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Clinical Studies

Inpatient opioid use varies by construct length among laminoplasty versus laminectomy and fusion patients

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ABSTRACT

Background: Laminoplasty (LP) and laminectomy and fusion (LF) are utilized to achieve decompression in patients with symptomatic degenerative cervical myelopathy (DCM). Comparative analyses aimed at determining outcomes and clarifying indications between these procedures represent an area of active research. Accordingly, we sought to compare inpatient opioid use between LP and LF patients and to determine if opioid use correlated with length of stay.

Methods: Sociodemographic information, surgical and hospitalization data, and medication administration records were abstracted for patients >18 years of age who underwent LP or LF for DCM in the Mass General Brigham (MGB) health system between 2017 and 2019. Specifically, morphine milligram equivalents (MME) of oral and parenteral pain medication given after arrival in the recovery area until discharge from the hospital were collected. Categorical variables were analyzed using chi-squared analysis or Fisher exact test when appropriate. Continuous variables were compared using Independent samples *t* tests and Mann-Whitney *U* tests.

Results: One hundred eight patients underwent LF, while 138 patients underwent LP. Total inpatient opioid use was significantly higher in the LF group (312 vs. 260 MME, p=.03); this difference was primarily driven by higher postoperative day 0 pain medication requirements. Furthermore, more LF patients required high dose (>80 MME/day) regimens. While length of stay was significantly different between groups, with LF patients staying approximately 1 additional day, postoperative day 0 MME was not a significant predictor of this difference. When operative levels including C2, T1, and T2 were excluded, the differences in total opioid use and average length of stay lost significance.

Conclusions: Inpatient opioid use and length of stay were significantly greater in LF patients compared to LP patients; however, when constructs including C2, T1, T2 were excluded from analysis, these differences lost significance. Such findings highlight the impact of operative extent between these procedures. Future studies incorporating patient reported outcomes and evaluating long-term pain needs will provide a more complete understanding of postoperative outcomes between these 2 procedures.

Background

Degenerative cervical myelopathy (DCM) is a prevalent and potentially debilitating disease among adults. Surgical decompression is the treatment of choice for symptomatic DCM [1]; both laminoplasty (LP) and laminectomy and fusion (LF) are routinely utilized to achieve decompression [2]. While evolving clinical and radiographic criteria often make one procedure more appealing than the other, significant variability in surgical indications exists, with some work suggesting that LP is underutilized [3].

In this context, comparative outcome-based investigations have been an area of active research with hopes of informing clinical management

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and promoting standardization. With regard to radiographic and clinical measures, Yoon et al. [4] found clinical equipoise between the 2 procedures in well selected patients. Additionally, Lau reported similar postoperative radiographic measures between the 2 types of surgery, as well as less blood loss in LP patients [5]. Notably, short-term outcomes are reported less frequently in the literature. A NSQIP review of short-term outcomes published in 2019 demonstrated shorter length of stay for LP patients and lower rates of discharge to skilled nursing facilities for LP compared to LF patients [6].

As ongoing studies aim to clarify the roles of these 2 procedures in addressing symptomatic DCM, one important consideration is the impact of postoperative pain. In an era when opioid misuse has become a global public health crisis [7], postoperative pain management is particularly poignant. Furthermore, there has been an evolving appreciation that perioperative prescription practices have long term ramifications on chronic opioid use, especially for opioid naïve patients [8]. Additionally, within spine surgery, perioperative pain management regimens have been shown to influence hospital length of stay [9]. With these considerations in mind, we sought to: (1) Compare opioid use in the acute postoperative period between LP and LF, and (2) Determine if potential opioid use differences correlated with any variability in length of stay.

Methods

This retrospective cohort study utilized data from the Research Patient Data Registry, a clinical patient registry that prospectively catalogs patient encounters in the Partners Healthcare system. The study underwent investigational review board approval and was granted exempt status.

Adult patients, 18 years of age or older, who underwent LP or LF for myelopathy or myeloradiculopathy due to degenerative pathology were included. The decision to proceed with LP or LF was determined by the treating surgeon. Surgery was performed at 1 of 4 hospitals between 2017 and 2019. Two hospitals were large academic medical centers and 2 were community hospitals with academic affiliation. Surgery was performed by 1 of 24 orthopedic spine surgeons or neurosurgeons who regularly perform one or both procedures. Patients who had undergone previous cervical spine surgery were excluded, as were patients who had procedures extending above C2 or below T2. Patients taking opioid medications prior to surgery were also excluded.

