Cervical Laminoplasty Versus Posterior Laminectomy and Fusion: Trends in Utilization and Evaluation of Complication and Revision Surgery Rates

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J Am Acad Orthop Surg 2022;30:858-866

DOI: 10.5435/JAAOS-D-22-00106

ABSTRACT

Introduction: Cervical laminoplasty (LP) and laminectomy with fusion (LF) are common operations used to treat cervical spondylotic myelopathy. Conflicting data exist regarding which operation provides superior patient outcomes while minimizing the risk of complications. This study evaluates the trends of LP compared with LF over the past decade in patients with cervical myelopathy and examines long-term revision rates and complications between the two procedures.

Methods: Patients aged 18 years or older who underwent LP or LF for cervical myelopathy from 2010 to 2019 were identified in the PearlDiver Mariner Database. Patients were grouped independently (LP versus fusion) and assessed for association with common medical and surgical complications. The primary outcome was the incidence of LP versus LF for cervical myelopathy over time. Secondary outcomes were revision rates up to 5 years postoperatively and the development of complications attributable to either surgery.

Results: In total, 1,420 patients underwent LP and 10,440 patients underwent LF. Rates of LP (10.5% to 13.7%) and LF (86.3% to 89.5%) remained stable, although the number of procedures nearly doubled from 865 in 2010 to 1,525 in 2019. On matched analysis, LP exhibited lower rates of wound complications, surgical site infections, spinal cord injury, dysphagia, cervical kyphosis, limb paralysis, incision and drainage/ exploration, implant removal, respiratory failure, renal failure, and sepsis. Revision rates for both procedures at were not different at any time point.

Conclusion: From 2010 to 2019, rates of LP have not increased and represent less than 15% of posterior-based myelopathy operations. Up to 5 years of follow-up, there were no differences in revision rates for LP compared with LF; however, LP was associated with fewer postoperative complications than LF.

Level of Evidence: Level III retrospective cohort study

Cervical spondylotic myelopathy (CSM) is a degenerative cervical spine condition characterized by a stepwise progression of symptoms including nondermatomal numbness/tingling, hyperreflexia, gait disturbances, and difficulty with fine-motor tasks. Studies have shown that nonoperative management is unable to affect the unfavorable natural history of the disease.[1] Owing to this, surgical intervention has become the mainstay in preventing symptom progression and occasionally in improving function.[1] The goal of surgical intervention is to decompress the spinal cord at the area of compression, which can be accomplished by anterior, posterior, or combined approaches.

Two predominant posterior treatments for CSM are laminoplasty (LP)[2,3] and laminectomy with fusion (LF).[4] Laminectomy alone and skiplaminectomies have generally fallen out of favor due to concerns for the development of postlaminectomy kyphosis.[5] LP has the benefit of being a motion-sparing procedure, where the lamina is hinged open and held in place by a plate, suture, or other means. This increases the space available for the spinal cord and allows it to drift posteriorly as needed, although the degree of acceptable kyphosis to allow for cord drift remains controversial.[6] Factors such as the K-line, modified K-line, and T1 slope have been used to predict the likelihood of failure of LP.[7-12] Conversely, LF involves removing the entire spinous process and lamina with subsequent fusion of the posterolateral facets (Figure 1). The most common reasons for LF compared with LP have been instability in the form of spondylolisthesis and marginal kyphosis.

Previous studies have examined LP compared with LF in CSM with varying conclusions regarding clinical and radiographic outcomes and the development of complications.[13] The lack of long-term follow-up and heterogeneous results based on inconsistent study data has left many spine surgeons with more questions than answers regarding the risks and long-term outcomes of these two procedures. This study aims to use two national databases to evaluate the trends of LP and LF over time while also comparing the complications and revision rates for these two procedures. Given recent studies illustrating the efficacy of LP, we hypothesize that the annual incidence of LP is increasing. In addition, we hypothesized that LF would have a higher complication rate with more revisions compared with LP.

