

**Research Article**

# Risk Factors Associated with Wound Complications Following Laminectomy for Intradural Extramedullary Tumors

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## Abstract

**Objective:** To determine the risk factors for 30-day wound complications following laminectomy for intradural extramedullary tumors. **Methods:** Adult patients undergoing laminectomy for intradural extramedullary tumors from 2012 to 2018 were identified in the National Surgical Quality Improvement Program database. Patients undergoing laminectomy for intradural extramedullary tumor were substratified into 2 cohorts: no wound complication or presence of wound complication, defined as superficial wound infection, deep wound infection, and dehiscence. In this analysis, pre-operative patient characteristics and demographic variables such as Age, BMI, Gender, ASA Class, Smoking, Functional Status, Diabetes, Chronic Obstructive Pulmonary Disease, Congestive Heart Failure, Hypertension, Renal Failure, Dialysis, Weight Loss, Steroid Use, Bleeding Disorder, Dyspnea at Rest, Dyspnea at moderate Exertion, and General Anesthesia were assessed. 30-day wound, cardiac, pulmonary, and thromboembolic complications, as well as mortality, postoperative transfusions, extended length of stay, and reoperation were assessed. Bivariate analyses, including chi-squared and analysis of variance, and multivariable logistical regression were performed. **Results:** Of 2,027 total patients undergoing laminectomy for intradural extramedullary tumor, 42 (2%) had wound complications. There were 383 cervical laminectomies with 10 (3%) associated wound complications, 868 thoracic laminectomies with 15 (2%) associated wound complications, and 776 lumbar laminectomies with 17 (2%) wound complications. Following adjustment, patients with wound complications were more likely to have high body mass index (OR 1.05, P=0.01) and weight loss (OR 12.23, P<0.001). Following adjustment, wound complication was also found to be associated with return to the operating room within thirty days (OR 35.09, P<.001) and length of stay greater than five days (OR 2.46, P<0.008). Mean days to any wound related complication was 14.85 days. Mean days to wound complication was 16 days for superficial surgical site infection (18 patients), 16 days for deep surgical site infection (16 patients), and 18 days for dehiscence (10 patients). **Conclusion:** Preoperative weight loss and increased body mass index were associated with increased odds of wound related complications. Wound related complication was also associated with increased odds of length of stay greater than five days and return to the operating room. **Level of Evidence:** Level III; Retrospective Case-Control Design using Large Database; Prognosis Study.

**Keywords:** Extramedullary; Intradural; Laminectomy; Spine; Tumors; Wound

Nerve sheath tumors and meningiomas compose the majority of IDEMTs, with neurofibromas, teratomas, lipomas, and metastases composing a minority [3]. Treatment typically involves surgical resection, which has a favorable prognosis and outcome [4,5].

## Introduction

Intradural Extramedullary Tumors (IDEMT) of the spine are uncommon with an incidence of 0.4 per 100,000 individuals [1]. Nonetheless, they account for 40-60% of all spinal tumors [1,2].

Despite the advances of medical and surgical care, surgical site infections and wound complications remain a major cause of morbidity following IDEMT resection and spine surgery in

general [6-11]. Incidence varies with different types of spinal surgery but range from 2 to 10% [12]. Surgical site infections are associated with a substantial increase in mortality, hospital stay, and healthcare costs [8,11,13,14]. A recent study by Villavicencio et al. determined that wound-related complications are the most common cause of readmission after spinal surgery [11]. Wound complication rates also tend to be worse in oncology patients, with higher rates of infection and mortality [15,16].

To the best of our knowledge, no study has examined the predictors of wound complications following IDEMT surgery. As such, the aim of this study was to determine the incidence and risk factors for 30-day wound complications following laminectomy for IDEMTs utilizing the National Surgical Quality Improvement Program database between 2012 to 2018.

## Methods

### Data Source

This was a retrospective cohort study using data from 2012 to 2018. American College of Surgeons, National Surgical Quality Improvement Program (ACS-NSQIP) database. ACS-NSQIP is a hospital-based registry drawing clinical data from more than 500 hospitals located in various socioeconomic communities and academic affiliations. The NSQIP database contains detailed information on demographic, preoperative, intraoperative, and 30-day post-operative outcome factors and empirically analyzes these variables to provide risk-adjusted estimates of post-operative complications. Quality improvement programs utilizing ACS-NSQIP have successfully reduced 30-day postoperative outcomes.

