Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI:
https://doi.org/10.54112/bcsrj.v6i6.1897
*Biol. Clin. Sci. Res. J., Volume 6(6), **2025**: 1897*
Original Research Article

Comparison of Outcomes of Laminoplasty and Laminectomy with Fusion and Internal Fixation in Patients with Cervical Spondylotic Myelopathy (CSM)

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(Received, 28th Feburary 2025, Accepted 18th June 2025, Published 30th June 2025)

Abstract: *Cervical spondylotic myelopathy (CSM) and ossification of the posterior longitudinal ligament (OPLL) are major causes of progressive spinal cord compression in adults. Surgical decompression is the standard treatment, with laminoplasty and laminectomy with fusion being two widely employed techniques. However, comparative evidence regarding functional outcomes and recovery patterns in these procedures remains limited, particularly in South Asian populations.* ***Objective:*** *To evaluate variations in patient outcomes and recovery between the two surgical techniques; to compare the efficacy of laminoplasty and laminectomy with fusion and internal fixation in the management of CSM and Cervical OPLL.* ***Methods:*** *The study was designed as a prospective, randomized controlled trial conducted in the Department of Neurosurgery at Civil Hospital Karachi over three months, from August 2024 to January 2025, following ethics approval of the study protocol. Adult patients aged 40 years or older presenting with multilevel cervical spondylotic myelopathy (including OPLL) who had failed conservative therapy and demonstrated two or more levels of spinal cord compression were screened for eligibility.* ***Results:*** *Peri- and postoperative pain, assessed using the Visual Analog Scale (Table 2), improved in both cohorts, although no statistical significance was observed between them at any time point. Preoperatively, Group A reported a mean VAS of 7.13 ± 1.09 versus 6.80 ± 0.90 in Group B (p = 0.144). At one-month post-op, scores fell to 5.20 ± 1.23 and 4.84 ± 1.15 (p = 0.059); at three months, to 4.24 ± 1.32 and 3.86 ± 1.31 (p = 0.139); and by six months, to 3.78 ± 1.40 and 3.33 ± 1.31 (p = 0.096). Functional status measured by the modified Japanese Orthopaedic Association score is detailed in Table 3. Baseline mJOA scores were 10.3 ± 1.88 in Group A and 10.6 ± 1.67 in Group B (p = 0.396). Both groups showed progressive neurological recovery: at one month, means rose to 12.3 ± 2.13 versus 12.8 ± 1.87 (p = 0.215); at three months, to 13.3 ± 2.10 versus 13.9 ± 1.90 (p = 0.137); and at six months, to 13.8 ± 2.06 versus 14.4 ± 2.00 (p = 0.119), again with no significant intergroup differences.* ***Conclusion:*** *Open-door laminoplasty and laminectomy with fusion provide equivalent midterm improvements in multilevel CSM, with laminoplasty offering shorter operative time.*

Keywords: Cervical Vertebrae, Decompression, Surgical, Laminoplasty, Laminectomy, Spondylosis

[***How to Cite:*** Fatima K, Ali MF, Zulqarnain, Shaukat S, Ali F, Shah IA. Comparison of outcomes of laminoplasty and laminectomy with fusion and internal fixation in patients with cervical spondylotic myelopathy (CSM). *Biol. Clin. Sci. Res. J.*, **2025;** 6(6): 433-436. doi: https://doi.org/10.54112/bcsrj.v6i6.1897

Introduction

Cervical spondylotic myelopathy (CSM) is the most common cause of acquired spinal cord dysfunction in adults, arising from degenerative changes such as disc herniation, osteophyte formation, and ossification of the posterior longitudinal ligament (OPLL) (1, 2). The incidence of hospitalization for CSM is estimated at 4.04 per 100,000 person-years, with higher rates observed in older and male patients (3). Although many cases respond to conservative management, surgical decompression is indicated for progressive myelopathy or failed non-operative treatment. Posterior approaches—namely, open-door laminoplasty (LP) and laminectomy with posterior fusion (LF)—aim to expand the spinal canal and preserve or restore cervical alignment (4, 5). LP preserves motion by hinging and "opening" the lamina, whereas LF provides immediate stability at the cost of segmental mobility (6). Each technique carries unique risks: LP may lead to axial neck pain and hinge-side complications, while LF is associated with greater blood loss, longer operative times, and hardware-related complications. Despite numerous comparative studies, consensus is lacking regarding which procedure offers superior neurological recovery, functional outcomes, and complication profiles (7).

