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Outpatient Posterior Lumbar Fusion

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Outpatient posterior lumbar fusion: a population-based analysis of trends and complication rates

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Abstract

STUDY DESIGN—Retrospective case control study

OBJECTIVE—To determine the nationwide trends and complication rates associated with outpatient posterior lumbar fusion (PLF).

SUMMARY OF BACKGROUND DATA—Outpatient lumbar spine fusion is now possible secondary to minimally invasive techniques that allow for reduced hospital stays and analgesic requirements. Limited data is currently available regarding the clinical outcome of outpatient lumbar fusion.

METHODS—The Humana administrative claims database was queried for patients who underwent 1–2 level PLF (CPT-22612 or CPT-22633 AND ICD-9-816.2) as either outpatients or inpatients from Q1 2007 to Q2 2015. The incidence of perioperative medical and surgical complications was determined by querying for relevant International Classification of Diseases and Current Procedural Terminology codes. Multivariate logistic regression adjusting for age, gender, and Charlson Comorbidity Index was used to calculate odds ratios (OR) of complications among outpatients relative to inpatients undergoing PLF.

RESULTS—Cohorts of 770 patients who underwent outpatient PLF and 26,826 patients who underwent inpatient PLF were identified. The median age was in the age 65–69 age group for both cohorts. The annual relative incidence of outpatient PLF remained stable across the study period (R^2=0.03, p=0.646). Adjusting for age, gender, and comorbidities, patients undergoing outpatient PLF had higher likelihood of revision/extension of posterior fusion (OR 2.33, CI 2.06–2.63, p<0.001), anterior fusion (OR 1.64, CI 1.31–2.04, p<0.001), and decompressive laminectomy (OR 2.01, CI 1.74–2.33, p<0.001) within one year. Risk-adjusted rates of all other postoperative surgical and medical complications were statistically comparable.

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CONCLUSIONS—Outpatient lumbar fusion is uncommonly performed in the United States. Data collected from a national private insurance database demonstrate a greater risk of postoperative surgical complications including revision anterior and posterior fusion and decompressive laminectomy. Surgeons should be cautious in performing posterior lumbar fusion in the outpatient setting as the risk of revision surgery may increase in these cases.

Keywords

arthrodesis; TLIF; PLIF; transforaminal lumbar interbody fusion; posterior lumbar interbody fusion; outpatient; ambulatory; pseudarthrosis; lumbar

INTRODUCTION

As concerns on rising healthcare costs in the United States mounts, interest has developed in outpatient spine surgery as a mechanism for population-level cost reduction.[1] This proposed strategy involves transitioning traditionally inpatient procedures to an ambulatory setting in appropriately selected patients to avoid costs associated with a standard postoperative hospital stay. Population-level studies have demonstrated that the incidence of outpatient spine surgery has increased over the last twenty years.[2] However, lumbar discectomies account for 70–90% of outpatient lumbar spine procedures performed in the United States, while outpatient fusions and laminectomies are comparatively uncommon. More recently, reports have emerged on successful outpatient anterior cervical discectomy and fusion with equivalent complication profiles, laying the groundwork to achieve instrumented spinal fusion in the ambulatory setting with well-defined patient selection criteria.[3,4]

While the hospital length of stay and complication rates following lumbar spinal fusion have steadily decreased secondary to minimally invasive techniques [e.g. posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF)] and improved postoperative analgesic protocols, outpatient posterior lumbar fusion (PLF) remains relatively uncommon.[5] This has been attributed to a steep learning curve for minimally invasive techniques, limited resources in the outpatient setting, pain control, and postoperative observation for neurological symptoms. Literature on outpatient 1–2 level PLF is limited to small case series from single institutions.[5–9] Though these studies have reported successful outcomes, they are limited by comparatively small samples sizes, short-term follow-up and outcome measures, and significant practitioner and patient selection bias. Typically, patients undergoing outpatient PLF are ideal surgical candidates with little to no medical comorbidities, thereby reducing the perioperative risk of surgery in the outpatient setting.[3] As minimally invasive techniques evolve and become more commonplace, outpatient PLF may become more attractive in carefully selected patients.

The purpose of this study was to use a large multi-institutional insurance records database to investigate national trends in outpatient 1–2 level PLF and to determine the frequency and risk of perioperative medical and long-term surgical complications requiring reoperation relative to inpatient PLF. Our initial hypothesis was that the incidence of outpatient PLF has increased over the last several years and that the perioperative complication rate of outpatient and inpatient PLF would be comparable.

