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Anterior cervical discectomy and fusion versus open-door laminoplasty approach in the management of cervical spondylotic myelopathy

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Abstract

Background: Cervical Spondylotic Myelopathy is a progressive and degenerative condition usually managed using anterior cervical discectomy and fusion (ACDF) and open door laminoplasty. The study compared the short-term clinical and perioperative outcomes of these two procedures.

Methods: In this prospective comparative study, 60 patients who were managed at Menoufia University Hospitals from January 2025 to January 2026 were enrolled. 30 received ACDF and 30 received laminoplasty. The parameters studied were modified Japanese Orthopedic Association (mJOA), Short form 36 (SF-36), Neck disability index (NDI), visual analogue scale (VAS) for neck and arm pain, complications, radiological outcome, reoperations, and satisfaction rates at three and six months.

Results: Both groups exhibited a marked improvement in mJOA, SF-36, NDI, and VAS score during six months. Laminoplasty showed statistically significant improvement in all the five clinical parameters, where all the six-month comparison in favor of laminoplasty ($P<0.001$). Laminoplasty was characterized by higher blood loss, drain output, and hospitalization time, while ACDF showed higher operative time. Dysphagia was more common with ACDF patients at three months (26.7% versus 0%, $p = 0.005$).

Conclusions While both methods were effective, laminoplasty was associated with better short-term neurologic, functional, and pain outcomes, with increased operative risk. ACDF used fewer perioperative resources and was associated with more early dysphagia.

Introduction

Degenerative cervical myelopathy (DCM), also termed cervical spondylotic myelopathy (CSM), is an evolving neurologic condition due to degenerative stenosis of the cervical spine canal with spinal cord compression. It is one of the leading causes of spinal cord dysfunction in adults without trauma and often detected late because of gradual onset and misdiagnosis among neurological or musculoskeletal conditions [1–6]. It presents with gait disorder, clumsy hands, limb weakness, sensory dysfunction, radiculopathy, sphincter malfunction, and worsening disability.

Surgeries for degenerative spine condition include decompression, stabilization, diskectomy, and combination therapy. The choice of operation can be anterior or posterior depending on the type of pathology, its anatomical localization, spinal alignment, and surgical strategy [7, 8]. In DCM, decompression is a major therapeutic step to stop the process of neurological damage and ensure the recovery. Anterior cervical discectomy and fusion (ACDF) allows direct decompression of anterior pathology, disc height restoration, foraminal decompression, and stabilization by means of interbody fusion and anterior instrumentation. ACDF is widely used in ventral compression, disc-level disease, radiculopathy, and short-segment pathology. But ACDF could be complicated by such problems as dysphagia, pseudarthrosis, adjacent segment degeneration, and increasing morbidity in multilevel fusion [9–15].

Laminoplasty is a posterior dynamic decompressive procedure, which is most often used for multilevel CSM in patients with preserved cervical lordosis and without instability. It achieves expansion of the spinal canal and avoids long-segment fusion [16–19]. Nevertheless, laminoplasty could be complicated by postoperative neck pain, wound complications, recurrence of stenosis, and loss of lordosis [20–25].

The purpose of the present study was to compare ACDF and open-door laminoplasty in patients with CSM, who underwent operation in Menoufia University Hospitals; it included the assessment of neurological recovery, quality of life, pain, disability, complications, reoperation, and patient satisfaction.

Materials & Methods

Study design and setting

A prospective comparative longitudinal study design was adopted at the Neurosurgery Department, Menoufia University Hospitals, Faculty of Medicine, Menoufia University, Egypt. The study was conducted from January 2025 to January 2026. A longitudinal follow-up design was employed for studying the post-operative recovery process [26].

Study population

The study involved 60 patients with either cervical myelopathy or myeloradiculopathy who met the inclusion criteria and underwent ACDF (n = 30) or open-door laminoplasty (n = 30) in 1 year.

Inclusion criteria

Patients were selected if they were suffering from either cervical myelopathy or myeloradiculopathy, which is due to either one of the following causes: cervical spondylosis, congenital cervical stenosis, or multilevel disc herniation.

