


A nationwide analysis of 30-day adverse events, unplanned readmission, and length of hospital stay after peripheral nerve surgery in extremities and the brachial plexus

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Background: Little is known on adverse events and their timing after peripheral nerve surgery in extremities. The aim of this study is to identify predictors and typical timing of complications, unplanned readmission, and length of hospital stay for patients undergoing peripheral nerve surgery in the extremities.

Methods: Data were extracted from the National Surgical Quality Improvement Program (NSQIP) registry from 2005 to 2015. Adult patients undergoing peripheral nerve surgery in the extremities were included. A subgroup analysis was performed for brachial plexus operations. Multivariable logistic regression was performed to identify predictors of any complication, surgical site infection, unplanned readmission, and reoperation.

Results: A total of 2,840 patients were identified; 628 were brachial plexus operations. Overall complications were 4.4% and 7.0%, respectively. Median time for occurrence of any complication was 8 days. The most common complications were wound-related (1.7%), which occurred at a median of 15 days postoperatively. Reoperation occurred in 1.8% of all cases; most commonly for musculoskeletal repair (16.7%). Unplanned readmissions occurred in 2.3% and were most often due to wound-related problems (24.1%). Preoperatively contaminated wounds, inpatient procedures, and longer operative time seemed to have the most influence on all adverse events. In brachial plexus pathology, insulin-dependent diabetes and emergency cases also negatively affected outcomes.

Conclusions: Complications usually occur one to two weeks postoperatively. Preoperatively contaminated wounds, inpatient procedures, and longer operative times influence outcome. Anatomical level of operation results in significantly different lengths of hospital stay; brachial plexus pathology has the longest length of stay.

1 | INTRODUCTION

Peripheral nerve surgery encompasses a small but diverse group of procedures, including nerve repair after trauma, tumor excision, and decompression for nerve entrapment. The literature regarding short-term complications after such procedures is sparse, and few studies

have examined the factors that contribute to their development. With increasing interest in cost-effectiveness and postoperative quality of life, understanding the prevalence and risk factors for adverse events after peripheral nerve surgery is increasingly important.

Studies examining complications after peripheral nerve surgery in extremities have typically been small, single-center case series. Many

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such studies have not specifically investigated the many possible pre- and perioperative factors influencing outcomes (Benson et al., 2006; Hilton, Jacob, Househam, & Tengah, 2007; Humphreys, Novak, & Mackinnon, 2007; Louis, Greene, & Noellert, 1985; Schmelzer, Della Rocca, & Caplin, 2006; Wood, & Wood, 2003). Complication incidence has been reported to vary from as little as 0.74% for any complication following open carpal tunnel release (Benson et al., 2006), to 12% of patients experiencing wound dehiscence after peroneal nerve decompression (Wood & Wood, 2003).

The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database is a prospectively-collected, multi-center dataset. These kinds of datasets tend to be more generalizable and less subject to bias when compared to single-center datasets, and can more easily help to identify independent predictors of adverse events (Dasenbrock et al., 2015; Lim, Parsa, Kim, Rosenow, & Kim, 2015). The goal of this study was to identify possible predictors and typical timing of complications, unplanned readmission, and time to hospital discharge among adult patients undergoing peripheral nerve surgery in extremities. These results could serve as a basis on which health care practitioners can provide safe and effective postoperative management for patients undergoing extremity peripheral nerve operations, both before and after hospital discharge.

2 | PATIENTS AND METHODS

Data from the ACS NSQIP registry were used from 2005 to 2015. The registry currently reports data from 603 participating hospitals nationwide on preoperative patient characteristics as well as 30-day postoperative data. The number of hospitals participating increases yearly. Trained surgical reviewers prospectively collect data for NSQIP using a uniform protocol. The data include patient characteristics, postoperative complications, reoperations, readmissions with associated diagnoses, and time to event in days. The NSQIP dataset has been previously validated (Sellers et al., 2013), and has been used to evaluate outcomes for multiple microsurgical procedures (Bydon et al., 2014; Dasenbrock et al., 2015; Garg, Merrell, Hillstrom, & Wolfe, 2011; Jubbal, Echo, Spiegel, & Izaddoost, 2017; Jubbal, Zavlin, & Suliman, 2017; Mlodinow, Ver Halen, Rambachan, Gaido, & Kim, 2013). Our Institutional Review Board has exempted the NSQIP database from review.