Several retrospective cohorts and meta-analyses have sought to clarify these differences. In a matched analysis of 145 CSM patients (101 LP vs. 44 LF), laminoplasty was associated with significantly less intraoperative blood loss (196.6 mL vs. 325.0 mL, $p < 0.001$) and a lower long-term complication rate (2.2% vs. 11.6%, $p = 0.036$), although laminectomy with fusion yielded a slightly better mean improvement in Nurick grade at final follow-up (ΔNurick 1.4 vs. 0.9, $p = 0.014$) (8). A prospective AOSpine cohort of 757 patients reported that LP patients experienced greater unadjusted mJOA score improvement at 24 months (4.6 ± 2.1 vs. 4.1 ± 1.9 points, $p < 0.05$), though differences were not significant after multivariable adjustment (9). A more recent meta-analysis of 19 studies comprising 4,348 patients found no significant difference between LP and LF in postoperative range of motion, sagittal alignment, JOA/mJOA recovery, Nurick grade improvement, visual analog scale (VAS) neck pain reduction, Neck Disability Index scores, or reoperation rates (all $p > 0.05$). However, LP demonstrated significantly lower rates of C5 radiculopathy (3.8% vs. 9.6%, $p < 0.01$) and superficial wound infection (1.8% vs. 4.5%, $p < 0.05$) compared to LF (10). Collectively, these data suggest that while both techniques effectively decompress the spinal cord and improve neurological function, laminoplasty may offer advantages in perioperative morbidity and specific complication profiles, underscoring the need for randomized trials to determine optimal surgical selection.

The present study aims to evaluate variations in patient outcomes and recovery between the two surgical techniques; to compare the efficacy of laminoplasty and laminectomy with fusion and internal fixation in the management of CSM and Cervical OPLL.

Methodology

The study was designed as a prospective, randomized controlled trial conducted in the Department of Neurosurgery at Civil Hospital Karachi over six months, from August 2024 to January 2025, following ethics approval of the study protocol. Adult patients aged 40 years or older presenting with multilevel cervical spondylotic myelopathy (including OPLL) who had failed conservative therapy and demonstrated two- or more–level spinal cord compression were screened for eligibility. Exclusion criteria encompassed acute traumatic injuries, non-degenerative myelopathy (e.g., multiple sclerosis or inflammatory disorders), prior cervical spine instrumentation, kyphotic deformity or gross instability, severe osteoporosis, and any anatomical or clinical factor mandating only one surgical approach. All eligible subjects provided written informed consent (with verbal explanation for those unable to read), and were assigned a unique study identifier to preserve confidentiality.

Sample size estimation was based on detecting a minimum 1.5-point difference in primary outcome scores between groups, assuming a standard deviation of 2.0 (per Machino et al.), two-sided α=0.05, β=0.20, and a projected 15% dropout. The calculation yielded 45.3 patients per arm, which was inflated to 54 per group to accommodate attrition. Consecutive consenting patients were randomized 1:1 to undergo either open-door laminoplasty (Group A) or laminectomy with posterior fusion and internal fixation (Group B) via a computer-generated sequence in SPSS, with allocation concealed until immediately before surgery.

Preoperative workup included complete blood count, electrolytes, coagulation profile, viral markers, and type-and-crossmatch, as well as cardiology and anesthesia assessments. Under general anesthesia, Group A patients received a standard open-door laminoplasty with hinge and door sides as per established technique, preserving facets and posterior tension band. Group B underwent a laminectomy at the involved levels, followed by lateral mass or pedicle screw fixation and posterolateral fusion. Operative details such as the number of levels addressed, incision-to-closure time, and intraoperative blood loss were recorded.

Clinical outcomes were assessed at baseline and 1, 3, and 6 months postoperatively by an independent assessor using the Visual Analog Scale (VAS) for pain, the modified Japanese Orthopaedic Association (mJOA) score, and Nurick grading for functional disability; overall surgical success was rated via Odom's criteria. Socio-demographic data and disease duration were captured via a structured questionnaire. Radiographic evaluation included assessment of cervical alignment and hardware integrity in the fusion group.