Patient characteristics including sociodemographic information, surgical data, medication administration records, and hospitalization data were abstracted from the electronic medical record. The primary outcome measure was defined as the morphine milligram equivalents (MME) of oral and parenteral pain medication given after arrival in the recovery area until discharge from the hospital. Individual postoperative pain control regimens were left to the determination of the treating surgical teams, but generally involved acetaminophen, an oral and parenteral opioid medication (most frequently Oxycodone or Hydromorphone), and a muscle relaxant. No provider routinely prescribed NSAIDs. MMEs were converted using the CDC Opioid-MME Conversion Chart [Data Resources | Opioids | CDC].

Statistical analysis was performed using SPSS Statistics, version 29 (IBM Corp). Categorical variables were analyzed using chi-squared analysis or Fisher exact test when appropriate. Continuous variables were compared using Independent samples t-tests and Mann-Whitney *U* tests for normally distributed and nonparametric data as determined by Kolmogorov – Smirnov tests, respectively. Data were represented as mean values with the standard error. We defined statistical significance a priori as a p-value <.05.

Results

Cohort characteristics

A total of 246 patients were included in the study; 108 (44%) underwent LF and 138 (56%) underwent LP (Table 1). For the LF cohort, 46% of patients were women and the average age was 66.4 years (SE 1.0). For the LP cohort, 40% of patients were women and the average age was 64.8 years (SE 0.9). Preoperative lordosis between groups was similar (LF 11.1° vs. LP 12.2°, p=.61). A significant difference in the number of operative levels existed between groups (LF 4.1 vs. LP 3.7, p=.005); 4-level procedures were most common across groups (Fig. 1). Operative times (LF 166 vs. LP 174 minutes, p=.15) and estimated blood loss (LF 280 vs. LP 176cc, p=.07) were similar.

Opioid use

Total inpatient opioid use was significantly higher in the LF group compared to the LP group (312 vs. 260 MME, p=.03) (Table 1). When analyzing daily opioid use, LF patients required significantly more pain medication on postoperative days 0 (64.3 vs. 43.0 MME, p<.001) and 3 (44.7 vs. 35.0 MME, p=.03) (Fig. 2). Within the first 2 postoperative days, a higher proportion of LF patients required high dose (>80 MME/day) opioid treatment (31 vs. 16 patients on POD0, 14 vs. 5 on

Table 1
Sociodemographic and surgical characteristics.

	Laminectomy and fusion	Laminoplasty	p-value*
Sample size, n	108	138	
Sociodemographic characteristics			
Mean age (SE) in years	66.4 (1.0)	64.8 (0.9)	.23
Gender, n (%)			031
Female	50 (46)	55 (40)	
Male	58 (54)	83 (60)	
Preoperative details			
Cervical lordosis (SE) in degrees	11.1 (1.1)	12.2 (0.9)	.61
Surgical details			
Operative levels (SE)	4.1 (0.09)	3.7 (0.05)	.005
Mean surgical time (SE) in minutes	166 (6.0)	174 (5.0)	.15
Mean estimated blood loss (SE) in cc	280 (31.8)	176 (11.0)	.07
Postoperative details			
Total opioid use (SE) in MME	312 (26)	260 (26)	.03
Length of stay (SE) in days	4.8 (0.4)	3.8 (0.2)	.002

SE, standard error; MME, morphine milligram equivalents.

* p-value for age was calculated using Independent samples t-test; p-values for operative levels, surgical time, and estimated blood loss were calculated using Mann-Whitney *U* tests; p-value for gender was calculated using chi-square test; significance set at alpha .05.