### Selection Criteria

Current Procedural Terminology codes used were 63280, 63281, and 63282 for laminectomy of cervical, thoracic, and lumbar IDEMTs respectively. Wound complication included superficial wound infection, deep wound infection, or wound dehiscence. Patients were divided into two cohorts: wound complication or no wound complication.

### Patient Demographics and Variables

Patient demographic and risk factor characteristics were assessed. Demographic variables included age ( $\geq 65$  years) and gender. Preoperative characteristics included diabetes, weight loss, Body Mass Index (BMI), dyspnea (at rest or moderate

exertion), current smoking status, steroid use, bleeding disorders, functional status (independent, partially/totally dependent  $\leq 30$  days before surgery, or unknown), previous surgeries (general anesthesia  $\leq 30$  days before surgery), cardiac comorbidity (history of hypertension or Chronic Heart Failure [CHF]  $\leq 30$  days before surgery), pulmonary comorbidity (history of Chronic Obstructive Pulmonary Disease [COPD]  $\leq 30$  days before surgery), renal comorbidity (history of dialysis or renal failure  $\leq 30$  days before surgery), and physical status (American Society of Anesthesiologist [ASA] classification). Operative patient characteristics included tumor location (cervical, thoracic, or lumbosacral). Postoperative variables included mortality, thromboembolic complication (pulmonary embolism or deep vein thrombosis), cardiac complication (cardiac arrest or myocardial infarction), neurological complication (Cerebrovascular Accidents [CVA]), intraoperative or postoperative red blood cell transfusion, prolonged length of stay (LOS)  $\geq 5$  days, and unplanned readmission (reoperation related to the initial procedure).

### Statistical Analysis

Pearson's Chi-squared ( $\chi^2$ ) test was used to perform univariate analysis on baseline patient demographics, preoperative, operative, and post-operative characteristics and post-operative wound complication. Multivariate Logistic regression was performed while adjusting for patient risk factors. Level of significance was set to 0.05. Odds Ratios (OR) were calculated with a 95% Confidence Interval (CI). All statistical analyses were performed using Stata Version 17.

## Results

### Study Population

A total of 2,027 patients were included in the study: 42 (2%) presented with wound complications and 1985 (98%) without wound complication. IDEM tumor location-specific analysis revealed 10 (3%) cervical laminectomies (n=383), 15 (2%) thoracic laminectomies (n=868), and 17 (2%) lumbar laminectomies (n=776) had associated post-operative wound complications (Table 1). Mean days to any wound complication was 14.85 days. Mean days to wound complication associated with superficial surgical site infection (18 patients), deep surgical site infection (16 patients), and dehiscence (10 patients) were 16 days, 16 days, and 18 days, respectively (Table 2).

Location	No Wound Complication	Wound Complication	Rate
Cervical	373	10	3%
Thoracic	853	15	2%
Lumbar	759	17	2%
Total	1985	42	2%

**Table 1:** Wound complication by location of intradural extramedullary tumor laminectomy.

Wound Complication	# of patients	Days to complication	Std Dev	Min	Max
Superficial Surgical Site Infection	18	15.72	6.76	5	29
Deep Surgical Site Infection	16	15.75	7.72	6	30
Dehiscence	10	17.50	6.59	11	29

**Table 2:** Days to wound complication.

#### Unadjusted Analysis

Patients with post-laminectomy wound complications frequently have higher BMI (32.92 kg/m<sup>2</sup> vs. 29.24 kg/m<sup>2</sup>; P=0.0007), weight loss (7% vs. 1%; P<0.0001) history of hypertension (55% vs. 39%; P=0.043) and diabetes (21% vs. 13%; P=0.09) (Table 3). Univariate analysis of post-operative outcomes demonstrated that patients with wound complications have prolonged LOS ≥5 days (59.52% vs. 37.23%; P=0.001) and unplanned admittance for reoperation (P<0.001) (Table 4).