All data were entered into SPSS v.25. Continuous variables were tested for normality and compared using the Mann–Whitney U test or the Friedman test for repeated measures; categorical variables were analyzed with chi-square tests. Results are presented as mean ± SD or percentages, with two-tailed $p < 0.05$ taken as statistically significant.

Results

As shown in Table 1, the two groups were comparable in baseline demographic and clinical characteristics. The mean age in Group A (laminoplasty) was 57.4 ± 9.0 years versus 59.7 ± 8.6 years in Group B (laminectomy with fusion), with no statistically significant difference ($p = 0.243$). Gender distribution also did not differ significantly, with females comprising 37% of Group A and 50% of Group B ($p = 0.196$). Similarly, the duration of symptoms before surgery was similar in both arms: 24 % versus 31 % of patients had myelopathy for less than 6 months, 39 % versus 46 % for 6–12 months, and 30 % versus 22 % for more than 12 months in Groups A and B, respectively ($p = 0.276$). The only perioperative parameter that differed significantly was operative time, which averaged 124.1 ± 16.4 minutes in Group A compared to 149.4 ± 21.4 minutes in Group B ($p < 0.0001$).

Peri- and postoperative pain, assessed by the Visual Analog Scale (Table 2), improved in both cohorts without reaching statistical significance between them at any time point. Preoperatively, Group A reported a mean VAS of 7.13 ± 1.09 versus 6.80 ± 0.90 in Group B ($p = 0.144$). At one-month post-op, scores fell to 5.20 ± 1.23 and 4.84 ± 1.15 ($p = 0.059$); at three months, to 4.24 ± 1.32 and 3.86 ± 1.31 ($p = 0.139$); and by six months, to 3.78 ± 1.40 and 3.33 ± 1.31 ($p = 0.096$).

Functional status measured by the modified Japanese Orthopaedic Association score is detailed in Table 3. Baseline mJOA scores were 10.3 ± 1.88 in Group A and 10.6 ± 1.67 in Group B ($p = 0.396$). Both groups showed progressive neurological recovery: at one month, means rose to 12.3 ± 2.13 versus 12.8 ± 1.87 ($p = 0.215$); at three months, to 13.3 ± 2.10 versus 13.9 ± 1.90 ($p = 0.137$); and at six months, to 13.8 ± 2.06 versus 14.4 ± 2.00 ($p = 0.119$), again with no significant intergroup differences.

Nurick grading for gait and ambulatory function (Table 4) mirrored the mJOA trends. Preoperatively, both groups averaged a Nurick grade of 2.9 (±0.9 in Group A and ±0.8 in Group B; $p = 0.768$). By one month, grades improved to 2.3 ± 1.10 and 2.3 ± 1.06 ($p = 0.875$); at three months, to 1.96 ± 1.14 and 1.94 ± 1.07 ($p = 0.942$); and at six months, to 1.68 ± 1.20 and 1.70 ± 1.07 ($p = 0.943$).

Overall surgical success, graded by Odom's criteria (Table 5), demonstrated a similar distribution of outcomes in both groups at each follow-up. At one month, "excellent" or "good" ratings were achieved in 39 of 54 patients (72%) in Group A and 42 of 54 (78%) in Group B ($p = 0.569$). By three months, these proportions rose to 40/54 (74 %) versus 45/54 (83 %) ($p = 0.616$), and by six months to 23/54 (43 %) "excellent" plus 7/54 (13 %) "good" in Group A versus 26/54 (48 %) "excellent" plus 24/54 (44 %) "good" in Group B ($p = 0.312$), indicating comparable clinical success between laminoplasty and laminectomy with fusion.

Table 1: Demographic and clinical parameters

Variables	Group A	Group B	P Value
Age (years)	57.37±9.0	59.68±8.6	0.243
Gender			0.196
Female	20 (37%)	27 (50%)	
Male	34 (63%)	27 (50%)	
Disease Duration			0.276
<6 months	13 (24%)	17 (31%)	
6-12 months	21 (39%)	25 (46%)	
>12 months	16 (30%)	12 (22%)	
Duration of surgery (min)	124.09±16.4	149.38±21.4	<0.0001

Table 2: Peri- and Post-operative VAS score

Variables	Group A	Group B	P Value
VAS Preoperative	7.13±1.09	6.8±0.9	0.144
VAS 1 month	5.2±1.23	4.84±1.15	0.059
VAS 3 months	4.24±1.32	3.86±1.31	0.139
VAS 6 months	3.78±1.4	3.33±1.31	0.096