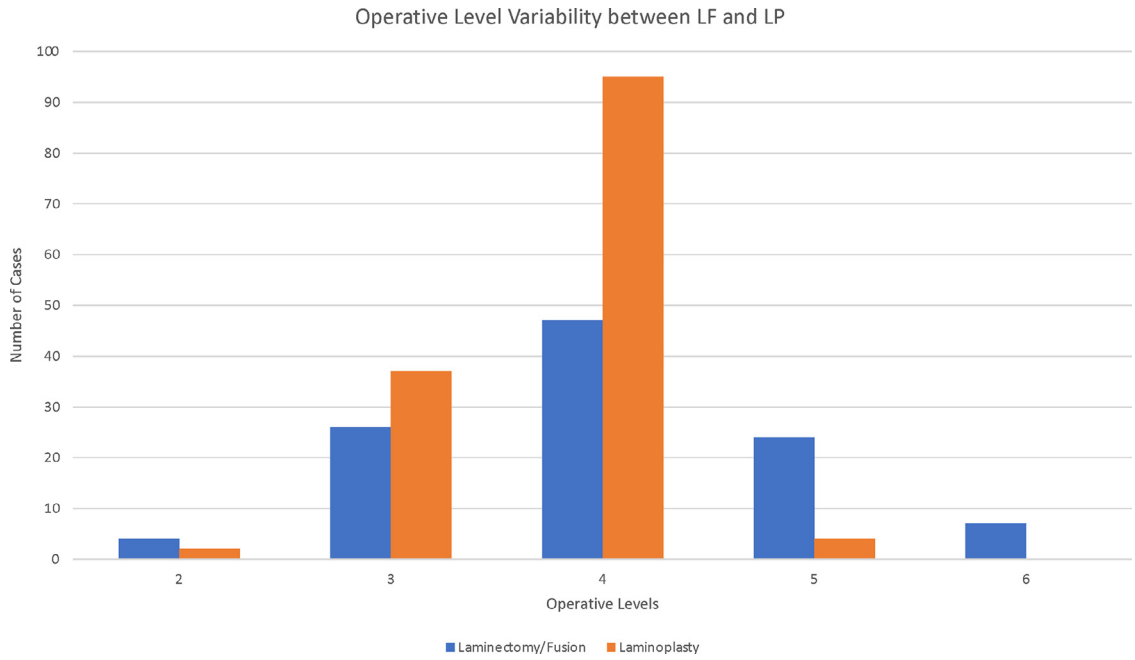

Fig. 1. Distribution in operative level between laminectomy and fusion and laminoplasty. LP, laminoplasty; LF, laminectomy and fusion.

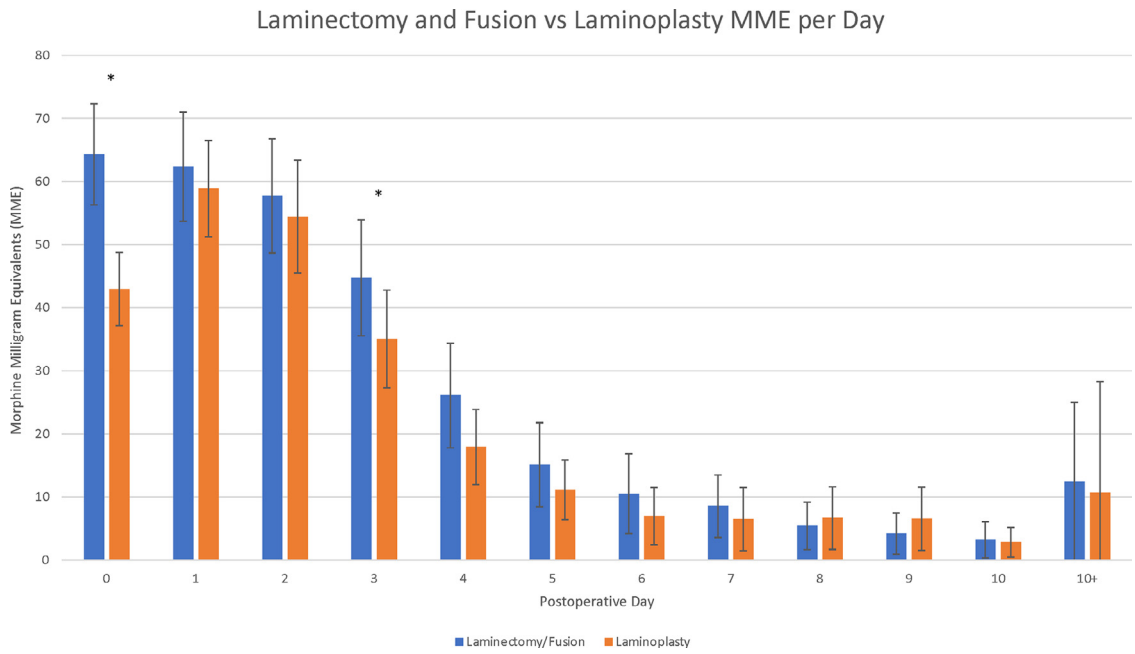

Fig. 2. Laminectomy and fusion versus laminoplasty average MME per day. MME, morphine milligram equivalents.