Methods

This was a retrospective cohort study that identified patients with cervical myelopathy undergoing either LP or LF in the PearlDiver Mariner database (PearlDiver,). The Mariner database is derived from provider group claims from all payer types as a national sample gathered from 2010 to 2019 sourced from multiple hospitals within the Human Claims Database. Cumulatively, the database includes 137 million patients, each of whom has at least one office visit documented in the US claims. Patients receiving surgical treatment for cervical myelopathy were identified using the *International Classification of Disease, Ninth Edition, Clinical Modification* (ICD-9-CM) diagnosis codes before 2015 and ICD-10 codes after 2015 when it was adopted. Current Procedural Terminology (CPT) codes were also used.

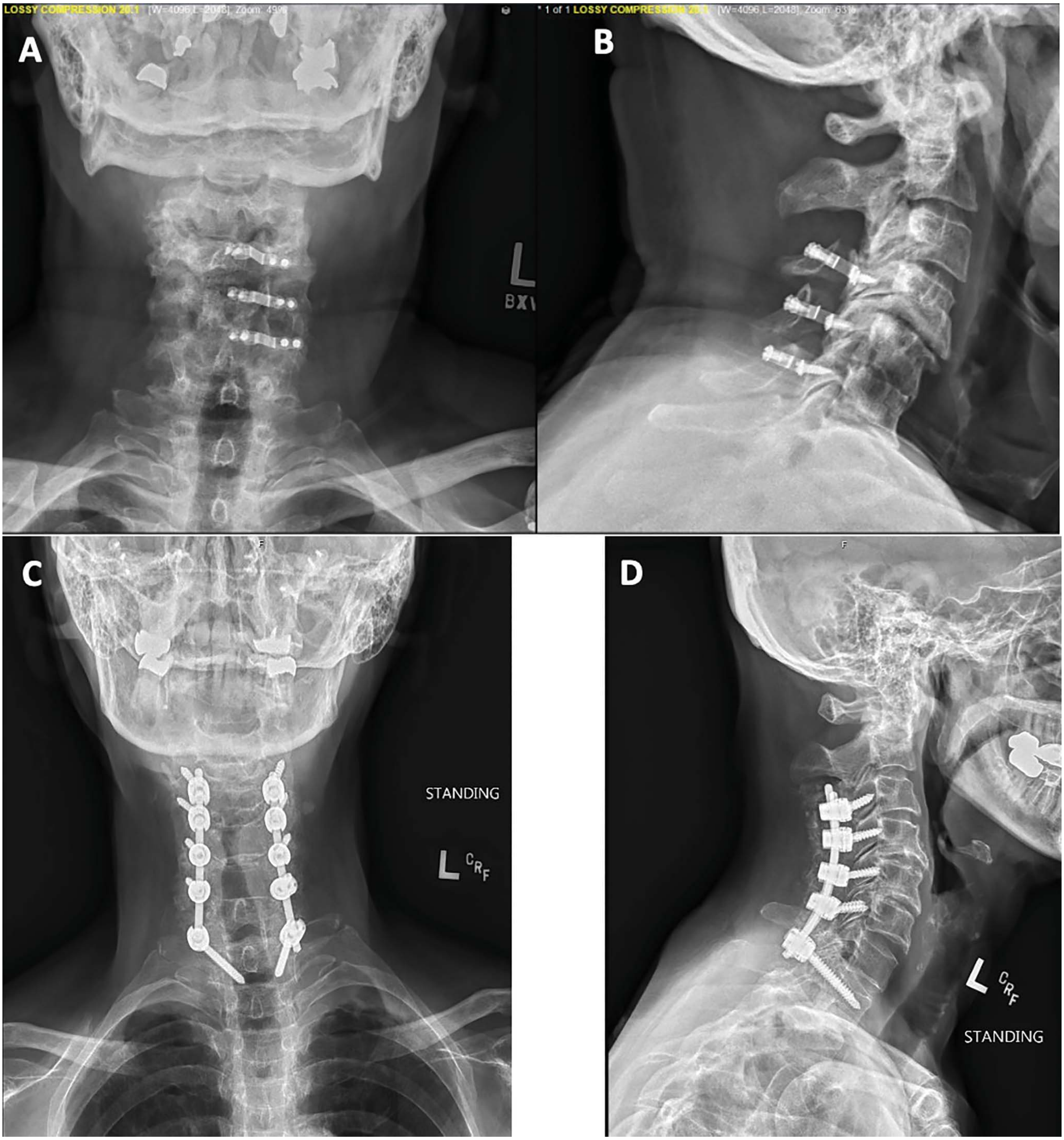
Variables

Patients with an ICD-9 or ICD-10 diagnosis code for cervical myelopathy were retained in the study (Table 1). The primary independent variable in this study was the type of surgical intervention conducted for myelopathy. Patients with myelopathy undergoing either LP or LF were identified using CPT procedural codes, retained in the study, and grouped independently (fusion versus LP). Patients with CPT codes 22551, 22554, 22845, and 22846 were specifically excluded to select for posterior-only approaches. Dependent variables included revision surgery and common surgical complications such as wound complications, surgical site infections, spinal cord injury, nerve root injury, dural tear, dysphagia, cervicalgia, cervical kyphosis, limb paralysis, incision and drainage, and implant removal. In addition, medical complications included deep vein thrombosis/pulmonary embolism, cerebrovascular accident/stroke, myocardial infarction, pneumonia, respiratory