MATERIALS AND METHODS

A retrospective review of the PearlDiver Patient Record Database (Colorado Springs, CO, USA) was conducted. This commercially available database consists of 20 million patient records from the Humana (Louisville, KY, USA) nationwide health insurance provider. Clinical diagnoses can be queried by using patient billing codes, including those classified by International Classification of Diseases (ICD) and Current Procedural Terminology (CPT).

Patients undergoing PLF were identified by querying the database using one of two primary index codes: (1) CPT-22612 [Arthrodesis, posterior or posterolateral technique, single level; lumbar (with lateral transverse technique, when performed] or (2) CPT-22633 [Arthrodesis, combined posterior or posterolateral technique with posterior interbody technique including laminectomy and/or discectomy sufficient to prepare interspace (other than for decompression), single interspace and segment; lumbar]. Only cases co-coded with ICD-9-816.2 (Fusion or refusion of 2–3 vertebrae) for 1–2 level fusion were included for both cohorts. Outpatients and inpatients were identified using service location modifiers “21” (inpatient) and “22” (outpatient), respectively. The service location modifier “22” represents discharge occurring from either a hospital or ambulatory surgery setting without an associated inpatient hospital admission and absolute length of stay less than 24 hours. Patient records were available for cases performed from Q1 2007 through Q2 2015 (to ensure inclusion of patients with sufficient follow-up for postoperative complications) and the demographic data for aggregate records included the patient age (reported as five-year ranges), gender, geographic location, year of procedure, and Charlson Comorbidity Index (CCI). The CCI is a well-validated prospective tool to determine one-year mortality based on 22 medical conditions.[10] Inferential statistics comparing the baseline age, gender, and regional distributions of the outpatient and inpatient cohorts was performed using χ^2 analysis. A two-tailed Student’s t-test was used to compare the baseline CCI of the two cohorts. A linear regression model was used to determine the R^2 coefficient to ascertain the trends for the annual incidence of procedures across the study period. Statistical significance was defined for $p<0.05$.

The aforementioned cohorts were queried to identify patients who had a series of postoperative surgical and medical complications based on CPT and ICD-9 codes, respectively. Surgical complications (Table 1) included hardware removal, surgical site infection (requiring irrigation and debridement (I&D), explantation of prosthesis, or evacuation), conversion to anterior fusion, revision or extension of posterior fusion, and decompressive laminectomy at both 6 months and 1 year following the primary index PLF. Neurological injury within 1 year was also queried. Medical complication categories (SDC Table 1) included deep vein thrombosis (DVT) and pulmonary embolism (PE) within 60 days; pneumonia, acute renal failure, and respiratory failure within 14 days; and acute myocardial infarction and cerebrovascular accident within 30 days. Using the PearlDiver statistical analysis package, multivariate logistic regression with patient age, gender, and CCI as covariates was performed to calculate adjusted odds ratios (OR) for each complication category with outpatient PLF treated as the exposed group.

RESULTS

A total of 770 patients who underwent outpatient 1–2 level PLF and 26,826 patients who underwent inpatient 1–2 level PLF were identified in the Humana database from 2007–2015 (Table 2). Across the study period, the overall incidence of outpatient PLF was 1.1 cases per 100,000 Humana-insured patients compared to 39.4 per 100,000 Humana-insured patients for inpatient PLF. The age distribution was younger for outpatient undergoing outpatient PLF when compared with inpatients ($p<0.001$) (Figure 1). For both cohorts, the median and mode age was in the 65–69 age group. The relative ratio of outpatient to inpatient PLF decreased with increased patient age ($R^2=0.662$, $p=0.002$). Females comprised 54.4% of outpatient PLF and 58.9% of inpatient PLF patients identified ($p=0.009$). The incidence of outpatient PLF was not equivalent between geographical regions ($p<0.001$), with the South region having the highest incidence of outpatient PLF (1.3 cases per 100,000). The mean CCI of outpatients and inpatients undergoing PLF were 1.63±2.57 and 2.52±2.71, respectively ($p<0.001$). The annual relative incidence of outpatient PLF remained stable across the study period ($R^2=0.03$, $p=0.646$).

