Original Article

Treatment strategies for cervical spondylotic myelopathy—is laminectomy alone a safe and effective option?

Connor A. Wathen[1], Arun T. Jacob[1,2], Dominique Bohorquez[1,3], Carthi Mannikarottu[1], Paul Marcotte[1]

[1]Department of Neurosurgery, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, USA; [2]Northeast Georgia Physician's Group, Gainesville, GA, USA; [3]Department of Otolaryngology-Head and Neck Surgery, University of Miami, Miami, FL, USA

Contributions: (I) Conception and design: CA Wathen, AT Jacob, P Marcotte; (II) Administrative support: None; (III) Provision of study materials or patients: None; (IV) Collection and assembly of data: CA Wathen, AT Jacob, D Bohorquez, C Mannikarottu; (V) Data analysis and interpretation: CA Wathen, AT Jacob, D Bohorquez, C Mannikarottu; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Connor A. Wathen, MD. Department of Neurosurgery, Perelman School of Medicine, University of Pennsylvania, 801 Spruce St, Philadelphia, PA 19107, USA. Email: wathenc@pennmedicine.upenn.edu.

Background: Cervical laminectomy may be underutilized in the treatment of cervical spondylotic myelopathy (CSM) due to concerns regarding potential for post-operative instability and/or kyphosis. The purpose of this retrospective, observational study is to assess the short-term clinical and radiological outcomes as well as complications associated with a group of carefully selected patients who underwent laminectomy alone for CSM and compared them to a cohort of patients who underwent laminectomy with fusion.

Methods: Patients with CSM were identified via review of a single surgeon's cases. All patients underwent preoperative clinical evaluation, lateral flexion-extension cervical radiographs, and documentation of neck and/or extremity pain via Nurick Scale and modified Japanese Orthopedic Association (JOA) scores. Postoperative follow-up occurred at 1, 3 and 6 months for all patients. Statistical analysis was performed via Student's *t*-test for parametric values and Wilcoxon (Mann-Whitney) rank sum test for ordinal scores. Multivariable linear regression was used to correct for co-variance.

Results: Forty-one patients who underwent laminectomy alone and 13 patients who underwent laminectomy with fusion were identified who met inclusion criteria. Both groups demonstrated significant improvement on Nurick and JOA scores postoperatively. Two patients in the laminectomy alone group required a subsequent one-level anterior cervical discectomy and fusion for onset of postoperative neck pain, without neurological symptoms or new deficits in the follow up period. There was no difference in rates of post-operative kyphosis between the groups.

Conclusions: In appropriately selected patients without pre-operative kyphosis or abnormal motion on flexion-extension films, cervical laminectomy remains a safe and effective treatment option.

Keywords: Cervical spondylotic myelopathy (CSM); cervical laminectomy; cervical fusion

Submitted Dec 28, 2022. Accepted for publication May 31, 2024. Published online Jul 22, 2024.
doi: 10.21037/jss-22-118
View this article at: https://dx.doi.org/10.21037/jss-22-118

Introduction

Cervical spondylosis is an age-related process of deterioration of the articular surfaces of the cervical spinal joints. While the majority of patients with cervical spondylosis are asymptomatic (1), symptomatic patients can present with loss of range of motion, axial or radicular pain, or neurological deficit involving radiculopathy and/or myelopathy. Cervical spondylotic myelopathy (CSM) is a major cause of disability among older persons and the most common cause of nontraumatic spinal cord dysfunction (2).

Nonoperative treatment options are available for pain and loss of range of motion for patients with cervical spondylosis

resulting in mild myelopathic symptoms (3). However, in the presence of significant or persistent neurological deficits, surgery is generally the treatment of choice (4). Surgical options that exist for the treatment of cervical myelopathy include laminectomy, laminectomy with fusion, and laminoplasty and anterior approaches the radiographic criteria utilized included (5). All these options are associated with unique risk profiles and complications (6). Cervical laminectomy, except in the presence of severe kyphosis or severe anterior spinal cord compression, is quite effective for accomplishing spinal cord decompression without impairing the range of motion of the cervical spine. With laminectomy alone, there is a theoretical concern of destabilizing the spine which could predispose to kyphotic deformity, recurrent neurological deficits, and/or axial neck pain (7,8). Correspondingly, the presence of significant neck pain, preoperative cervical kyphosis, or overt instability, are all clear indications for fusion (9-11). There is increased operative risks associated with the addition of fusion to laminectomy (12,13), including the possibility of a pseudoarthrosis or adjacent level deterioration (14). In addition to the risks associated with fusion, patients are left with an impairment in range of motion of their cervical spine which can be significant, especially following a multilevel procedure (15,16). In the absence of a clear indication for fusion, the clinical outcomes and short-term complication rate of decompression alone should be comparable to a decompression with fusion. Nevertheless, there has been an increasing trend away from the use of laminectomy alone towards the use of fusion procedures for the treatment of myelopathy in recent years (17).

In this paper, we analyze clinical and radiological outcomes following laminectomy alone and laminectomy with fusion for CSM. The purpose of the study is to assess the short-term results and complications associated with a group of carefully selected patients who underwent laminectomy alone for CSM and compared them to a cohort of patients who underwent laminectomy with fusion. We present this article in accordance with the STROBE reporting checklist (available at https://jss.amegroups.com/article/view/10.21037/jss-22-118/rc).