Exclusion criteria

Patients with inflammatory arthritis, ankylosing spondylitis, rheumatoid arthritis, dynamic instability, or previous cervical radiation were excluded from the study.

Preoperative assessment

All patients had comprehensive history-taking, physical examination, neurological examination, laboratory evaluation, and radiological assessment. Neurological examination consisted of motor strength, sensory, reflexes, and autonomic involvement. Radiological examination involved cervical magnetic resonance imaging, cervical computed tomography, and plain cervical radiology as needed.

Clinical outcomes were evaluated using the mJOA [28] for neurological function, SF-36 [29, 30] for health-related quality of life, NDI [31, 32] for neck-related disability, and VAS [33] for neck and arm pain.

Surgical decision-making

The procedure was determined by clinical and radiological factors, which included level involvement, location and direction of the compression, cervical sagittal balance, radiculopathy, axial pain in the neck, presence of comorbidities, and surgeon's assessment. ACDF surgery was considered in cases of anterior disc-level compression and shorter-segment disease. The laminoplasty procedure was used in cases of multilevel stenosis with preserved cervical sagittal alignment.

ACDF technique

For the patients who underwent ACDF procedure, the positioning was done supine with the neck kept in its normal lordotic position without causing any excessive extension. The incision chosen was transverse anterior cervical incision. The level of the target disc was checked fluoroscopically. The procedures carried out were discectomy, decompression, osteophyte removal, endplate preparation, interbody cage placement, and anterior plating fixation using cage or plate. Hemostasis was achieved and layered closure was done [34].

Open-door laminoplasty technique

The positioning for patients who underwent laminoplasty was prone with neutral or slightly flexed cervical alignment. Posterior midline approach was chosen. Lamina exposure was done preserving posterior muscle attachments. The trough was made in the lamina-lateral mass joint. The contralateral hinge was thinned preserving ventral cortex of lamina. The laminar arch was opened serially and was fixed [23–25, 27, 35–39].

Follow-up and outcomes

Patients were followed up after 3 and 6 months post-surgery. The follow-up outcomes included mJOA, SF-36, NDI, VAS neck pain, VAS arm pain, fusion/alignment, dysphagia, recurrent stenosis, re-operation and patient satisfaction.

Statistical analysis

Continuous variables were reported as mean ± standard deviation whereas categorical variables were reported as frequency and percentages. For between group comparison of continuous variables, independent samples t-test, assuming unequal variances was conducted. Paired samples t-test was done for within group change over time. Fisher exact test for 2 x 2 tables and Chi-square test for multi

category variable were done for the between group comparison of categorical variables. Two-tailed test were used for significance testing at level of $P < 0.05$. No multivariate modeling was done.

Ethical considerations

Approval of the protocol was taken from the Institutional Review Board of the Faculty of Medicine, Menoufia University and approval from Neurosurgery Department (approval no. 2/2025 NEUS 5 – 1). Written informed consent was taken from all the patients. No external funding was received.

Results

There were 60 participants in the study; 30 had ACDF surgery, while 30 had laminoplasty surgery. Generally, there was no significant difference between these two groups regarding their baseline characteristics. The average age of those in the ACDF group was 63.26 ± 4.55 years, whereas it was 64.54 ± 4.43 years for the laminoplasty group ($p = 0.274$). The percent of males among those in ACDF and laminoplasty groups was 43.3% and 50.0%, respectively ($p = 0.796$). The between-groups difference in BMI, smoking, diabetes mellitus, hypertension, duration of symptoms, or sphincter affection was not significant as well (all $p > 0.05$) (Table 1).

Neurological disability, quality of life, and pain scores means at baseline were also equal with no statistically significant difference. The preoperative mJOA score was 10.37 ± 1.11 and 10.12 ± 1.45 for the ACDF and laminoplasty groups, respectively ($p = 0.457$). SF-36 was 43.23 ± 7.30 versus 43.53 ± 6.53 ($p = 0.867$), NDI was 59.46 ± 7.57 versus 59.91 ± 7.37 ($p = 0.816$), VAS neck pain was 7.69 ± 0.96 versus 7.42 ± 1.04 ($p = 0.300$), and VAS arm pain was 6.91 ± 0.94 versus 6.61 ± 0.99 ($p = 0.234$).