Among surgical complications, the most common complications requiring reoperation at one year were revision and/or extension of posterior fusion (8.44% outpatient, 6.04% inpatient), conversion to anterior fusion (2.34% outpatient, 2.23% inpatient), and decompressive laminectomy (5.32% outpatient, 4.40% inpatient) (Table 3). All other surgical complications occurred in fewer than 1.4% of patients undergoing PLF in the outpatient and inpatient setting. When adjusting for patient age, gender, and CCI, patients undergoing outpatient PLF had a greater likelihood of posterior revision/extension (OR 2.33, CI 2.06–2.63, $p<0.001$), anterior fusion (OR 1.64, CI 1.31–2.04, $p<0.001$), and decompressive laminectomy (OR 2.01, CI 1.74–2.33, $p<0.001$); outpatient PLF was also associated with increased likelihood of posterior revision/extension (OR 2.18, CI 1.89–2.52, $p<0.001$) and decompressive laminectomy (OR 1.73, CI 1.44–2.08, $p<0.001$) at 6 months. Rates of surgical wound exploration and neurological injury could not be compared statistically due to database restrictions wherein bucket queries returning <11 patients are unspecified due to administrative restrictions. Rates of acute renal and respiratory failure were statistically comparable, while rates of thromboembolic and cerebrovascular events could not be compared statistically (Table 3).

DISCUSSION

With the increasing emphasis on value-based care and cost efficiency in this healthcare environment, surgeons and healthcare administrators are showing increasing interest in outpatient spine surgery as a realistic means for minimizing costs and burden associated with lengthy postoperative hospital courses and increasing satisfaction in an appropriately selected patient population.[11] This has primarily been in the form of outpatient lumbar discectomies, laminotomies, foraminotomies, anterior cervical discectomy and fusion, cervical disc arthroplasty, and cement augmentation procedures.[2,7,12,13] Over the past decade, minimally invasive techniques using tubular and other specialized retractors facilitated the emergence of PLF (TLIF, PLIF) in the outpatient setting through blunt dissection between muscle fibers, percutaneous pedicle screw placement, and indirect

visualization using image guidance. However, clinical data on outpatient lumbar fusion remains limited.[14] Due to this relatively recent emergence in the spine literature, information on national trends and complication rates in outpatient PLF are sparse, and its feasibility outside of small case series from high-volume institutions is poorly understood. To our knowledge, the present study reports the largest cohort of patients across multiple institutions evaluating the trends and postoperative complications associated with PLF performed in the outpatient setting.

Demographically, we found the age distribution of Humana-insured patients undergoing outpatient PLF to be younger when compared to that of the inpatient comparison cohort. The result that outpatient PLF patients were younger than their inpatient counterparts is expected given that patient eligibility for outpatient spine surgery is based on thorough evaluation of patients' medical comorbidities and general anesthetic and perioperative risk, to which older patients would be inherently more susceptible. Indeed, age is a known independent risk factor for perioperative complications in spine surgery.[15] Not surprisingly, the outpatient cohort in this study had a lower baseline CCI, consistent with the paradigm of careful patient selection by practitioners that has been reported in prior literature on outpatient PLF and spine surgery as a whole.[6,16,17] Furthermore, this study found that the relative incidence of outpatient PLF varied by geographical region, with the incidence being higher in the South than other regions. This regional epidemiology may be intrinsic to biases from the Humana® coverage pool, though it may also reflect practice patterns in the outpatient spine surgery literature in general, wherein the majority of early outcomes data to date has emerged from the South and Midwest.[6–8,18]

This study found that outpatient PLF was relatively uncommon in the United States, with just 770 cases reported from 2007–2015 in the entire Humana-insured patient population of more than 20 million subscribers annually. Moreover, there was no trend towards increase or decrease across the study period, which is contrary to our original hypothesis. Given the increasing trend of spine surgeries performed as outpatients, we expected that posterior lumbar surgery would follow this trend as well. Despite advances in minimally invasive techniques and postoperative pain control, lumbar fusion has a postoperative course and complication profile that makes it less palatable for spine surgeons to perform in the outpatient setting as compared to lumbar discectomy and ACDF. In addition, insurance approvals are likely more difficult to obtain in a surgery that typically occurs in an inpatient setting. However, direct-to-consumer marketing regarding minimally invasive surgery, financial pressures, and relationships with ambulatory surgery centers may influence surgeons to bring more of these cases to the outpatient setting especially if the patients are young and healthy.