Highlight box

Key findings

- In appropriately selected patients, cervical laminectomy alone remains a safe and effective treatment for cervical spondylitic myelopathy.

What is known and what is new?

- Cervical spondylitic myelopathy is an increasingly common, major source of disability.
- Cervical laminectomy with fusion has supplanted laminectomy alone as the preferred treatment due to concerns for post-operative instability, kyphosis, and possible subsequent neurological deficits.

What is the implication, and what should change now?

- Cervical laminectomy without fusion provides a cost-effective treatment option and can be utilized in the treatment of cervical spondylotic myelopathy (CSM) in patients without preoperative kyphosis or instability on baseline flexion-extension radiographs.

Methods

This study is a retrospective, observational study evaluating outcomes of patients operated upon for CSM. All patients were operated upon by the senior author. Data were obtained by review of patient records over a 6-year interval. Patients included in the analysis presented with symptomatic spondylotic myelopathy, confirmed stenosis by MRI, and all had spinal cord compression at 2 or more levels. All patients underwent preoperative clinical evaluation, lateral flexion-extension cervical radiographs, and documentation of neck and extremity pain (on a 1–5 scale with 1 being no pain, 2 mild pain, 3 moderate pain, 4 severe pain, and 5 intolerable pain), and Nurick Scale and modified Japanese Orthopedic Association (JOA) scores.

The surgical approach was based on clinical and neuroimaging criteria with cervical arthrodesis reserved for patients with neck pain, defined as a score of 4 or more, kyphosis or excessive motion on preoperative flexion and extension radiographs. Laminectomy alone was performed in patients in whom neck pain was limited (3 or less), the degree of motion was not excessive, and the alignment normal or straightened. The radiographic criteria included: The absence of radiographic instability based on trial criteria in the absence of an anterior translation more than 3 mm on flexion and extension views. Kyphosis was determined by observation of the sagittal curvature of the spine in the neutral position. The spine was considered kyphotic if the curvature of the spine in the neutral position was forward flexed beyond straight and/or if there was exaggerated kyphotic configuration upon flexion. It was not considered necessary to measure Cobb angles to determine if the spine sagittal configuration was beyond straight.

We have focused on certain technical details of the

laminectomy procedure that may contribute to decrease the likelihood of inducing instability with decompression alone. The muscle dissection was limited laterally to the junction of the lamina and facet joints to minimize the trauma to the muscles, facet joint capsules, and segmental nerves innervating the paraspinal musculature. In addition, dissection of tendons and muscles from the posterior elements of C2 was limited to the greatest extent possible.

Postoperative follow-up occurred at 1, 3 and 6 months for all patients and some had longer follow-up as needed. Each follow-up assessment included a clinical examination, documentation of neck and extremity pain, Nurick scale, and JOA evaluations in addition to plain radiographs. Patients were also asked to assess their general clinical condition on a scale from 1–4 (1 being worse than pre-op, 2 stable, 3 improved, and 4 dramatically improved). Flexion and extension views were repeated on patients who underwent laminectomy without fusion. Surgical complications were recorded including superficial wound infection, deep wound infection, cerebral spinal fluid leak, post-operative neurologic deterioration, reoperation, and medical complications (including pneumonia, urinary tract infection, and thrombotic complications).

Statistical analysis

Statistical analysis was performed via Student's *t*-test for parametric values, chi-square test for categorical variables, and Wilcoxon (Mann-Whitney) rank sum test for ordinal scores. Multi-variable linear regression was used to correct for co-variance. All statistical analysis used SPSS v. 28 (IBM).

Ethics

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was deemed minimal risk and exempt by the University of Pennsylvania Institutional Review Board (IRB) given its retrospective nature, lack of patient contact, and anonymization of data. Accordingly, individual consent for this retrospective analysis was also waived.

Results

Forty-one patients with CSM underwent cervical laminectomy alone and 13 had laminectomy with fusion. *Figures 1*,*2* show representative films of patients with long-term follow-up following laminectomy alone. The mean age was 64.7 and 64.6 years at the time of surgery for laminectomy alone and laminectomy with fusion, respectively. The mean duration of preoperative symptoms was 27.4 months in the laminectomy alone group and 19.5 months for the fusion group. Seventy percent of patients in both groups had associated co-morbidities. Spinal cord signal abnormality consistent with the presence of myelomalacia was seen in 34% and 54% of the patients, respectively. 75% of the patients in the fusion group had evidence of kyphosis on the preoperative X-rays. The only statistically significant preoperative difference between the 2 groups was the incidence of kyphosis or straightening and excessive neck motion on preoperative films, which formed the basis of the surgical decision-making regarding laminectomy with or without fusion (*Table 1*). The significantly greater incidence of postoperative kyphosis in the fusion patients is a product of the selection criteria. Its significance disappears (P=0.99) when corrected for the presence of preoperative kyphosis.

The mean follow-up was 10.3 months for the laminectomy group and 7.7 months for the fusion group. Postoperative findings are compared in *Table 2*. All patients had an arrest of myelopathy progression as assessed by postoperative neurologic function with no patients demonstrating a decline in Nurick or modified JOA scores as shown in *Figure 3*. Both groups showed significant improvement in postoperative Nurick and modified JOA scores with no significant differences between groups. The general clinical condition of the patients also showed improvement in both groups compared to the preoperative baseline.