Table 1
Baseline demographic and clinical characteristics

Variable	ACDF, n = 30	Laminoplasty, n = 30	p value
Age, years	63.26 ± 4.55	64.54 ± 4.43	0.274
BMI, kg/m²	29.25 ± 3.01	28.93 ± 3.76	0.717
Symptom duration, months	12.41 ± 4.14	11.92 ± 4.68	0.669
mJOA score	10.37 ± 1.11	10.12 ± 1.45	0.457
SF-36 score	43.23 ± 7.30	43.53 ± 6.53	0.867
NDI score	59.46 ± 7.57	59.91 ± 7.37	0.816
VAS neck pain	7.69 ± 0.96	7.42 ± 1.04	0.300
VAS arm pain	6.91 ± 0.94	6.61 ± 0.99	0.234
Male sex	13 (43.3%)	15 (50.0%)	0.796
Smoking	15 (50.0%)	10 (33.3%)	0.295
Diabetes mellitus	7 (23.3%)	8 (26.7%)	1.000
Hypertension	8 (26.7%)	13 (43.3%)	0.279
Sphincter affection	6 (20.0%)	5 (16.7%)	1.000

The mean operative time was higher in the ACDF group (3.82 ± 1.16 h) compared to the laminoplasty group (3.30 ± 0.32 h; p = 0.024). On the contrary, laminoplasty resulted in greater mean blood loss (403.65 ± 77.52 vs. 175.00 ± 58.57 ml; p < 0.001), higher drainage output (267.69 ± 108.57 vs. 58.70 ± 20.78 ml; p < 0.001), and longer mean hospital stay (5.31 ± 1.01 vs. 2.30 ± 0.78 days; p < 0.001). Dural tear occurred in 2 laminoplasty patients (6.7%) and no ACDF patients (p = 0.492; Table 2).

Table 2
Operative and early postoperative data

Variable	ACDF, n = 30	Laminoplasty, n = 30	p value
Operative time, hours	3.82 ± 1.16	3.30 ± 0.32	0.024
Blood loss, ml	175.00 ± 58.57	403.65 ± 77.52	< 0.001
Drain output, ml	58.70 ± 20.78	267.69 ± 108.57	< 0.001
Hospital stay, days	2.30 ± 0.78	5.31 ± 1.01	< 0.001
Dural injury	0 (0.0%)	2 (6.7%)	0.492

At 3 months, there was marked improvement from baseline in mJOA, SF-36, NDI, VAS neck pain, and VAS arm pain (all within-group p < 0.001) as seen in Table 3. For the ACDF group, the mean value of

mJOA improved from 10.37 ± 1.11 to 13.11 ± 1.12, SF-36 from 43.23 ± 7.30 to 64.37 ± 8.63, and NDI from 59.46 ± 7.57 to 36.43 ± 9.16. The mean VAS neck pain score decreased from 7.69 ± 0.96 to 3.60 ± 1.09, while that of VAS arm pain decreased from 6.91 ± 0.94 to 3.21 ± 0.98.

For the laminoplasty group, the mean value of mJOA improved from 10.12 ± 1.45 to 13.96 ± 1.46, SF-36 from 43.53 ± 6.53 to 71.14 ± 7.99, and NDI decreased from 59.91 ± 7.37 to 30.75 ± 7.70. The mean VAS neck pain decreased from 7.42 ± 1.04 to 2.53 ± 0.88, while VAS arm pain decreased from 6.61 ± 0.99 to 2.08 ± 0.94. At 3 months, laminoplasty had significantly better mean mJOA ($p = 0.014$), SF-36 ($p = 0.003$), NDI ($p = 0.012$), neck VAS ($p < 0.001$), and arm VAS ($p < 0.001$), with significantly greater improvement from baseline for all five outcomes.