failure, renal failure, sepsis, and urinary tract infection. Revision codes were used to identify revision surgeries occurring 3 months, 6 months, 1 year, and 5 years after the initial CPT procedure code for fusion or LP. A 5-year analysis was conducted on a separate subgroup of patients from the years 2010 to 2015 to allow for adequate follow-up for comparison.

Statistical Analyses

Statistical analysis was conducted using the PearlDiver Bellwether research query interface. Common statistical metrics such as frequencies, means, and odds ratios were gathered using the R statistical package that is used by the Bellwether system. Descriptive statistics and demographics were generated for the total cohort of patients with cervical myelopathy (Table 2). Matched cohorts of patients undergoing LF and LP accounting for age, sex, Charlson Comorbidity Index score, and national region

Figure 1



Radiographs showing the patients with similar preoperative presentations and radiographic alignment. **A** and **B** show AP and lateral views of the first patient who underwent laminoplasty with full resolution of symptoms at the 1-year follow-up. **C** and **D** show an AP and lateral views of the second patient who underwent a laminectomy with posterolateral fusion. This patient also had full resolution of symptoms at the 1-year follow-up. Neither patient developed complications from their surgeries.

were created for comparison. Bivariate analysis of matched and unmatched variables included chi-squared tests of association between surgical intervention and outcomes or complications. Linear regression modeling was used to analyze rates of utilization of LF versus LP from 2010 to 2019. Statistical significance was maintained as $P < 0.05$. This study was exempt from institutional review board approval because the PearlDiver