No patients in the laminectomy group experienced delayed neurologic deficit during the follow-up period. The incidence of cervical instability was 3% among the patients who underwent a laminectomy alone. In this series, only 2 patients in the laminectomy group required a subsequent intervention in the follow-up period to correct symptomatic segmental instability, without neurological symptoms or new deficits, resulting from the index procedure. These two patients each required a 1 level anterior discectomy and fusion to stabilize a subluxation presenting with neck pain, following the laminectomy. The patients did not require multilevel fusions for the symptoms and imaging findings. Two patients in the laminectomy group required re-operation for deep wound infections. There were 2 superficial wound infections treated with wound care and antibiotics alone, but these did non necessitate re-operation. No other surgical complications were identified through the duration of the study period.

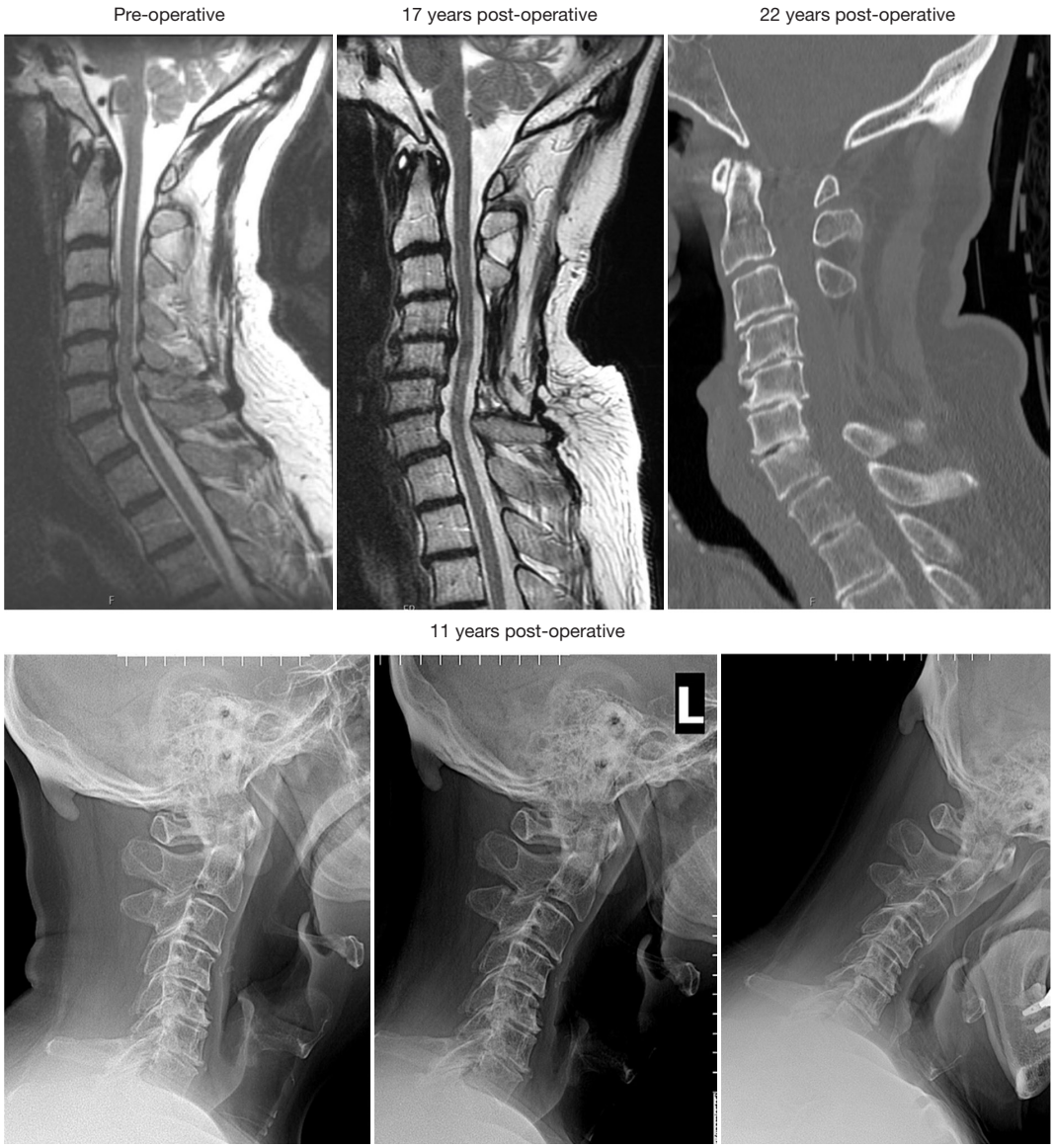

Figure 1 Longitudinal imaging following cervical laminectomy. Preoperative MRI shows multilevel degenerative changes worst from C4 to C6. Patient underwent repeat MRI 17 years post-op to evaluate upper extremity paresthesias. This showed excellent decompression without development of adjacent level disease. Subsequent CT 22-year post-operatively was obtained for evaluation after a fall. Flexion extension films show straightening of the cervical spine but no abnormal motion. CT, computed tomography; MRI, magnetic resonance imaging.