At 3 months, early fusion was observed in all 30 ACDF cases. Maintenance of alignment was noted in 28 of 30 laminoplasty patients, whereas early loss of lordosis was noted in 2 patients. Dysphagia was noted in 8 ACDF cases (26.7%) and 0 laminoplasty cases ($p = 0.005$). Re-operation was noted in 1 ACDF case and 3 laminoplasty cases ($p = 0.612$). Recurrent stenosis was noted in 3 laminoplasty cases and 0 ACDF cases ($p = 0.237$).

Table 3
Clinical outcomes at 3 months

Outcome	ACDF baseline	ACDF 3 months	LP baseline	LP 3 months	p at 3 months	p for change
mJOA	10.37 ± 1.11	13.11 ± 1.12	10.12 ± 1.45	13.96 ± 1.46	0.014	< 0.001
SF-36	43.23 ± 7.30	64.37 ± 8.63	43.53 ± 6.53	71.14 ± 7.99	0.003	< 0.001
NDI	59.46 ± 7.57	36.43 ± 9.16	59.91 ± 7.37	30.75 ± 7.70	0.012	< 0.001
VAS neck	7.69 ± 0.96	3.60 ± 1.09	7.42 ± 1.04	2.53 ± 0.88	< 0.001	< 0.001
VAS arm	6.91 ± 0.94	3.21 ± 0.98	6.61 ± 0.99	2.08 ± 0.94	< 0.001	< 0.001

Both groups showed further progress from 3 to 6 months, and there was significant improvement in each one of the five clinical outcomes ($p < 0.001$ for all). In the ACDF group, the mean mJOA score was 13.85 ± 1.17, the SF-36 score was 72.50 ± 8.76, the NDI score was 26.18 ± 9.23, the VAS neck pain was 2.75 ± 0.97, and VAS arm pain 2.27 ± 1.01 as demonstrated in (Table 4). For the laminoplasty group, the mean scores were 15.27 ± 1.46 for mJOA, 81.72 ± 7.90 for SF-36, 17.33 ± 8.04 for NDI, 1.50 ± 0.90 for VAS Neck pain and 1.05 ± 0.77 for VAS Arm Pain. The results at 6 months favored the laminoplasty group on all five scores (mJOA, SF-36, NDI, Neck pain and Arm pain; all $p < 0.001$).

Table 4
Six-month clinical outcomes and change from baseline

Outcome	ACDF 6 months	ACDF change	LP 6 months	LP change	p at 6 months	p for change
mJOA	13.85 ± 1.17	3.48 ± 0.89	15.27 ± 1.46	5.15 ± 0.67	< 0.001	< 0.001
SF-36	72.50 ± 8.76	29.26 ± 4.78	81.72 ± 7.90	38.20 ± 3.19	< 0.001	< 0.001
NDI	26.18 ± 9.23	-33.28 ± 3.60	17.33 ± 8.04	-42.58 ± 4.87	< 0.001	< 0.001
VAS neck	2.75 ± 0.97	-4.94 ± 0.82	1.50 ± 0.90	-5.92 ± 0.89	< 0.001	< 0.001
VAS arm	2.27 ± 1.01	-4.65 ± 0.84	1.05 ± 0.77	-5.57 ± 0.88	< 0.001	< 0.001

In the ACDF group, 30 out of 30 cases were fused at 6 months. In the laminoplasty group, 26 cases maintained their alignment while lordosis was lost in 4 (13.3%); p = 0.112 versus ACDF. Dysphagia occurred in only 1 ACDF case (3.3%) while no dysphagia was reported in the laminoplasty group (p = 1.000). Re-operation continued to be observed in 1 ACDF patient and 3 laminoplasty patients (p = 0.612), as well as recurrent stenosis in 3 laminoplasty patients (p = 0.237; Table 5).