	No Wound Complication	%	Wound Complication	%	P-Values
Total	1985		42		
Cervical	373	19%	10	24%	0.575
Thoracic	853	43%	15	36%	
Lumbar	759	38%	17	40%	
Age (Mean)	54.97		55.09		0.961
<b>BMI (Mean)</b>	<b>29.24</b>		<b>32.92</b>		<b>0.0007</b>
Male	903	45%	21	50%	0.562
Female	1082	55%	21	50%	
ASA Class 1	76	4%	1	2%	0.69
ASA Class 2	801	40%	14	33%	
ASA Class 3	1006	51%	24	57%	
ASA Class 4	98	5%	3	7%	
Smoking	290	15%	6	14%	0.953
Functional Status - Independent	1855	93%	38	90%	0.571
Functional Status - Dependent	104	5%	4	10%	
Functional Status - Totally Dependent	17	1%	0	0%	
Functional Status - Unknown	9	0%	0	0%	
<b>Diabetes</b>	<b>250</b>	<b>13%</b>	<b>9</b>	<b>21%</b>	<b>0.09</b>
Chronic Obstructive Pulmonary Disease	54	3%	2	5%	0.424
Congestive Heart Failure	3	0%	0	0%	0.801
<b>Hypertension</b>	<b>781</b>	<b>39%</b>	<b>23</b>	<b>55%</b>	<b>0.043</b>
Renal Failure	0	0%	0	0%	
Dialysis	4	0%	0	0%	0.771
<b>Weight Loss</b>	<b>17</b>	<b>1%</b>	<b>3</b>	<b>7%</b>	<b>&lt;0.001</b>

Steroid Use	132	7%	3	7%	0.899
Bleeding Disorder	35	2%	0	0%	0.385
Dyspnea at rest	4	0%	0	0%	0.459
Dyspnea at mod exertion	67	3%	0	0%	0.459
General Anesthesia	1978	100%	42	100%	0.997

**Table 3:** Patient Characteristics and Demographic Variables.

	Odds ratio	lower CI bound	upper CI bound	p-value
<b>BMI</b>	<b>1.05</b>	<b>0.01</b>	<b>1.01</b>	<b>1.092</b>
Diabetes	1.14	0.49	2.65	0.769
Hypertension	1.88	0.88	4.05	0.105
<b>Weight Loss</b>	<b>12.23</b>	<b>3.27</b>	<b>45.75</b>	<b>&lt;0.001</b>

**Table 4:** Risk Factor Analysis.

### Multivariate Analysis

Multivariate logistic regression analysis of risk-adjusted 30-day morbidity and mortality outcomes revealed that patients with post-laminectomy wound complications were more likely to have high body mass index (OR 1.05, 95% CI 1.01-1.092; P = 0.01) and weight loss (OR 12.23, 95% CI 3.27-45.75; P<0.001) (Table 5). Wound complication was also found to be associated with return to the operating room within thirty days (OR 35.09, 95% CI 17.49-70.40; P<.001), and LOS  $\geq$ 5 days (OR 2.46, 95% CI 1.26-4.78; P<0.008) (Table 6).

	No Wound Complication	%	Wound Complication	%	P-Values
Total	1985		42		
Cardiac Arrest	5	0.25%	0	0.00%	0.745
Myocardial Infarction	2	0.10%	0	0.00%	0.837
Deep Vein Thrombosis	28	1.41%	1	2.38%	0.6
Pulmonary Embolism	19	0.96%	0	0.00%	0.524
CVA or Stroke	4	0.20%	0	0.00%	0.771
Mortality	20	1.01%	0	0.00%	0.513
Transfusion	87	4.38%	1	2.38%	0.529
<b>Length of Stay &gt; 5 days</b>	<b>739</b>	<b>37.23%</b>	<b>25</b>	<b>59.52%</b>	<b>0.001</b>
<b>Return to OR</b>	<b>67</b>	<b>3.38%</b>	<b>23</b>	<b>54.76%</b>	<b>&lt;0.001</b>

**Table 5:** Post-operative Outcomes.

	Odds ratio	lower CI bound	upper CI bound	p-value
Length of Stay > 5 days	2.46	1.26	4.78	0.008
Return to OR	35.09	17.49	70.40	<0.001