Discussion

One of the aims of our study was to analyze whether laminectomy alone in patients with a lordosis or straightened spine, without preoperative abnormal motion, had an adverse outcome with regard to neurological complications or clinically significant deformity or instability, when compared to a group undergoing laminectomy and fusion. The published literature comparing surgical outcomes of laminectomy alone and laminectomy with fusion have been mixed, but largely have not shown a clinically significant difference in surgical outcomes (18-20). Comparable results between laminectomy alone versus fusion with respect to Nurick scores, modified JOA score and overall improvement in general clinical condition of patients in our series correlates with similar findings in the literature. Many of these studies lack data regarding the selection criteria

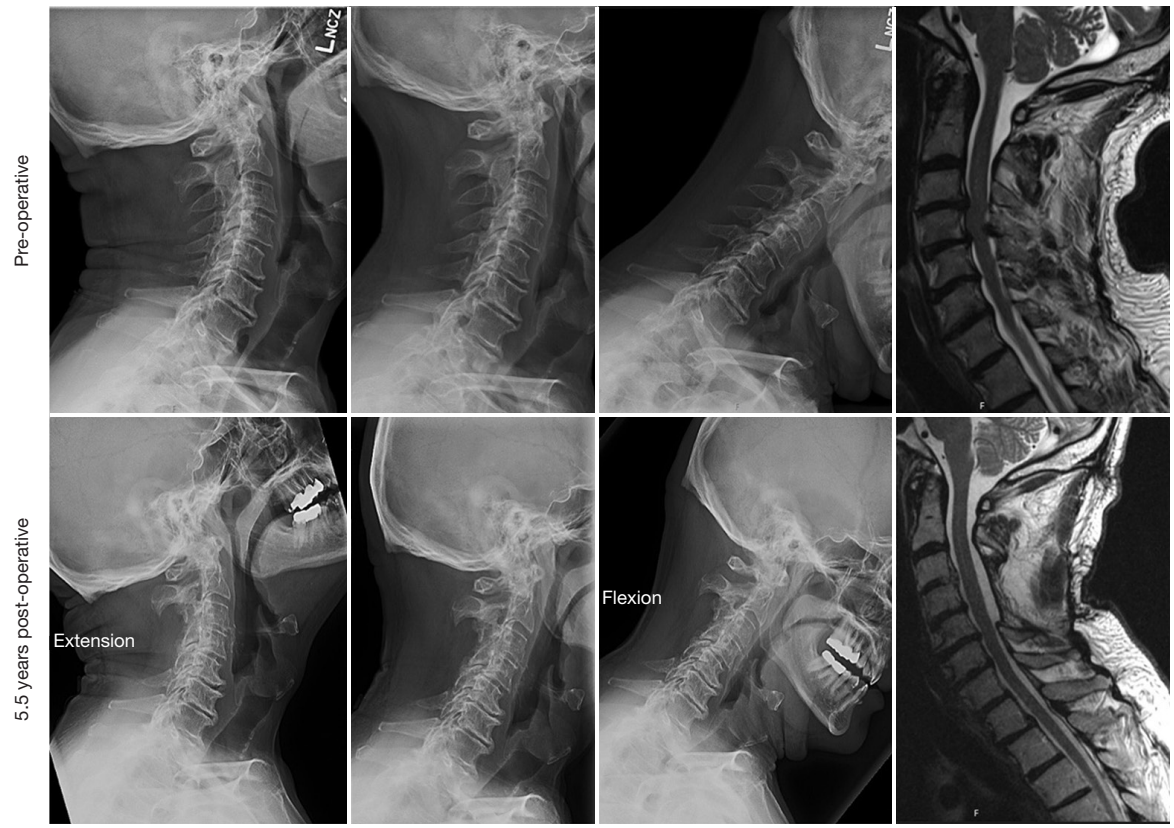

Figure 2 Flexion-extension X-rays and sagittal T2 MRI at pre-operative baseline and 5.5-year follow-up. This patient presented with cervical radiculopathy and myelopathy. Pre-operative MRI showed multilevel changes with cord deformation and compression at C3–4 and C4–5. Flexion extension films showed preserved cervical lordosis with no evidence of pathologic motion. Repeat imaging was obtained 5.5 years post operatively which shows mild loss of lordosis, but no abnormal motion. MRI shows excellent decompression without development of stenosis at the adjacent levels. MRI, magnetic resonance imaging.

Table 1 Preoperative patient characteristics

Variable	Laminectomy (n=41)	Laminectomy and fusion (n=13)	P value
Age (years)	64.7±11.7	64.6±14.2	0.98
Female sex (%)	41.5±29.9	23.1±21.9	0.24
Symptom duration (months)	27.4±32.5	19.5±9.3	0.45
Preop conservative treatment (%)	14.6±35.8	15.4±37.6	0.95
Prior surgery (%)	14.7±47.8	13.0±43.6	0.62
MRI cord signal (%)	34.1±48.0	53.8±51.9	0.24
Comorbidities (%)	70.7±46.1	69.2±48.0	0.92
No. of levels operated (n)	4.15±0.79	3.61±1.19	0.15
Excessive movement on flex-ex (%)	0	63.6±41.0	<0.001
Kyphosis (%)	0	75.0±45.2	<0.001
Straightening (%)	5.7±23.5	41.7±66.9	<0.001

Data are presented as mean ± standard deviation. MRI, magnetic resonance imaging.