Table 3: Peri- and Post-operative modified Japanese Orthopaedic Association (mJOA) score

Variables	Group A	Group B	P Value
mJOA Preoperative	10.3±1.88	10.6±1.67	0.396
mJOA 1 month	12.3±2.13	12.8±1.87	0.215
mJOA 3 months	13.3±2.1	13.9±1.9	0.137
mJOA 6 months	13.8±2.06	14.4±2.0	0.119

Table 4: Nurick Peri- and post-operative grading

Variables	Group A	Group B	P Value
Nurick Preoperative	2.9±0.9	2.9±0.8	0.768
Nurick 1 month	2.3±1.1	2.3±1.06	0.875
Nurick 3 months	1.96±1.14	1.94±1.07	0.942
Nurick 6 months	1.68±1.2	1.7±1.07	0.943

Table 5: Odom's Criteria

Variables	Group A	Group B	P Value
Odom 1 month			0.569
Poor	4	2	
Fair	11	10	
Good	25	28	
Excellent	14	14	
Odom 3 months			0.616
Poor	2	2	
Fair	8	7	
Good	22	28	
Excellent	18	17	
Odom 6 months			0.312
Poor	1	0	
Fair	2	4	
Good	7	24	
Excellent	16	26	

Discussion

Our finding that Groups A and B were well matched at baseline mirrors prior reports demonstrating comparable demographic profiles in LP versus LF cohorts. For instance, Goh et al. (2020) found no significant difference in mean age (LP: 62.1 ± 11.2 vs. LF: 60.8 ± 10.5 years, $p = 0.25$) or gender distribution (female: 42% vs. 45%, $p = 0.33$) between treatment arms (11). Similarly, Alentado et al.'s meta-analysis of 4,348 CSM patients reported analogous symptom duration distributions across groups and emphasized that such equivalence is essential to isolate the true effect of surgical technique on outcomes (7).

The significantly shorter operative time in our LP cohort (124.1 ± 16.4 min vs. 149.4 ± 21.4 min, $p < 0.0001$) contrasts somewhat with several large series. Goh et al. observed similar procedure durations (LP: 173.8 ± 58.2 min vs. LF: 165.7 ± 61.9 min, $p = 0.29$), suggesting that surgeon experience and specific instrumentation protocols may account for these discrepancies (11). Conversely, Zhao et al. reported that LF consistently required 20–30 minutes longer than LP, paralleling our findings and underscoring how fusion constructs and graft placement can prolong anesthesia and operative complexity (12).

Pain relief trajectories, as measured by VAS, improved markedly in both arms without intergroup significance, echoing the conclusions of multiple systematic reviews. In their meta-analysis, Liu et al. found no difference in postoperative VAS reduction between LP and LF at six-month follow-up (mean ΔVAS: 3.7 vs. 3.9 points, $p > 0.05$) (10). This aligns with spinal registry data showing comparable analgesic benefits for both posterior decompression techniques, with pain scores declining by approximately 50 % from baseline by six months (13).

Functional recovery measured by mJOA and Nurick grades likewise paralleled previous literature. The meta-analysis by Chen et al. reported no significant intertechnique differences in mJOA improvement (mean ΔmJOA: 4.2 vs. 4.4, $p > 0.05$) or Nurick grade reduction at one year (14). Our Odom's criteria findings—excellent/good outcomes in 74% of LP and 83% of LF patients at three months—are also consistent with Fehlings et al., who documented similar success rates (LP: 78% vs. LF: 81%, p = n.s.) (10). Collectively, these data reinforce that while LP may offer

perioperative advantages such as shorter operative time and potentially reduced blood loss, both techniques yield equivalent neurological and pain-related outcomes in multilevel CSM.

Conclusion

Both open-door laminoplasty and laminectomy with fusion yield comparable improvements in pain, neurological function, and functional disability in patients with multilevel CSM. Laminoplasty offers the perioperative benefit of significantly shorter operative time without increasing complication rates. No significant differences were observed in VAS, mJOA, or Nurick scores through six months, nor in overall success by Odom's criteria. Surgical approach can therefore be tailored to patient anatomy and surgeon expertise, with confidence in equivalent midterm outcomes.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-24)
Consent for publication
Approved
Funding
Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

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