POD1, and 10 vs. 3 on POD2). Notably, when total opioid use was adjusted by number of operative levels, the significant difference disappeared (LF 82.1 vs. LP 71.4, p=.11).

Length of stay

Total duration of hospital admission was significantly different between groups, with LF patients staying approximately 1 day longer on average than LP patients (4.8 vs. 3.8, p=.002) (Table 1). Multivariable analysis using linear regression revealed that patient age, estimated blood loss, operative time, and postoperative day 0 MME were not significant predictors of length of stay (Table 2). However, type of surgery was significant, with LF associated with longer time to discharge (B=0.97, p=.03).

Construct length

A subgroup analysis was performed to determine the effect of including of C2 or thoracic vertebrae on operative variables and postoperative opioid use. When operative levels including C2, T1, and T2 were excluded, LF patients decreased to 69 and LP decreased to 134. Average age remained similar between groups (LF 66.9 vs. LP 64.6, p=.15). Operative levels (LF 3.6 vs. LP 3.7, p=.13), EBL (LF 258 vs. LP 178cc, p=.20), and operative time (LF 162 vs. LP 174 minutes, p=.09) were also similar (Table 3).

Table 2
Multivariable analysis of length of stay.

	Regression coefficient, *B* (95% CI)	p-value*
Primary predictor		
Laminectomy and fusion	0.97	.03
Laminoplasty (ref)		
Covariates		
Age	0.02	.44
EBL	0.0	.82
OR time	0.01	.14
POD0 MME	0.001	.84

CI, confidence interval; ref; reference value; MME, morphine milligram equivalents.

* p-values generated using a Generalized Linear Model, significance set at alpha .05.

Within this subset of patients, while postoperative day 0 opioid use was significantly different between groups (LF 62.7 vs. LP 43.0 MME, p<.001), the previously observed significant difference in total MME was not maintained (LF 292 vs. LP 247 MME, p=.19). Furthermore, average length of stay lost statistical significance, with LF patients staying 4.5 days compared with LP patients staying 3.8 days on average (p=.07).

Discussion

Cervical LP and LF are techniques utilized for spinal cord and nerve root decompression, often in the setting of DCM. Presently, spine surgeons and researchers are working to optimize the surgical indications and outcomes of these procedures. In this effort, the significance of acute postoperative pain management should not be overlooked given its potential impact on length of stay, long-term opioid use, and patient reported outcome measures.

To date, several investigations aimed at understanding differences in pain and pain management between these surgeries have been performed; however, there is a notable paucity in the literature with respect to perioperative comparisons. In their matched cohort analysis including 13 LF and 13 LP patients, Heller et al. [10] found similar decreases in overall pain severity in both groups at roughly 2 year follow-up; furthermore, 1 patient in each group was still using opioid medications at that visit. A more recent study compared opioid use within 6 months of surgery between LF and LP cohorts. This was completed for both a single-surgeon cohort as well as national database cohort [11]. While LF patients in the single-surgeon cohort demonstrated a significantly higher rate of 6-month opioid use (15.7% vs. 5.1%, p=.02), this difference was not observed in the national cohort. Notably, in the LF group, the number of patients with preoperative opioid use was significantly higher in the national cohort compared to the single-surgeon cohort (37% vs. 17%, p<.001); this was not observed for LP patients.

Our analysis demonstrated that patients undergoing LP used fewer MME of opioid pain medication during their hospitalizations than patients undergoing LF. This difference was largely driven by higher opioid use on postoperative day 0 (64.3 vs. 43.0 MME, p<.001). However, when levels rarely included in LP constructs but commonly seen in LF constructs (C2, T1, T2) were excluded from analysis, the difference in total opioid pain use lost statistical significance.

C2 and C7 represent significant origins and attachment sites for the musculature of the posterior neck. Their role in the structural stability of the cervical spine and their potential as pain generators when stripped of muscular attachments has been well described [12–14]. It is worth noting that while LP decompresses the instrumented level as well as the interspaces cranial and caudal, full decompression at the upper and lower instrumented levels of LF are not always completed. Therefore, creating cohorts of similar levels may result in artificially similar groups. Also, the extent of preoperative kyphosis is another important consideration in the decision between LF and LP, with fusion procedures typically utilized to achieve better correction and fixation. Our cohorts demonstrated similar degrees of cervical lordosis (LF 11.1° vs. LP 12.2°, p=.61); thus, cervical alignment was not a confounder between groups.