Table 2 Postoperative outcomes following laminectomy alone or laminectomy and fusion

Variable	Laminectomy (n=41)	Laminectomy and fusion (n=13)	P value
Parametric measurements			
Length of stay (days)	5.4±4.5	4.4±3.2	0.29
Follow-up (months)	10.3±7.4	7.7±21.9	0.25
Complications (%)	17.1±38.1	7.7±5.5	0.34
Reoperation rate (%)	4.8±21.8	0	0.16
Postoperative kyphosis (%)	0	54.5±52.2	0.006
Excessive movement on flex-ex (%)	2.4±18.6	14.3±37.8	0.49
Ordinal measurements			
Nurick score (pre-operative)	2.37±1.30	2.31±1.44	0.89
Nurick score (follow up)	1.95±1.21	2.08±1.44	0.90
JOA score (pre-operative)	13.15±2.20	11.92±3.07	0.11
JOA score (follow up)	14.59±1.76	13.58±3.73	0.38
Neck pain score (pre-operative)	0.85±1.04	1.00±1.22	0.67
Neck pain score (follow up)	0.61±0.86	0.77±1.09	0.59
Extremity pain score (pre-operative)	0.8±1.11	0.77±1.09	0.93
Extremity pain score (follow up)	0.46±0.71	0.31±0.63	0.48
Clinical change score	2.98±0.48	2.85±0.69	0.54

Data are presented as mean ± standard deviation. JOA, Japanese Orthopedic Association.

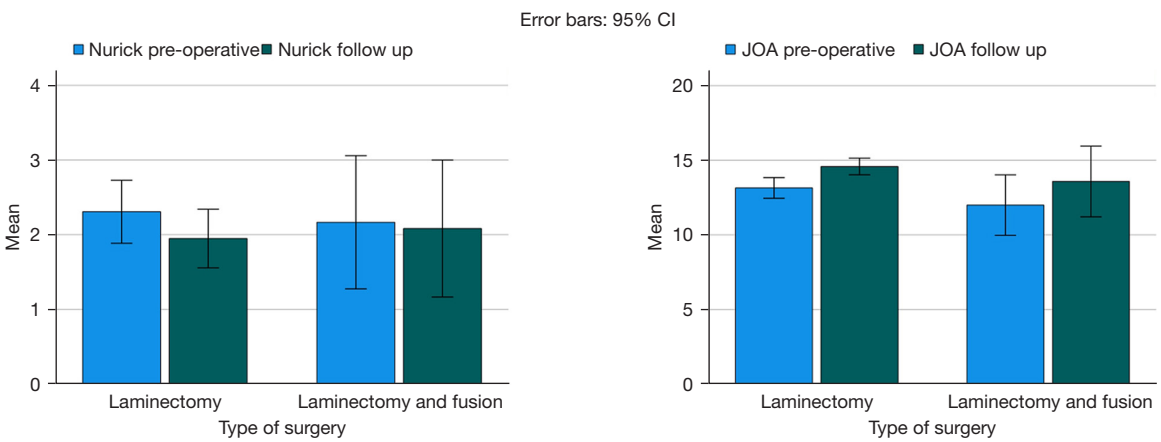

Figure 3 The top panel shows changes in the Nurick scale between pre-op and last follow-up between patients undergoing laminectomy alone versus laminectomy with fusion. No statistically significant differences were detected within or between groups. The bottom panel shows pre-operative and follow-up modified JOA scores between the two groups. Again, no statistically significant differences were detected. JOA, Japanese Orthopedic Association; CI, confidence interval.

used to determine the type of surgical intervention utilized.

Most studies comparing the utility of non-operative management to surgical decompression have focused on patients with mild disease (modified JOA >12 to 13) (21,22). While non-operative management may be considered for patients with mild, slowly-progressive disease, CSM is a

surgical disease unless the patient has significant contra-indications to surgery, regardless of the severity of the neurologic deficits, the presence of multilevel disease, or the failure of conservative therapies. Surgeon preference, the extent of disease, associated comorbidities, and the presence of cervical instability/kyphosis are all factors to consider when determining which procedure to utilize (23). Historically, laminectomy without instrumentation was the primarily available surgical option. Over the past 2 decades, however, laminectomy with fusion has become the treatment of choice for posterior approaches to treat CSM. The rationale driving this shift in practice is the concern for development of delayed neurological deficit, instability, and/or kyphosis following laminectomy alone. Several studies have been published comparing various aspects of surgical treatment, including anterior versus posterior fusion (24), incidence of kyphosis (25), and cost effectiveness of different types of procedures (26). While such data have contributed to this change in practice, there is no class I or II evidence to support the use of laminectomy and fusion over laminectomy alone.