Table 1. ICD-9, ICD-10, and CPT Codes Included in Analysis

Myelopathy	ICD-10-D-M5000, ICD-10-D-M5001, ICD-10-D-M5002, ICD-10-D-M50020, ICD-10-D-M50021, ICD-10-D-M50022, ICD-10-D-M50023, ICD-10-D-M4712, ICD-9-D-72271, ICD-9-D-7211
Laminoplasty	CPT-63051
Fusion	CPT-22600
Revision	CPT-22548, CPT-22551, CPT-22552, CPT-22554, CPT-22585, CPT-22595, CPT-22600, CPT-22614, CPT-22856, CPT-63001, CPT-63015, CPT-63035, CPT-63040, CPT-63043, CPT-63045, CPT-63048, CPT-63050, CPT-63051, CPT-63075, CPT-63076, CPT-0090T, CPT-0092T, ICD-9-P-8101, ICD-9-P-8102, ICD-9-P-8103, ICD-9-P-8132, ICD-9-P-8133, ICD-9-P-8461, ICD-9-P-8462
Wound complications	ICD-9-D-99811, ICD-9-D-99812, ICD-9-D-99813, ICD-9-D-99830, ICD-9-D-99831, ICD-9-D-99832, ICD-9-D-99883, ICD-9-D-99851, ICD9-D-99859, ICD-10-D-L7622, ICD-10-D-L7632, ICD-10-D-L7634, ICD-10-D-T8130XA, ICD-10-D-T8131XA, ICD-10-D-T8140XA, ICD10-D-T8141XA, ICD-10-D-T8142XA
Surgical site infection	ICD-9-D-99851, ICD-9-D-99859, ICD-9-D-99660, ICD-9-D-99667, ICD-10-D-T8140XA, ICD-10-D-T8141XA, ICD-10-D-T8142XA, ICD-10-D-T8463XA, ICD-10-D-T847XXA, ICD-10-D-T8579XA
Spinal cord injury	ICD-9-D-95200, ICD-9-D-95209, ICD-10-D-S140XXA, ICD-10-D-S14101A, ICD-10-D-S14102A, ICD-10-D-S14103A, ICD-10-D-S14104A, ICD-10-D-S14105A, ICD-10-D-S14106A, ICD-10-D-S14107A, ICD-10-D-S14108A, ICD-10-D-S14109A
Nerve root injury	ICD-9-D-9530, ICD-10-D-S142XXA
Dural tear	ICD-9-D-34931, ICD-10-D-G9741, CPT-63707, CPT-63709, CPT-63710
Dysphagia	ICD-9-D-78720, ICD-9-D-78729, ICD-10-D-R1310, ICD-10-D-R1319
Dysphonia	ICD-9-D-78442, ICD-10-D-R490
Cervicalgia	ICD-9-D-7231, ICD-10-D-M542
Cervical kyphosis	ICD-9-D-73712, ICD-9-D-73719, ICD-10-D-M4012, ICD-10-D-M40202, ICD-10-D-M40292, ICD-10-D-M963
Limb paralysis	ICD-9-D-34400, ICD-9-D-34409, ICD-9-D-3441, ICD-9-D-3442, ICD-9-D-34430, ICD-9-D-34432, ICD-9-D-34440, ICD-9-D-34442, ICD-9-D-3445, ICD-10-D-G8100, ICD-10-D-G8104, ICD-10-D-G8110, ICD-10-D-G8114, ICD-10-D-G8190, ICD-10-D-G8194, ICD-10-D-G8220, ICD-10-D-G8222, ICD-10-D-G8250, ICD-10-D-G8254, ICD-10-D-G830, ICD-10-D-G8310, ICD-10-D-G8314, ICD-10-D-G8320, ICD-10-D-G8324
Incision + drainage and/or exploration	CPT-22010, CPT-22830, CPT-63265
Implant removal	CPT-22852
DVT/PE	ICD-9-D-41511, ICD-9-D-41513, ICD-9-D-41519, ICD-10-D-I2609, ICD-10-D-I2692, ICD-10-D-I2699, ICD-9-D-45340, ICD-9-D-45341, ICD-9-D-45342, ICD-10-D-I82401, ICD- 10-D-I82409, ICD-10-D-I82411, ICD-10-D-I82419, ICD-10-D-I82431, ICD-10-D-I82439, ICD-10-D-I82441, ICD-10-D-I82449, ICD-10-D-I824Y1, ICD-10-D-I824Y9, ICD-10-D-I824Z1, ICD-10-D-I824Z9
CVA	ICD-9-D-430, ICD-9-D-431, ICD-9-D-4320, ICD-9-D-4329, ICD-9-D-99702, ICD-10-D-16200:ICD-10-D-16203, ICD-10-D-1621, ICD-10-D-1629, ICD-10-D-197811, ICD-10-D-197821, ICD-10-D-1609
MI	ICD-9-D-41000:ICD-9-D-41002, ICD-9-D-41010:ICD-9-D-41012, ICD-9-D-41020:ICD-9-D-41022, ICD-9-D-41030:ICD-9-D-41032, ICD-9-D-41040:ICD-9-D-41042, ICD-9-D-41050:ICD-9-D-41052, ICD-9-D-4 1060:ICD-9-D-41062, ICD-9-D-41070:ICD-9-D-41072, ICD-9-D-41080:ICD-9-D-41082, ICD-9-D-41090:ICD-9-D-41092, ICD-10-D-I2101, ICD-10-D-I2102, ICD-10-D-I2109, ICD-10-D-I2111, ICD-10-D-I2119, ICD-10-D-I2121, ICD-10-D-I2129, ICD-10-D-I213, ICD-10-D-I214, ICD-10-D-I219, ICD-10-D-I2IAI, ICD-10-D-I21A9
Pneumonia	ICD-9-D-4800:ICD-9-D-4809, ICD-9-D-481, ICD-9-D-4820:ICD-9-D-4822, ICD-9-D-48230:ICD-9-D-48239, ICD-9-D-48240:ICD-9-D-48249, ICD-9-D-48281:ICD-9-D-48289, ICD-9-D-4829, ICD-10-D4120:ICD-10-D4123, ICD-10-D-J1281, ICD-10-D-J1289, ICD-10-D-J129, ICD-10-D-J13, ICD-10-D-J14, ICD-10-D4150, ICD-10-D-J151, ICD-10-D-J1520, ICD-10-D-J15211, ICD-10-DJ15212, ICD-10-D-J1529, ICD-10-D-J153:ICD-10-D-J159