Multivariable analysis of length of stay demonstrated type of surgery to be only significant predictor, with LF patients staying 1 day longer than LP patients on average (4.8 vs. 3.8, p=.002). These findings are consistent with previously published results. In their comparison of nearly 2,400 LF patients and 1,400 LP patients, Boniello et al. [6] found a significant difference in length of stay of approximately 1 day (LF 4.5 vs. LP 3.7, p<.01). In analyzing 101 LP and 44 LF patients, Lau et al. [5] also found a trend toward shorter hospital stays for LP patients (4.3 vs. 3.5 days, p=.054). In our study, postoperative day 0 opioid use was not predictive of the difference in hospital duration. Of note, providers at our institutions rarely prescribed initial opioid regimens in excess of 80 MME/day. This ceiling on prescribing practices falls in line with what is practiced at other institutions, and represents a dose of approximately 10 mg of Oxycodone every 3 hours [15]. In order for opioid naïve patients to obtain doses greater than this, escalation to the house staff or ordering provider had to occur. On postoperative day 0, 29% of patients who underwent LF required greater than 80 MME compared with 12% of LP patients. On the first postoperative day, this difference narrowed to 13% and 4% and by postoperative day 2 the difference was 9% and 2%.

There are several notable limitations to our study. The retrospective nature, wherein the decision to perform LF versus LP was determined by surgeon discretion, is subject to selection bias. Furthermore, surgical details such as muscle sparing procedures, screw placement, and open-door versus French-door LP techniques were not abstracted. Thus, while

Table 3
Sociodemographic and surgical characteristics for subgroup analysis.

	Laminectomy and fusion	Laminoplasty	p-value*
Sample size, n	69	134	
Sociodemographic characteristics			
Mean age (SE) in years	66.9 (1.3)	64.6 (0.9)	.20
Surgical details			
Operative levels (SE)	3.6 (0.08)	3.7 (0.04)	.13
Mean surgical time (SE) in minutes	162 (7.8)	174 (5.1)	.09
Mean estimated blood loss (SE) in cc	258 (32)	178 (11)	.20
Postoperative details			
Total opioid use (SE) in MME	292 (33)	247 (22)	.19
Length of stay (SE) in days	4.5 (0.4)	3.8 (0.2)	.07

SE, standard error; MME, morphine milligram equivalents.

* p-values for age, operative levels, surgical time, and estimated blood loss were calculated using Mann-Whitney *U* tests; significance set at alpha .05.

inferences can be made from comparisons between operative levels, operative time, and estimated blood loss, the full surgical variability and impact is not fully elucidated. Additionally, neither baseline nor postoperative patient reported outcomes or VAS pain scores were collected. VAS data is commonly obtained by nursing staff at our institutions, but there is significant variability in the means and time of day of collection. Also, the scheduling of physical therapy is not uniform, and may have a strong influence on reported pain scores. We sought to avoid variability introduced by these factors by analyzing cumulative pain medication use, which was consistently written on an as needed basis for this cohort of opioid naïve patients. Furthermore, measures of baseline function and myelopathy severity were not consistently collected across cohorts, potentially confounding comparisons between groups. Additionally, the use of additional concurrent analgesic medications is a potential confounder. Most providers implemented multiagent regimens consisting of acetaminophen, an opioid, and a muscle relaxing agent. Using MME attempts to obviate the differences in potency between different opioid medications; however, variable impacts of frequency and dosing of alternative agents on opioid use and length of stay were not assessed. Similarly, the use of NSAIDs is a potential confounder to this study. Among our cohorts, NSAID use was rare and frequently limited in duration. Separately, inclusion was limited to opioid naïve patients to minimize cohort heterogeneity. Effectively, this limits our findings to this select group of patients. Lastly, our study did not track posthospitalization opioid medication use. Access to this information would provide more a complete picture of opioid use between the 2 groups.

Conclusions

In summary, our study found lower inpatient opioid pain medication use among DCM patients undergoing LP compared with LF. A higher percentage of LP opioid naïve patients achieved postoperative pain control with standard pain regimens and discharged home more quickly than LF patients. However, when operative levels including C2, T1, T2 were excluded from analysis, the differences in total opioid pain use and length of stay lost statistical significance, highlighting the importance of operative extent between LP and LF constructs. Future work will clarify the effect of confounding factors such as multimodal pain regimens, analyze both short and long-term patient reported outcomes, and assess for any correlation between perioperative opioid use and long-term dependence.

Declarations of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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