Hamanishi and Tanaka published a series of 69 patients in which 34 underwent laminectomy with fusion for instability on preoperative X-rays and 35 patients underwent laminectomy alone (27). Both groups showed comparable surgical outcomes. JOA scores showed 50.8% improvement in the laminectomy alone versus 51.2% improvement in the fusion group with mean follow-up of 3.35 years. Incidence of progressive kyphosis was 12% in the fusion group and 17% in the laminectomy alone group. However, the difference in kyphosis incidence was not correlated with a difference in clinical outcome. Pérez-López reported similar improvement in Nurick score between a cohort of 19 patients who underwent laminectomy alone to 17 patients who underwent laminectomy and fusion (28). The surgical selection criteria were not described in the study.

Although not studied in the present work, cervical laminoplasty is another surgical option for the treatment of CSM, One recent study utilizing the PearlDiver database found that laminoplasty procedures accounted for less than 15% of the 11,860 posterior procedures performed for CSM (29). In that study, the authors found that there were no differences in revision rates and a decrease in complications following laminoplasty compared to laminectomy and fusion. Sakaura *et al.* also reported on a cohort of patients who underwent C3–6 open-door laminoplasty with at least 8–10 years of follow-up (30). They found no significant declines in postoperative neurologic function related to progression of CSM Similar findings have also been reported in comparative studies between laminectomy and laminoplasty (31). Ishida *et al.* evaluated the surgical results of 55 patients following laminectomy or laminoplasty for CSM (32). The extent of decompression was also analyzed and found to correlate with surgical outcome. The study showed similar surgical outcomes in the 2 groups. More recent systematic reviews, though, have also shown higher complication rates following laminoplasty relative to laminectomy without fusion (33). In the senior authors' view, laminoplasty does not directly address the theoretical short comings of either laminectomy or fusion. It's contribution to stabilizing the spine is uncertain and likely varies significantly from case to case.

Kyphosis and cervical instability

The reported incidence of post-laminectomy kyphosis varies widely in published series from 14% to 47% (34-36). However, many of these studies were published in the 1970s and 80s and included patients who underwent laminectomy for intraspinal lesions, (tumors and cysts), which is a very different disorder than CSM. Laminectomy for intraspinal lesions, especially in pediatric patients and young adults, has a significant associated risk of incurring kyphosis following the procedure (37). Kaptain *et al.* analyzed the incidence of kyphotic deformity following laminectomy in 46 patients with CSM (38). Kyphosis developed in 6 of 20 patients with preoperative straight spines and in 3 of 22 patients with lordotic spines preoperatively. Importantly though, kyphosis did not show any correlation with functional outcome in this study. Guigui *et al.* reported a series of 58 patients who underwent multilevel laminectomy for myelopathy (39). Spinal destabilization was observed in 15 patients (25%), all of whom showed hypermobility on preoperative X-rays. Despite the higher rate of instability detected on imaging, only 3 (5%) of patients required cervical stabilization. In line with these studies linking the presence of preoperative instability and/or loss of lordosis with subsequent kyphosis, our study findings also support the importance of preoperative dynamic cervical X-rays to define the need to consider fusion as a component of the surgical procedure.

The incidence of postoperative cervical instability in our series was 2.4% following laminectomy alone. The one patient who did develop instability presented with neck pain within weeks of her index procedure. She was treated successfully with a 1 level anterior discectomy and fusion.

Except for 2 patients who underwent a re-exploration for a deep wound infection, no other patient presented with pain or neurological symptoms necessitating a subsequent intervention during the follow-up period.

Late deterioration

Although outcome measures in the early postoperative phase showed comparable results, late neurological deterioration has been reported to be higher in patients with cervical laminectomy alone(40). As mentioned above, there is no scientific data to substantiate this claim. Our study did not directly investigate this consideration, given the mean follow up duration of 10 months. Such a study will require lengthy follow-up and careful analysis of pre- and postoperative symptoms and radiographic data. In order to attribute a late deterioration or complication to the laminectomy, the patient would have to have incurred a complication along the operated segment of the spine and it would have to be determined that the alteration of the spinal mechanics by laminectomy directly contributed to the deterioration rather than progression of the underlying spondylotic process. These findings would also have to be compared to the rate of late deterioration and complications associated with laminectomy and fusion.

Cost

Cost-benefit analyses attempt to limit the cost of care without compromising the quality of treatment options and patient outcomes. Several papers have been published recently analyzing the cost effectiveness and quality adjusted life years of different spinal surgical techniques. Highsmith *et al.* published cost-outcome comparison between cervical laminoplasty and laminectomy with fusion (41). In this study instrumentation cost for a 4-level fusion was approximately $12,000, about 3 times the cost of laminoplasty hardware. In addition, fusion patients had a higher rate of reoperation, further reducing the cost effectiveness of the procedure. Clearly, a laminectomy without fusion is the most cost-effective procedure for CSM.

Strengths and limitations

One strength of this study is that all treated patients were evaluated and treated by a single surgeon using a consistent set of criteria for selection of procedure. Our study is limited by a small sample volume and no long-term follow up data, especially in the laminectomy with fusion group. The single-surgeon, single institution nature of this study may limit generalizability.