While literature on outpatient spine surgery can be found from the 1990s, the earliest published case series on outpatient lumbar dates back to 2013 wherein Villavicencio and colleagues reported a series of 27 patients who underwent TLIF with discharge within 24 hours.[9] Compared to patient who had an overnight stay, they reported no significant differences in short-term complications. Since then, a handful of case series have been reported on PLF with ≤24 hours postoperative stay with equivalent outcomes and short-term complication profiles.[5,7,8,18,19] Of note, these previous studies all reported data from single

institutions with comparatively small sample sizes and limited data on long-term fusion and reoperation rates. They also neither provide population-level trends nor ascertain the feasibility of outpatient PLF in the general orthopedic community where it may have greatest impact on the American healthcare enterprise.

In context, the fact that outpatient PLF is relatively uncommon is reinforced by the central finding of this study that after adjusting for baseline demographics and comorbidities. outpatient PLF is associated with a higher risk of: (1) posterior revision/extension of fusion (OR 2.33 at one year), (2) conversion to anterior fusion (OR 1.64 at one year), and (3) stenosis requiring decompressive laminectomy (OR 2.01 at one year). To our knowledge, this is the first report of higher postoperative complication rates in the outpatient lumbar fusion literature. Given the careful selection of patients as candidates for outpatient PLF who are presumably healthier and more functional at baseline, the increased incidence of surgical complications is a concerning finding.

The underlying cause of the association between outpatient PLF and the elevated risk of revision surgery is not readily apparent. We surmise that this may be due to higher rates of postoperative pseudarthrosis necessitating instrumentation revision, though the likely etiology that would explain this difference between outpatients and inpatients is uncertain. Minimally invasive techniques allow for limited visualization of the spinal anatomy through tubular or specialized retractors and proper adherence to the principles of discectomy, endplate preparation, and interbody fusion may be difficult, despite the use of specialized instruments. With limited visualization, incomplete decompression may occur, leading to continued pain and symptoms from residual stenosis and the need for revision laminectomy. Also, the time pressure to complete the surgery efficiently and expeditiously in the ambulatory surgery center setting may contribute to these outcomes as surgeons rush to complete the procedure, thereby increasing the risk of incomplete decompression and pseudarthrosis. Adjacent segment disease (ASD) causing stenosis may further account for the reoperations requiring laminectomy at different levels than the index surgery. ASD with instability may contribute to the need to extend the fusion.

Of note, our study found equivalent incidence of other complications including surgical evacuation of hematoma, renal failure, and respiratory failure. These are important postoperative complications following PLF that may potentially affect the surgeon’s decision on outpatient discharge versus postoperative hospital stay. We acknowledge the possibility that provider selection may account for the higher complication rates observed in this study, wherein individual high-volume centers that have reported equivalent outcomes may be better equipped to perform PLF on an outpatient basis than the non-selected population of providers that is represented by the Humana database.

While the findings in this study are unique, such a study design has several limitations. First, the PearlDiver database has limited granularity and provides aggregate rather than individual patient data for privacy concerns. Because the database is searched by CPT and ICD codes, the available data on baseline health characteristics and complications are less comprehensive than are available through conventional chart review. Though this is partially mitigated by multivariate logistic regression controlling for CCI, this database design is still

susceptible to source data biases and errors from miscoding. Second, this design also limits analysis of early complications including emergency department presentations, hospitalizations, and readmission for postoperative anemia or pain control, which cannot be adequately captured using CPT and ICD codes. These events could significantly countermand cost savings associated with early discharge. Here, the use of billing service location modifiers as the primary query agent predisposes our data to ambiguity, wherein it is conceivable that due to variations or errors in coding practices patients who undergo "outpatient" PLF at an ambulatory surgery center may be subsequently admitted to a hospital building under a separate inpatient encounter. Third, it is difficult to ascertain the relative efficacy of various approaches to lumbar fusion (e.g. posterolateral arthrodesis versus PLIF versus TLIF). Finally, the database provides no information on functional or patient-reported outcomes. While this was beyond the scope and intent of the study, it should be incorporated to determine the relative effectiveness of outpatient PLF.