(*continued*)

Table 1. *(continued)*

Respiratory failure	ICD-9-D-51881, ICD-9-D-51851, ICD-10-D-J9600:ICD-10-D-J9602, ICD-10-D-J95821
Renal failure	ICD-9-D-5845:ICD-9-D-5849, ICD-10-D-N170:ICD-10-D-N1I79
Sepsis	ICD-9-D-99591, ICD-9-D-99592, ICD-10-D-T8144XA
UTI	ICD-9-D-5990, ICD-9-D-59780, ICD-9-D-59789, ICD-9-D-5950, ICD-9-D-5959, ICD-10-D-N390, ICD-10-D-N341, ICD-10-D-N342, ICD-10-D-N3000, ICD-10-D-N3090

CPT = Current Procedural Terminology, CVA = cerebrovascular accident, DVT = deep vein thrombosis, ICD = International Classification of Disease, MI = myocardial infarction, PE = pulmonary embolism, UTI = urinary tract infection

Mariner data set is publicly available and contains exclusively deidentified patient discharge records.

Results

In total, 417,328 patients with cervical myelopathy met inclusion criteria, including a subset of patients who subsequently underwent LP (1,420 patients) and LF (10,440 patients, Table 2). The median age was 57 years, and most of the sample was female (54.9%). The South (42.2%) and Northeast (22.9%) were the regions associated with the highest percentage of patients in the sample. Rates of LP and LF remained relatively stable for the duration of the study, although the number of procedures captured in the data set nearly doubled during this period from 865 in 2010 to 1,525 in 2019 (Table 3). LP procedures ranged from 10.5% to 13.7% of total annual procedures in the sample over the years studied.

In total, 1,089 of the 1,420 patients (76.69%) undergoing LP had reported neck pain, compared with 8,386 of 10,440 (80.33%) undergoing LF ($P = 0.001$). In addition, 45 of the 1,420 patients (3.17%) undergoing LP had previous anterior cervical diskectomy and fusion (ACDF) surgery, compared with 1,982 of 10,440 (18.98%) undergoing LF ($P < 0.001$) (Table 2).