Conclusions

Cervical spondylosis is a progressive disorder. When it manifests as CSM, surgery is necessary. A variety of surgical options are feasible depending on the configuration of the compression and patient factors. While all of the commonly performed procedures are highly successful in stabilizing the patient's neurological condition, there is no one procedure that will ensure that the patient will not require a second procedure, be it to correct a complication from the index procedure, or to treat progression of symptomatic spondylosis at adjacent segments. Despite current trends towards increased utilization of laminectomy with fusion, in properly selected patients, laminectomy without fusion remains a safe and effective option. Patients without a significant component of neck pain and without evidence of preoperative cervical kyphosis or pathologic motion on flexion-extension films are good candidates for laminectomy alone. Based on the present data, such patients are not at risk of catastrophic complications from a laminectomy for CSM and short-term complications can be managed by a limited surgical procedure on an elective basis. Laminectomy alone has the added benefits of superior cost effectiveness and motion preservation. The absence of clear evidence that fusion combined with laminectomy dramatically improves clinical outcomes in the short or long-term provides strong rationale for considering laminectomy alone. By forgoing an instrumented fusion, laminectomy directly addresses spinal cord compression while maintaining the patients' mobility. Long-term follow up data, in addition to an ongoing randomized clinical trial comparing these two surgical modalities, may provide additional data to determine which patients are best treated with laminectomy alone versus laminectomy and fusion.

Acknowledgments

Posthumous authorship has been granted to Dr. Sherman Stein for his extensive contributions to this manuscript.
Funding: None.

Footnote

Reporting Checklist: The authors have completed the

STROBE reporting checklist. Available at https://jss.amegroups.com/article/view/10.21037/jss-22-118/rc

Data Sharing Statement: Available at https://jss.amegroups.com/article/view/10.21037/jss-22-118/dss

Peer Review File: Available at https://jss.amegroups.com/article/view/10.21037/jss-22-118/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jss.amegroups.com/article/view/10.21037/jss-22-118/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was deemed minimal risk and exempt by the University of Pennsylvania Institutional Review Board (IRB) given its retrospective nature, lack of patient contact, and anonymization of data. Accordingly, individual consent for this retrospective analysis was also waived.

References

1. Shedid D, Benzel EC. Cervical spondylosis anatomy: pathophysiology and biomechanics. Neurosurgery 2007;60:S7-13.
2. Bakhsheshian J, Mehta VA, Liu JC. Current Diagnosis and Management of Cervical Spondylotic Myelopathy. Global Spine J 2017;7:572-86.
3. Hirpara KM, Butler JS, Dolan RT, et al. Nonoperative modalities to treat symptomatic cervical spondylosis. Adv Orthop 2012;2012:294857.
4. Rhee JM, Shamji MF, Erwin WM, et al. Nonoperative management of cervical myelopathy: a systematic review. Spine (Phila Pa 1976) 2013;38:S55-67.
5. Mummaneni PV, Kaiser MG, Matz PG, et al. Cervical surgical techniques for the treatment of cervical spondylotic myelopathy. J Neurosurg Spine 2009;11:130-41.
6. Badiee RK, Mayer R, Pennicooke B, et al. Complications following posterior cervical decompression and fusion: a review of incidence, risk factors, and prevention strategies. J Spine Surg 2020;6:323-33.
7. Sciubba DM, Chaichana KL, Woodworth GF, et al. Factors associated with cervical instability requiring fusion after cervical laminectomy for intradural tumor resection. J Neurosurg Spine 2008;8:413-9.
8. Kumar VG, Rea GL, Mervis LJ, et al. Cervical spondylotic myelopathy: functional and radiographic long-term outcome after laminectomy and posterior fusion. Neurosurgery 1999;44:771-7; discussion 777-8.
9. Gok B, McLoughlin GS, Sciubba DM, et al. Surgical management of cervical spondylotic myelopathy with laminectomy and instrumented fusion. Neurol Res 2009;31:1097-101.
10. Wieser ES, Wang JC. Surgery for neck pain. Neurosurgery 2007;60:S51-6.
11. Anderson PA, Matz PG, Groff MW, et al. Laminectomy and fusion for the treatment of cervical degenerative myelopathy. J Neurosurg Spine 2009;11:150-6.
12. Heller JG, Silcox DH 3rd, Sutterlin CE 3rd. Complications of posterior cervical plating. Spine (Phila Pa 1976) 1995;20:2442-8.
13. McAllister BD, Rebholz BJ, Wang JC. Is posterior fusion necessary with laminectomy in the cervical spine? Surg Neurol Int 2012;3:S225-31.
14. Verla T, Xu DS, Davis MJ, et al. Failure in Cervical Spinal Fusion and Current Management Modalities. Semin Plast Surg 2021;35:10-3.
15. Bechara BP, Bell KM, Hartman RA, et al. In vivo analysis of cervical range of motion after 4- and 5-level subaxial cervical spine fusion. Spine (Phila Pa 1976) 2012;37:E23-9.
16. Kasliwal MK, Witiw CD, Traynelis VC. Neck range of motion following cervical spinal fusion: A comparison of patient-centered and objective assessments. Clin Neurol Neurosurg 2016;151:1-5.
17. Theologis AA, Sing DC, Chekeni F, et al. National Trends in the Surgical Management of Adolescent Idiopathic Scoliosis: Analysis of a National Estimate of 60,108 Children From the National Inpatient Sample Over a 13-Year Time Period in the United States. Spine Deform 2017;5:56-65.
18. de Dios E, Heary RF, Lindhagen L, et al. Laminectomy