There were significant differences in patient satisfaction between the two groups at both time points. At the 3-month mark, there were 11 excellent, 9 good, 9 fair, and 1 poor responses from the ACDF group, while the laminoplasty group had 14 excellent, 14 good, 1 fair, and 1 poor responses (overall p = 0.031). At the 6-month point, the ACDF group had 11 excellent, 12 good, 6 fair, and 1 poor responses, while the laminoplasty group had 20 excellent and 10 good responses (overall p = 0.010).

Table 5
Radiological outcome, complications, and satisfaction at 3 and 6 months

Variable	ACDF 3 months	LP 3 months	p value	ACDF 6 months	LP 6 months	p value
Fusion/alignment status	30 early fusion	28 maintained; 2 early loss of lordosis	NA	30 fused	26 maintained; 4 loss of lordosis	NA
Loss of lordosis	0 (0.0%)	2 (6.7%)	0.492	0 (0.0%)	4 (13.3%)	0.112
Dysphagia	8 (26.7%)	0 (0.0%)	0.005	1 (3.3%)	0 (0.0%)	1.000
Reoperation	1 (3.3%)	3 (10.0%)	0.612	1 (3.3%)	3 (10.0%)	0.612
Recurrent stenosis	0 (0.0%)	3 (10.0%)	0.237	0 (0.0%)	3 (10.0%)	0.237
Satisfaction distribution	Excellent 11 (36.7%); Good 9 (30.0%); Fair 9 (30.0%); Poor 1 (3.3%)	Excellent 14 (46.7%); Good 14 (46.7%); Fair 1 (3.3%); Poor 1 (3.3%)	0.031	Excellent 11 (36.7%); Good 12 (40.0%); Fair 6 (20.0%); Poor 1 (3.3%)	Excellent 20 (66.7%); Good 10 (33.3%); Fair 0 (0.0%); Poor 0 (0.0%)	0.010

Discussion

The present prospective comparative study showed that there is substantial neurological and functional improvement with both ACDF and laminoplasty over a 6-month period. The main finding of this study was that while both methods had their own pattern of morbidity, laminoplasty had a substantially greater improvement in all the parameters of mJOA, SF-36, NDI, neck pain, and arm pain. As the baseline demographic and clinical variables were comparable, postoperative differences became more noticeable.

ACDF was found to produce significant improvement in all outcomes. mJOA improved from 10.37 before the surgery to 13.11 in 3 months and 13.85 in 6 months. Moreover, SF-36 improved from 43.23 before the surgery to 64.37 and 72.50 respectively. NDI, neck VAS, and arm VAS decreased significantly in this period of time. These results proved the effectiveness of the ACDF technique in terms of neurological decompression and functional improvement and corresponded to its known application for ventral decompression, foraminal decompression, disc space restoration, and stabilization [9–15].

The laminoplasty group displayed even more pronounced clinical improvements. The mean mJOA score rose from 10.12 pre-operatively to 13.96 at three months and 15.27 at six months; the SF-36 score from 43.53 to 71.14 and then 81.72. Neck disability index (NDI), neck pain, and arm pain were also significantly better. In comparison to ACDF, at the three month follow-up point, the laminoplasty group performed significantly better for mJOA ($p = 0.014$), SF-36 ($p = 0.003$), NDI ($p = 0.012$), neck visual

analogue scale (VAS) ($p < 0.001$), and arm VAS ($p < 0.001$). All five outcome measures showed statistically significant superiority for laminoplasty at six months (all $p < 0.001$), while change from baseline was also superior for laminoplasty. These data clearly indicate the efficacy of laminoplasty as a motion-preserving technique for decompression surgery in selected cases [16–18, 25].

The differences in outcomes between groups were consistently increasing throughout the follow-up. Mean mJOA changes from baseline to 6 months were 3.48 ± 0.89 for ACDF and 5.15 ± 0.67 for laminoplasty ($p < 0.001$). Also, improvement in SF-36 as well as decreases in NDI, neck VAS, and arm VAS were more pronounced after laminoplasty (all $p < 0.001$). Consistency of results between neurological function, disability, QoL, and pain suggests that these findings reflect clinically meaningful advantage in a wide range of outcomes rather than improvement of any specific measurement.

