recovery (<25%).
Overall, a favorable outcome (excellent + good recovery) was achieved in 76.5% of patients, indicating that the majority experienced substantial neurological improvement following surgery. This finding is consistent with the significant postoperative improvement observed in mJOA scores and supports the effectiveness of multilevel decompression with posterior instrumentation in achieving meaningful functional recovery.

*Table 3. Peri-operative complications*

| Complication | n (%) | 95% CI |
|---|---|---|
| Surgical site infection | 4 (11.8%) | 1% – 22.6% |
| Durotomy | 3 (8.8%) | 0% – 18.3% |
| Transient weakness | 3 (8.8%) | 0% – 18.3% |
| Neurological deficit | 2 (5.9%) | 0% – 13.8% |

Perioperative complications were observed in a subset of patients, with an overall acceptable incidence. Surgical site infection was the most common complication, occurring in 4 patients (11.8%; 95% CI: 1%–22.6%). Durotomy was encountered in 3 patients (8.8%; 95% CI: 0%–18.3%) and was managed intraoperatively without long-term sequelae. Transient postoperative weakness was observed in 3 patients (8.8%; 95% CI: 0%–18.3%), all of whom showed gradual recovery with conservative management. Persistent neurological deficit was noted in 2 patients (5.9%; 95% CI: 0%–13.8%), representing the most significant complication in this cohort (Table 3). Overall, the complication rates were within acceptable limits and comparable to previously reported literature.

Solid fusion was achieved in the majority of patients, observed in 32 out of 34 cases (94.1%; 95% CI: 86.2%–100%). Non-union was identified in 2 patients (5.9%; 95% CI: 0%–13.8%). Fusion outcomes are summarized in Table 4. These findings indicate a high rate of successful arthrodesis following posterior cervical laminectomy with instrumentation in the present study

*Table 4. Fusion outcome*

| Variables | n (%) | 95% CI |
|---|---|---|
| Fusion achieved | 32 (94.1%) | 86.2% – 100% |
| Non-union | 2 (5.9%) | 0% – 13.8% |

## DISCUSSION

The present study demonstrates that multilevel posterior cervical laminectomy with instrumentation is a clinically effective and reproducible surgical modality for the management of degenerative cervical myelopathy, resulting in significant improvements in neurological function, pain relief, and cervical sagittal alignment.

The mean improvement in mJOA score (5.15 points) observed in this study is consistent with previously reported outcomes. Similar improvements have been reported by Du et al.[7] and Singrakhia et al.[8], who demonstrated substantial neurological recovery following posterior decompression and stabilization. These findings highlight the effectiveness of posterior approaches in relieving spinal cord compression and improving neurological function.

The mechanism of neurological recovery is largely explained by the concept of posterior spinal cord drift, which allows indirect decompression of anterior compressive elements. This concept has been well supported by studies such as those by Fang et al.[4] and Liu et al.[5], as well as long-term outcome studies by Du et al.[7], all of which demonstrated significant neurological improvement following posterior decompression and fusion.
The significant reduction in VAS score in the present study reflects effective pain relief following surgical intervention. This is consistent with findings by Fang et al.[4], who attributed pain reduction to decompression of neural elements and stabilization of motion segments, thereby reducing abnormal micromotion and inflammatory processes.

Functional improvement, as demonstrated by the reduction in Nurick grade, indicates enhanced ambulatory capacity and improved quality of life. Similar findings have been reported in previous studies evaluating functional outcomes following posterior decompression[3,8].

A notable finding in this study is the significant improvement in cervical lordosis, with a mean increase of 8.40°. Restoration of sagittal alignment is a key determinant of postoperative outcomes. Studies by Du et al.[7] and Elkholy et al.[12] have demonstrated a strong correlation between improved cervical alignment and better functional outcomes. Furthermore,

Liu et al.[4] emphasized the importance of sagittal balance in predicting postoperative neurological recovery.

The fusion rate of 94.1% observed in this study is comparable to previously reported rates in the literature, including those by Du et al.[7] and Elkholy et al.[12], supporting the reliability of posterior instrumentation in achieving stable arthrodesis.

The overall favorable outcome rate of 76.5% in this study is slightly lower than the 95.3% reported by Du et al.[7] This discrepancy may be attributed to differences in patient characteristics, disease severity, and shorter follow-up duration in the present study. Nevertheless, the outcomes remain clinically meaningful and comparable to contemporary series. These findings are further supported by large multicenter studies such as that by Fehlings et al.[1] and Tetreault et al.[2], which demonstrated consistent neurological improvement following surgical management of cervical myelopathy across diverse patient populations.

The complication rates observed in this study were within acceptable limits and comparable to existing literature. Surgical site infection, durotomy, and transient neurological deficits were the most common complications, consistent with findings reported by Fang Z et al.[4] and Elkholy H et al.[12], who noted that such complications are generally manageable and do not significantly affect long-term outcomes. Transient neurological worsening is often attributed to cord manipulation or edema and typically shows gradual recovery. Importantly, no implant failure or mortality was observed, which aligns with studies such as Du et al.[7], supporting the safety and reliability of posterior cervical laminectomy with instrumentation.

In the present study, lateral mass screw fixation was utilized in all patients, and cervical pedicle screws were not employed. This is because the study population consisted of degenerative cervical spine disease without severe instability or fixed kyphotic deformity, where lateral mass fixation provides adequate stability and favorable clinical outcomes. Moreover, lateral mass screws are associated with a lower risk of neurovascular complications and are technically less demanding[7,12]. Given the satisfactory neurological recovery, restoration of cervical alignment, and high fusion rates observed, the use of pedicle screws was not deemed necessary in this cohort[5,12].

Despite these favorable outcomes, certain limitations must be acknowledged. The study is limited by its small sample size, single-center design, and relatively short follow-up duration, which precludes evaluation of long-term complications such as adjacent segment degeneration, implant failure, and sustained fusion outcomes. Additionally, the absence of a control group limits direct comparison with alternative surgical approaches such as laminoplasty or anterior decompression, although previous studies have demonstrated advantages of posterior instrumentation in maintaining sagittal alignment and stability. Although mJOA and Nurick scores are ordinal variables, they were analyzed as continuous variables for ease of statistical comparison, which may introduce potential bias. Multivariate regression analysis was not performed due to limited sample size, which may affect the ability to identify independent predictors.

The findings of this study reinforce the role of posterior decompression with instrumentation as a reliable strategy in real-world clinical settings, particularly in resource-limited environments. Future studies involving larger cohorts, multicenter participation, and long-term follow-up are required to further validate these findings and establish the long-term efficacy of this surgical technique.

## CONCLUSION

Multilevel cervical laminectomy with posterior instrumentation is a safe, effective, and reliable surgical option for the management of multilevel cervical degenerative disc disease.

The procedure provides significant neurological recovery, effective pain relief, improved functional outcomes, restoration and maintenance of cervical sagittal alignment. It is particularly well suited for patients with multilevel (3–5 level) disease, where wide decompression and stabilization are required. The high fusion rate and acceptable complication profile further support its use in routine clinical practice.
Posterior decompression with instrumentation remains a widely accepted and effective approach for multilevel cervical degenerative pathology, offering durable clinical and radiological outcomes.

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