On unmatched analysis, chi-squared tests of association revealed a statistically significant association between LP (versus LF) and reduced rates of wound complications (odds ratio [OR] = 0.76, $P = 0.007$), surgical site infections (OR = 0.7, $P = 0.008$), spinal cord injury (OR = 0.57, $P = 0.002$), dysphagia (OR = 0.72, $P < 0.0001$), cervical kyphosis (OR = 0.56, $P = 0.001$), limb paralysis (OR = 0.66, $P < 0.0001$), incision and drainage/exploration (OR = 0.49, $P < 0.0001$), implant removal (OR = 0.31, $P = 0.001$), deep vein thrombosis/pulmonary embolism (OR = 0.68, $P < 0.0001$), myocardial infarction (0.84, $P = 0.005$), pneumonia (OR = 0.72, $P = 0.02$), respiratory failure (OR = 0.62, $P < 0.0001$), renal failure (OR = 0.83, $P = 0.004$), sepsis (OR = 0.67, $P = 0.005$), and urinary tract infection (OR = 0.8, $P < 0.0001$) (Table 4).

On matched analysis accounting for age, sex, Charlson Comorbidity Index score, and region of the country, chi-squared tests of association revealed a statistically significant association between LP (versus LF) and reduced rates of wound complications (OR = 0.67, $P = 0.002$), surgical site infections (OR = 0.60, $P = 0.002$), spinal cord injury (OR = 0.6, $P = 0.02$), dysphagia (OR = 0.77, $P = 0.01$), cervical kyphosis (OR = 0.55, $P = 0,01$), limb paralysis (OR = 0.67, $P < 0.0001$), incision and drainage/exploration (OR = 0.45, $P < 0.0001$), implant removal (OR = 0.28, $P = 0.001$), respiratory failure (OR = 0.74, $P = 0.01$), renal failure (OR = 0.84, $P = 0.04$), and sepsis (OR = 0.85, $P = 0.04$).

Revision rates for both procedures remained similar, and differences were not significant at 3 months (LP = 1.34%, LF = 1.86%, $P = 0.75$), 6 months (LP = 4.01, LF = 4.20, $P = 0.69$), and 1 year (LP = 5.63, LF = 5.90, $P = 0.62$). Cases from 2010 to 2015 were analyzed separately to look at 5-year revision rates. Within that cohort of patients, we found similar results to those at earlier timepoints (LP = 4.72, LF = 5.79, $P = 0.26$) (Table 5).

Discussion

This investigation examined 11,860 patients undergoing LP or posterior laminectomy and fusion for CSM. Although there remains substantial controversy regarding whether LP or LF provides improved clinical outcomes and reduced complications in the treatment of CSM, studies such as this provide data regarding current trends in utilization and national complication and revision rates.

This study demonstrated that over time, the rates of LP have remained constant compared with LF, despite an increasing prevalence of published literature supporting LP as a treatment option for CSM.[14-17] This is consistent with previous studies that have suggested that LP is an underutilized procedure based on radiographic criteria.[18]

In addition, this study also found that in a matched analysis, LF was associated with higher rates of wound

Table 2. Summary of Total Patients, Revision Surgeries, and Demographics

Factor	n (%)	*P* Value
Total patients with cervical myelopathy	41,7328	
Total patients undergoing spinal laminoplasty	1,420 (11.97)	
Total patients undergoing spinal fusion	10,440 (88.03)	
Patients undergoing laminoplasty with neck pain	1,089 (76.69)	
Patients undergoing spinal fusion with neck pain	8,386 (80.33)	0.001
Patients undergoing laminoplasty with prior ACDF	45 (3.17)	
Patients undergoing spinal fusion with prior ACDF	1,982 (18.98)	<0.001
Total number of revision surgeries	1,030 (8.68)	
Total reoperations within 30 d	713 (0.30)	
Total reoperations within 5 yr	2,220 (1.40)	
Median age (yr)	58	
Female	228,893 (54.85)	
Male	188,431 (45.15)	
Midwest	86,183 (20.61)	
Northeast	95,914 (22.94)	
South	176,579 (42.23)	
Unknown	1,277 (0.31)	
West	58,135 (13.90)	

ACDF = anterior cervical diskectomy and fusion

complications and surgical site infections, dysphagia, cervicalgia, development of cervical kyphosis, limb paralysis, and other medical complications such as respiratory issues, renal failure, and sepsis. However, at each time point examined, the rate of revision surgery was similar between the two groups.