In summary, outpatient lumbar fusion remains uncommon in the United States. Data collected from a national private insurance database demonstrates greater risk of perioperative surgical complications including revision anterior and posterior surgery postoperatively, as well as higher risk for decompressive laminectomy postoperatively. This may signify an increased risk of pseudarthrosis, continued stenosis and/or instability, and persistent or recurrent symptoms. Surgeons should be aware of the potential risks for revision and reoperation with outpatient PLF and counsel patients appropriately.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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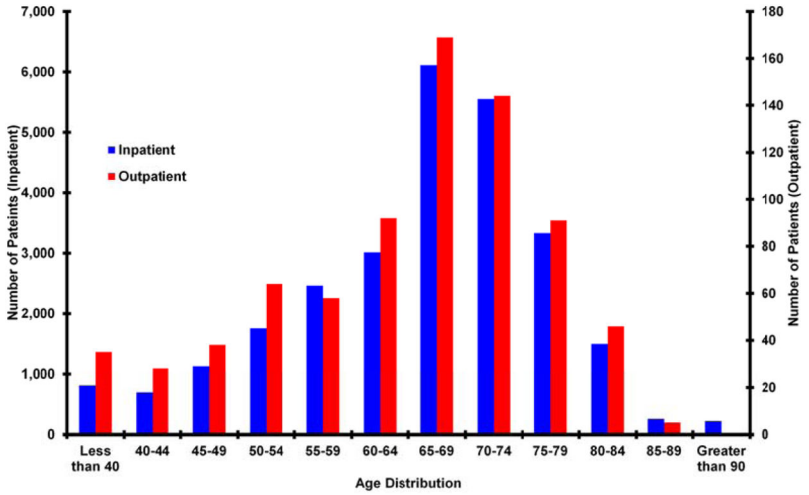

FIGURE 1.

Age distributions of Humana-insured patients undergoing PLF as either an outpatient (red) or inpatient (blue). The age distributions between the two groups are statistically comparable. For both cohorts, the median and mode age was in the 65–69 age group.

Table 1

List of queried surgical complications following PLF

Complication Category	Code	Code Description
I&D/Explantation/Evacuation	CPT-22015	Incision and drainage, open, of deep abscess (subfascial), posterior spine; lumbar, sacral, or lumbosacral
	CPT-22830	Exploration of spinal fusion
	CPT-63267	Laminectomy for excision or evacuation of intraspinal lesion other than neoplasm, extradural; lumbar
Posterior Revision/Extension	CPT-22612	Arthrodesis, posterior or posterolateral technique, single level; lumbar (with lateral transverse technique, when performed)
	CPT-22614	Arthrodesis, posterior or posterolateral technique, single level; each additional vertebral segment
	CPT-22630	Arthrodesis, posterior interbody technique, including laminectomy and/or discectomy to prepare interspace (other than for decompression), single interspace; lumbar
	CPT-22632	Arthrodesis, posterior interbody technique, including laminectomy and/or discectomy to prepare interspace (other than for decompression), single interspace; each additional interspace
	CPT-22633	Arthrodesis, combined posterior or posterolateral technique with posterior interbody technique including laminectomy and/or discectomy sufficient to prepare interspace (other than for decompression), single interspace and segment; lumbar
	CPT-22634	Arthrodesis, combined posterior or posterolateral technique with posterior interbody technique including laminectomy and/or discectomy sufficient to prepare interspace (other than for decompression), single interspace and segment; each additional interspace and segment
Anterior Fusion	CPT-22558	Arthrodesis, anterior interbody technique, including minimal discectomy to prepare interspace (other than for decompression); lumbar
	CPT-22585	Arthrodesis, anterior interbody technique, including minimal discectomy to prepare interspace (other than for decompression); each additional interspace
	CPT-22845	Anterior instrumentation; 2 to 3 vertebral segments (List separately in addition to code for primary procedure)
Decompressive laminectomy	CPT-63042	Laminotomy (hemilaminectomy), with decompression of nerve root(s), including partial facetectomy, foraminotomy and/or excision of herniated intervertebral disc, reexploration, single interspace; lumbar
	CPT-63044	Laminotomy (hemilaminectomy), with decompression of nerve root(s), including partial facetectomy, foraminotomy and/or excision of herniated intervertebral disc, reexploration, single interspace; each additional lumbar interspace
	CPT-63045	Laminectomy, facetectomy and foraminotomy (unilateral or bilateral with decompression of spinal cord, cauda equina and/or nerve root[s], [eg, spinal or lateral recess stenosis]), single vertebral segment; cervical
	CPT-63048	Laminectomy, facetectomy and foraminotomy (unilateral or bilateral with decompression of spinal cord, cauda equina and/or nerve root[s], [eg, spinal or lateral recess stenosis]), single vertebral segment; each additional segment, cervical, thoracic, or lumbar
Neurological deficit	ICD-9-344[#]	Other paralytic syndromes