Satisfaction of patients followed the same clinical course. There were significant differences in distribution of satisfaction at 3 months ($p = 0.031$) and 6 months ($p = 0.010$). At 6 months, 66.7% of patients who had laminoplasty were highly satisfied as compared to 36.7% patients with ACDF. This high satisfaction in laminoplasty patients corresponds to the significantly higher improvement in mJOA, SF-36, NDI, and pain scores.

The complication pattern was clearly dependent on the surgical approach used. Dysphagia was found to occur significantly more frequently following ACDF at 3 months (26.7% vs 0% following laminoplasty; $p = 0.005$), and decreased to one patient (3.3%) in the ACDF group at 6 months, with no cases in the laminoplasty group at either follow-up. Preventive measures for neurological complications after laminoplasty have been described [22, 37]. Loss of lordosis was seen only in patients who underwent laminoplasty, from 2 cases at 3 months to 4 cases at 6 months, underscoring the significance of sagittal balance in laminoplasty results [20, 21, 25].

The peri-operative results also revealed significant differences between the two groups. ACDF surgery took significantly more time compared to laminoplasty surgery (mean operative time – 3.82 ± 1.16 vs 3.30 ± 0.32 hours; $p = 0.024$). Nevertheless, laminoplasty surgery was associated with significantly increased blood loss ($p < 0.001$), greater drain output ($p < 0.001$), and significantly extended hospital stay ($p < 0.001$). The results imply that despite the better functional outcomes attained via laminoplasty surgery, increased utilization of resources and complications of the posterior approach were incurred.

Collectively, the findings highlight a clinically relevant trade-off between the two techniques. ACDF yielded substantial neurological and functional gains along with less blood loss, drain volume, and postoperative stay, but increased the likelihood of early dysphagia. Laminoplasty yielded substantially greater gains in neurological function, quality of life, disability, pain, and patient satisfaction but had a larger burden. As such, the selection of the appropriate technique needs to be based on an individualized assessment of compression site, compression degree, sagittal balance, required extent of decompression, and potential morbidity of each approach.

Conclusions

Both ACDF and open-door laminoplasty produced significant improvements in terms of the patients' clinical status after 6 months. Laminoplasty produced better neurological and functional gains, but it also had a higher perioperative morbidity, while ACDF was less burdening but caused more cases of dysphagia. Therefore, the approach chosen should depend on clinical benefits and morbidity of the procedure.

Limitations

Limitations include a small number of patients, non-random allocation to the groups, and 6 months of follow-up. This does not change the significance of the results obtained in the current study but does require further validation in larger groups over extended periods of time.

Abbreviations

ACDF
anterior cervical discectomy and fusion
ASD
adjacent segment disease
CSM
cervical spondylotic myelopathy
LP
laminoplasty
mJOA
modified Japanese Orthopaedic Association
NDI
Neck Disability Index
OPLL
ossification of the posterior longitudinal ligament
SF-36
Short Form-36
VAS
visual analogue scale
QOL
Quality of life

Declarations

Ethics Approval:

This study was performed in accordance with the ethical principles of the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of the Faculty of Medicine, Menoufia University,

Egypt in February 2025 (approval no. 2/2025 NEUS 5 – 1). [40]

Consent to Participate:

Written informed consent was obtained from all participants before enrollment in the study.

Clinical Trial Number

Not applicable.

Consent for publication:

Not applicable because no identifiable patient data are included.

Competing interests:

The authors declare that they have no competing interests.

Disclosure:

The authors state that NO patients in the present laminoplasty cohort overlap with the cohort in Alemam et al. (2026), cited as [27].

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Author Contribution

Authors' contributions: SE and HE designed and supervised the study. AFS,MAS contributed to surgical management and supervision. MD,ATS contributed to patient recruitment, follow-up, and data collection. MAS contributed to data organization, literature review, and manuscript drafting. All authors reviewed and approved the final manuscript.

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Availability of data and materials:

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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