Although it is believed that the incidence of complications following these procedures are similar, previous studies have suggested that LP may have fewer complications than LF.[15,19-23] Other studies have shown no difference between these two procedures regarding clinical or radiologic outcomes.[14,16,24] One study by Nurboja et al[25] suggested that patients who underwent LP had higher rates of axial neck pain compared with LF. However, more recent literature supports comparable and even lower rates of axial neck pain after LP.[15,26-32] Our study found notable baseline differences in the rates of preoperative axial neck pain, with more

Table 3. Laminoplasty and Laminectomy With Fusion Procedures by Year

Year	Laminoplasty	Fusion	%	%
2010	92	773	10.60	89.40
2011	118	789	13.00	87.00
2012	112	850	11.60	88.40
2013	155	976	13.70	86.30
2014	165	1,085	13.20	86.80
2015	134	1,119	10.70	89.30
2016	135	1,113	10.80	89.20
2017	129	1,085	10.60	89.40
2018	134	1,138	10.50	89.50
2019	199	1,326	13.00	87.00

Table 4. Unmatched and Matched Analysis of Medical and Surgical Complications by Procedure

Complications	Laminoplasty	Fusion	Unmatched		Matched	
			OR	*P* Value	OR	*P* Value
Wound complications	116	167	0.76	0.007	0.67	0.002
Surgical site infection	64	104	0.7	0.008	0.6	0.002
Spinal cord injury	37	61	0.57	0.002	0.6	0.02
Nerve root injury	<11	<11	0.74	0.57	0.67	0.6
Dural tear	26	33	0.98	1	0.78	0.36
Dysphagia	220	271	0.72	<0.0001	0.77	0.01
Cervicalgia	1,057	1,047	0.92	0.21	1.04	0.69
Cervical kyphosis	33	58	0.56	0.001	0.55	0.01
Limb paralysis	139	197	0.66	<0.0001	0.67	<0.0001
Incision + drainage and/or exploration	40	85	0.49	<0.0001	0.45	<0.0001
Implant removal	<11	28	0.31	0.001	0.28	0.001
DVT/PE	102	128	0.68	<0.0001	0.78	0.08
CVA	17	<11	0.85	0.58	1.7	0.24
MI	963	990	0.84	0.005	0.91	0.28
Pneumonia	60	67	0.72	0.02	0.89	0.59
Respiratory failure	152	197	0.62	<0.0001	0.74	0.01
Renal failure	373	424	0.83	0.004	0.84	0.04
Sepsis	54	67	0.67	0.005	0.8	0.26
UTI	473	526	0.8	<0.0001	0.85	0.04

CVA = cerebrovascular accident, DVT = deep vein thrombosis, MI = myocardial infarction, OR = odds ratio, PE = pulmonary embolism, UTI = urinary tract infection

patients in the LF having axial neck pain compared with LP patients. This is likely due to the previously held belief discussed above that questioned the effectiveness of LP in patients with pre-existing axial neck pain. In addition, our study found a markedly higher rate of prior ACDF in the LF group compared with the LP group. Although there are many possible reasons for this finding, one of the most likely is that these were staged procedures allowing for the correction of cervical kyphosis to allow for the "drift back" phenomenon where the cervical spinal cord can drift back in the cervical spine after decompression.[33]

In deciding which approach to choose, it is first important to identify when a posterior-based surgery is not appropriate. In cases where there is primarily ventral pathology, or in cases of cervical kyphosis, an anterior surgery such as ACDF or cervical disk replacement should be considered.[34] The modified K-line has been developed and validated to determine when the kyphosis is too great to allow for posterior decompression.[11,35] To determine this, a line is drawn from the center of the spinal cord on a sagittal MRI from C2-7. If the distance from the k-line to the source of ventral pathology is less than 4 mm, a posterior decompression is less likely to be successful. Many studies have examined outcomes comparing LP and LF and have found similar improvements in both neurologic recovery and patient outcome measures.[19,36,37] In many of these studies, preoperative alignment characteristics were similar; however, studies have suggested that local kyphosis and radiographic