alone versus laminectomy with fusion for degenerative cervical myelopathy: a long-term study of a national cohort. Eur Spine J 2022;31:334-45.
19. Kotter MRN, Tetreault L, Badhiwala JH, et al. Surgical Outcomes Following Laminectomy With Fusion Versus Laminectomy Alone in Patients With Degenerative Cervical Myelopathy. Spine (Phila Pa 1976) 2020;45:1696-703.
20. Revesz DF, Charalampidis A, Gerdhem P. Effectiveness of laminectomy with fusion and laminectomy alone in degenerative cervical myelopathy. Eur Spine J 2022;31:1300-8.
21. Rhee J, Tetreault LA, Chapman JR, et al. Nonoperative Versus Operative Management for the Treatment Degenerative Cervical Myelopathy: An Updated Systematic Review. Global Spine J 2017;7:35S-41S.
22. Wu JC, Ko CC, Yen YS, et al. Epidemiology of cervical spondylotic myelopathy and its risk of causing spinal cord injury: a national cohort study. Neurosurg Focus 2013;35:E10.
23. Hsu W, Dorsi MJ, Witham TF. Surgical Management of Cervical Spondylotic Myelopathy. Neurosurg Q 2009;19:302-7.
24. Ghogawala Z, Terrin N, Dunbar MR, et al. Effect of Ventral vs Dorsal Spinal Surgery on Patient-Reported Physical Functioning in Patients With Cervical Spondylotic Myelopathy: A Randomized Clinical Trial. JAMA 2021;325:942-51.
25. Albert TJ, Vacarro A. Postlaminectomy kyphosis. Spine (Phila Pa 1976) 1998;23:2738-45.
26. Goh BC, Striano BM, Lopez WY, et al. Laminoplasty versus laminectomy and fusion for cervical spondylotic myelopathy: a cost analysis. Spine J 2020;20:1770-5.
27. Hamanishi C, Tanaka S. Bilateral multilevel laminectomy with or without posterolateral fusion for cervical spondylotic myelopathy: relationship to type of onset and time until operation. J Neurosurg 1996;85:447-51.
28. Pérez-López C, Isla A, Alvarez F, et al. [Efficacy of arthrodesis in the posterior approach of cervical myelopathy: comparative study of a series of 36 cases]. Neurocir Astur Spain. 2001 Aug;12(4):316–23; discussion 323-324.
29. McDonald CL, Hershman SH, Hogan W, et al. Cervical Laminoplasty Versus Posterior Laminectomy and Fusion: Trends in Utilization and Evaluation of Complication and Revision Surgery Rates. J Am Acad Orthop Surg 2022;30:858-66.
30. Sakaura H, Hosono N, Mukai Y, et al. C3-6 laminoplasty for cervical spondylotic myelopathy maintains satisfactory long-term surgical outcomes. Global Spine J 2014;4:169-74.
31. Lao L, Zhong G, Li X, et al. Laminoplasty versus laminectomy for multi-level cervical spondylotic myelopathy: a systematic review of the literature. J Orthop Surg Res 2013;8:45.
32. Ishida Y, Suzuki K, Ohmori K, et al. Critical analysis of extensive cervical laminectomy. Neurosurgery 1989;24:215-22.
33. Bartels RH, van Tulder MW, Moojen WA, et al. Laminoplasty and laminectomy for cervical sponydylotic myelopathy: a systematic review. Eur Spine J 2015;24 Suppl 2:160-7.
34. Butler JC, Whitecloud TS 3rd. Postlaminectomy kyphosis. Causes and surgical management. Orthop Clin North Am 1992;23:505-11.
35. Kato Y, Iwasaki M, Fuji T, et al. Long-term follow-up results of laminectomy for cervical myelopathy caused by ossification of the posterior longitudinal ligament. J Neurosurg 1998;89:217-23.
36. Ryken TC, Heary RF, Matz PG, et al. Cervical laminectomy for the treatment of cervical degenerative myelopathy. J Neurosurg Spine 2009;11:142-9.
37. Katsumi Y, Honma T, Nakamura T. Analysis of cervical instability resulting from laminectomies for removal of spinal cord tumor. Spine (Phila Pa 1976) 1989;14:1171-6.
38. Kaptain GJ, Simmons NE, Replogle RE, et al. Incidence and outcome of kyphotic deformity following laminectomy for cervical spondylotic myelopathy. J Neurosurg 2000;93:199-204.
39. Guigui P, Benoist M, Deburge A. Spinal deformity and instability after multilevel cervical laminectomy for spondylotic myelopathy. Spine (Phila Pa 1976) 1998;23:440-7.
40. Arnold H, Feldmann U, Missler U. Chronic spondylogenic cervical myelopathy. A critical evaluation of surgical treatment after early and long-term follow-up. Neurosurg Rev 1993;16:105-9.
41. Highsmith JM, Dhall SS, Haid RW Jr, et al. Treatment of cervical stenotic myelopathy: a cost and outcome comparison of laminoplasty versus laminectomy and lateral mass fusion. J Neurosurg Spine 2011;14:619-25.

Cite this article as: Wathen CA, Jacob AT, Bohorquez D, Mannikarottu C, Marcotte P. Treatment strategies for cervical spondylotic myelopathy—is laminectomy alone a safe and effective option? J Spine Surg 2024;10(3):344-353. doi: 10.21037/jss-22-118