[*] Excludes cases with concomitant codes for I&D and Explantation of Prosthesis

[#] Includes all ICD sub-codes

Table 2

Age, gender, regional, and case year distributions of study cohorts

	Outpatient PLF (N=770)		Inpatient PLF (N=26826)		
	N	[a] Incidence (per 100,000)	N	[a] Incidence (per 100,000)	
Age					
Less than 40	35	0.3	814	6.9	0.04
40 to 44	28	1.2	696	29.4	0.04
45 to 49	38	1.3	1123	39.1	0.03
50 to 54	64	1.8	1756	50.4	0.04
55 to 59	58	1.5	2463	63.5	0.02
60 to 64	92	2.3	3016	74.6	0.03
65 to 69	169	1.2	6109	45.0	0.03
70 to 74	144	1.2	5550	46.3	0.03
75 to 79	91	1.0	3332	37.0	0.03
80 to 84	46	0.8	1496	24.4	0.03
85 to 89	5	0.2	254	10.8	0.02
90+	0	0.0	217	4.7	-
Gender					
Male	351	0.8	11023	34.3	0.03
Female	419	0.9	15803	36.0	0.03
Geographical region					
Midwest	147	0.8	7003	35.6	0.02
Northeast	13	0.3	557	10.6	0.02
South	532	1.3	16368	40.1	0.03
West	78	0.8	2898	28.0	0.03
Case year					
2007	46	0.7	1561	24.8	0.03
2008	62	0.9	2064	30.1	0.03
2009	57	0.9	2492	39.6	0.02
2010	77	1.3	2727	46.2	0.03
2011	77	1.2	3050	46.7	0.03

	Outpatient PLF (N=770)		Inpatient PLF (N=26826)		
	N	**[a] Incidence (per 100,000)**	**N**	**[a] Incidence (per 100,000)**	
2012	92	1.3	3442	47.8	0.03
2013	122	1.5	4984	50.5	0.03
2014	150	1.6	4649	48.2	0.03
2015	87	N/A	2857	N/A	0.03

[a]Incidence per 100,000 Humana-insured patients

[b]N/A where complete incidence data not available for 2015 calendar year at time of query

Table 3

Frequency and adjusted odds ratio (OR) of surgical and medical complications following outpatient PLF

	Outpatient PLF (n=770)		Inpatient PLF (n=26826)			
	N	**Frequency (%)**	**N**	**Frequency (%)**	**¥ Adjusted OR (for outpatient PLF)**	**p-value**
Surgical Complications						
I&D/Explantation/Evacuation (at 6 months)	*	*	323	1.20%	*	*
I&D/Explantation/Evacuation (at 1 year)	*	*	341	1.27%	*	*
Posterior Revision/Extension (at 6 months)	53	6.88%	1104	4.12%	**2.18 (1.89–2.52)**	**<0.001**
Posterior Revision/Extension (at 1 year)	65	8.44%	1620	6.04%	**2.33 (2.06–2.63)**	**<0.001**
Anterior Fusion (at 6 months)	*	*	354	1.32%	*	*
Anterior Fusion (at 1 year)	18	2.34%	597	2.23%	**1.64 (1.31–2.04)**	**<0.001**
Decompressive Laminectomy (at 6 months)	31	4.03%	791	2.95%	**1.73 (1.44–2.08)**	**<0.001**
Decompressive Laminectomy (at 1 year)	41	5.32%	1181	4.40%	**2.01 (1.74–2.33)**	**<0.001**
Neurological Injury	*	*	296	1.10%	*	*
Medical Complications						
DVT	*	*	310	1.16%	*	*
PE	*	*	337	1.26%	*	*
Pneumonia	*	*	19	0.07%	*	*
Acute renal failure	24	3.12%	985	3.67%	1.09 (0.85–1.40)	0.499
Respiratory failure	16	2.08%	729	2.72%	1.24 (0.95–1.63)	0.111
MI	*	*	244	0.91%	*	*
Cerebrovascular accident	*	*	303	1.13%	*	*

*Indicates complications where <11 cases were reported and unspecified due to administrative restrictions for patient confidentiality, corresponding to a frequency of <1.4%; OR cannot be defined for these instances

¥Adjusted OR derived from multivariate logistic regression with patient age, gender, and Charlson Comorbidity Index (CCI) used as covariates