Table 5. Revision Rates by Procedure Type

Factor	3 mo	%	6 mo	%	1 yr	%	5 yr	%
Laminoplasty	19	1.34	57	4.01	80	5.63	67	4.72
Fusion	194	1.86	438	4.20	616	5.90	605	5.79
P value	0.75		0.69		0.62		0.25	

instability are the main contraindications of LP compared with LF.[18,38] Given the findings of this and previous studies suggesting increased complications with LF compared with LP, LP should be an increasingly used procedure for the treatment of CSM, given the similar indications for their utilization.

One critique of previous studies is small sample size and poor long-term follow-up, limiting the ability to adequately evaluate outcomes between the two procedures. In our review of the literature, some previous studies failed to include all relevant ICD-9 and ICD-10 codes to detect an initial diagnosis of cervical myelopathy or subsequent revision; the omission of all relevant codes diminishes the ability to make accurate inferences. Two studies examined the strength of the literature comparing LP and LF and both determined that the current literature is generally of poor quality, limiting the potential to draw meaningful conclusions.[13,36]

To the best of our knowledge, this was the largest database study examining these two procedures, thereby enabling the ability to control for important potential confounding variables. Using two separate databases allows for the evaluation of outcome measures that have not previously been able to be concurrently examined. We also present the follow-up of up to 5 years postoperatively on a cohort of patients, which is more likely to capture complications, the progression of symptoms, adjacent segment degeneration, or hardware failure requiring revision.

Our study does have several limitations. Any retrospective study has the potential to introduce bias and error and present confounding variables. In addition, any error in coding or documentation from the surgeons who treated the patients in the database has the potential to introduce a source of error into the results. Although the large database makes these data generalizable, the fact that patients are not randomized into either treatment group also presents the possibility that there may have been specific indications for one surgery compared with the other surgery. These limitations due limit the ability to determine causation from our findings of complications. This study was unable to capture follow-up rates for individual patients and could not evaluate the need for any revisions past 5 years. In addition, since 5-year follow-up data are not yet available on patients who underwent surgery in 2016 or later, our 5-year data only represent the cohort of patients who were operated on from 2010 to 2015. Another limitation is that no grading systems for myelopathy were included in the database, so the severity of myelopathy could not be determined for individual patients. Furthermore, we were unable to assess preoperative radiographic parameters to determine the presence of kyphosis or segmental instability, which might influence a surgeon's preference to perform one procedure over the other. In addition, we did not examine the number of levels addressed in the two surgical cohorts. For example, some patients may have had a cervical decompression with cervicothoracic fusion, which is a larger operation than LP with higher potential morbidity. However, given that some surgeons may choose this operation for the same pathology that could be treated by LP, we believe that this still lends validity to our findings. Finally, more than 100,000 patients with CSM were not accounted for through posterior-based approaches in our data set. A large number of patients may have had nonoperative management or anteriorly based surgery; however, our database does not include any rationale or explanation for this finding.

Until a large, randomized, prospective study is performed, these issues will continue to be a limitation to any additional study. Despite these limitations, this study demonstrates a markedly lower rate of postoperative complications in patients with CSM undergoing LP versus LF in a large sample with a long-term follow-up.

Conclusion

Both LP and LF are successful treatment options for CSM. Despite growing evidence showing successful outcomes, LP remains an underutilized procedure because the incidence of posterior cervical LP has not increased over the past decade. Our study suggests that compared with LF, LP is associated with lower rates of wound complications, surgical complications, and medical complications. Despite the lower rate of complications, there were no differences in the need for revision surgery between these two procedures. Spine surgeons should therefore choose the more appropriate surgical procedure based on patient factors and radiographic parameters because additional prospective randomized controlled studies are necessary to form a more decisive treatment algorithm. Our data demonstrate that LP is a treatment option for CSM that is associated with fewer complications compared with LF.

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