**Table 6:** Post-operative Outcomes Analysis.

## Discussion

Despite their uncommon nature, IDEMTs pose a challenge in both surgical and medical management. As such, studying postoperative complications of IDEMT surgery, such as surgical site infections, and their predictors could highlight opportunities of risk-reduction and treatment optimization in IDEMT surgery. Given the diversity of spinal surgery, it is important to specifically examine IDEMT surgery rather than infer from work done on other types of spinal surgery. This study found that preoperative high body mass index and weight loss were associated with increased odds of wound related complications within 30-days of IDEMT laminectomy. Furthermore, wound related complications were also associated with postoperative increased odds of length of stay greater than five days as well as readmission [17-21]. Pre-operative obesity was associated with increased odds of wound complications after IDEMT surgery in our study. The association between obesity and post-operative complications has been reported in many types of spine surgery [10,22-24]. It has also been repeatedly detected in the NSQIP database. Ahn et al. examined NSQIP data and found that obesity is a risk factor for non-home discharge [25]. Another study examining NSQIP data found that high BMI was a risk factor for developing hospital acquired conditions (including wound infection), after spinal tumor excision [15]. The association of obesity with surgical infections is widely recognized and is hypothesized to be due to a combination of immunosuppression, wound healing delay, disrupted micro- and macro-circulation, lymphedema, and impaired skin [26]. Awareness of this could help in risk stratification and preoperative medical management in patients with high BMI.

Weight loss was the other factor associated with wound complications in our study. Anand et al. also found weight loss as a risk factor for wound infection post-spinal fusion and decompression [9]. Weight loss is a multifactorial phenomenon that can be caused by a wide range of causes. For example, preoperative weight loss could indicate alterations in appetite or ability to eat. Cervical compression by IDEMTs may alter an individual's ability to consume food. Decreased nutritional status has also been found in the literature to predispose individuals to impaired wound healing and subsequent postoperative wound-related complications. This association is important as it may imply that optimization of preoperative nutritional status could decrease the risk of wound complications. Furthermore, weight loss could also be caused by cancer. While IDEMTs are benign, preoperative weight loss may imply a concomitant disseminated oncologic process. Malignancy is known to lead to impaired immune function, metabolic demand, and weight loss, which together may lead to poor wound healing.

The incidence of wound complications we found following IDEMT laminectomy (2%) was similar to that found in the literature [6-8]. Safaei et al. found a 5% incidence of wound infection following 221 IDEMT resections [6]. Bhimani, et al. analyzed 991 IDEMT patients using NSQIP data and found a 2.5% incidence of wound complications [7]. This rate seems to

be comparable to rates of wound complications seen in general extradural spine surgery [9-11]. For instance, Schoenfeld et al. analyzed NSQIP data of patients undergoing spine surgery and found a 2.3% incidence of wound complications [10], and Veeravagu, et al. analyzed NSQIP data of patients undergoing spinal decompression and fusion and found a 3% infection rate [9]. Overall, these findings further support surgical excision as a safe option for the treatment of IDEMTs, with a risk of infection comparable to that of general spine surgery.

Interestingly, aside from preoperative BMI and weight loss, other preoperative patient characteristics such as age, smoking, steroid use, diabetes, cardiac complications, and other systemic comorbidities were similar between those with and without postoperative wound related complications. This suggests that BMI and weight loss are the main risk factors for those undergoing surgery for IDEM spinal tumors. Our results support the possibility that patient management for wound complications should focus on weight management and understanding the drivers of preoperative weight loss. ASA classification, steroid use, smoking, diabetes, and systemic comorbidities have been shown to predict worse outcomes in other forms of spinal surgery [10,11,16,21,22,25,27,28]. Nonetheless, they did not reach statistical significance in our analysis. This may be due to the fact the IDEM tumors are non-malignant and lack systemic symptoms. The main issue with this tumor type is the ability for a surgeon to perform surgical decompression. Furthermore, IDEM tumor resection requires relatively smaller incision compared to more complex surgery types such as adult spinal deformity or multi-level fusion. Finally, those with IDEM tumor causing spinal cord compression may have lower rates of degenerative spine conditions compared to other indications requiring spinal surgery. Further studies are needed to understand why BMI and weight loss may be the main risk factors for wound complications following resection of IDEM tumors.

This study has several limitations. As with any retrospective analysis, we were limited by the variables recorded in the NSQIP database. For example, we could not account for tumor characteristics (size, malignancy, histologic type, etc.). This is important knowing the diversity of IDEMTs. We were also not able to account radiotherapy/chemotherapy use, which can have important implications on wound healing and infection. In addition, we could not track complications that occurred more than 30 days after surgery and therefore our results might not be applicable for long-term follow-up. Nonetheless, the use of NSQIP allowed us to analyze a good sample size for an otherwise uncommon pathology. The continued growth of NSQIP will continue to allow progressively better powered studies.

## Conclusion

This study found that BMI and weight loss are associated with post-operative wound complications. Furthermore, wound complications following laminectomy for IDEMTs were associated with increased length of stay and return to the operating room.

Preoperative optimization of nutritional status and BMI may be associated with risk of wound complications.

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