Patients were included that met the following criteria: (1) age 18 years or older; (2) with a current procedural terminology (CPT) code specifically indicating peripheral nerve surgery in extremities. Fox and Mackinnon, 2011 Patients were excluded for the following: (1) CPT codes for head and neck surgery; (2) CPT codes with unspecified nerves.

Pertinent covariates collected by NSQIP were extracted. Sex and preoperative functional status were evaluated. Age was examined in quartiles (18–50, 51–65, 66–75, 76+ years), as were operative times (<44, 44–75, 75–150, >150 minutes). The American Society of Anesthesiologists (ASA) classification was examined categorically (I–II versus III–V). Covariates collected by NSQIP were evaluated when they were present in at least 20 patients and had <10% missing cases: smoking (in the past year), hypertension requiring medication, dyspnea, chronic

obstructive pulmonary disease (COPD), diabetes mellitus, and any bleeding disorder (defined by NSQIP as vitamin K deficiencies, hemophilia, thrombocytopenia, and long-term anticoagulant usage). Body mass index (BMI) was determined based on height and weight and distributed as follows: 18–24.99 kg/m² (normal range), <18 kg/m² (underweight), 25–34.99 kg/m² (overweight and WHO obesity class I), ≥35 kg/m² (WHO obesity class II and III). Preoperative steroid usage (within 30 days) was also extracted. An open wound is defined by NSQIP as any incision that directly communicates with air, regardless of infection. Preoperative systemic inflammatory response syndrome with or without proven infection was also evaluated, as was admission type and case urgency (emergency or elective, as defined by surgeon). Clean wounds were classified as Class I and compared to Class II (clean/contaminated), Class III (contaminated) and Class IV (dirty/infected).

Unplanned readmission, reoperation, and death within 30 days were extracted; other complications were categorized as neurological (cerebrovascular accident), cardiovascular (cardiac arrest, myocardial infarction), hematologic, pulmonary, wound-related and other infectious complications. Time to event was obtained as well as whether the complication occurred prior to hospital discharge. Nonroutine discharge was characterized as a discharge to any facility other than home. Unplanned reoperations have been reported since the initiation of NSQIP, while unplanned readmissions have only been reported since 2011. Reasons for readmission or reoperation have only been tracked since 2012. Reasons for readmission are defined as primary diagnosis code for readmission; reasons for reoperation are coded with associated CPT codes and International Statistical Classification of Diseases and Related Health Problems (ICD-9) diagnosis codes. Length of hospital stay was assessed by selection of patients that were coded to receive an inpatient procedure. We further divided this subset of patients into 4 different groups, based on anatomical level of operation as coded by CPT: digits/hand/foot (1), arm/leg (2), lumbar plexus (3), brachial plexus (4). A subgroup analysis was performed on patients who underwent brachial plexus operations. Cases were selected using CPT codes 64713, 64861 and ICD-9 codes 353.0, 953.4. The same methods were used as described above.

Covariates with >1% missing data were stratified into a separate “missing” group for use in logistic regression. Descriptive statistical analyses were performed on baseline demographics after categorization. Any significant differences between strata for categorical variables were assessed using univariable logistic regression. Multivariable analysis was performed thereafter to maximize parsimony and avoid overfitting. Multivariable models were built to identify independent predictors of any postoperative complications, surgical site infection, reoperation, and readmission in all cases of peripheral nerve surgery in extremities. A separate multivariable model was created for any complication in our subgroup analysis of brachial plexus patients. Bonferroni corrections were used to correct for multiple comparisons. For all tests, $P < .05$ was considered significant. For each model a Hosmer-Lemeshow test for goodness of fit was performed and an area under the operating curve was calculated. A Kruskal-Wallis test was performed to assess statistical difference in length of stay between categorized CPT groups, and post-hoc tests were applied to assess differences between

individual groups. Statistical analyses were conducted using IBM® (Armonk, New York) Statistical Package for the Social Sciences (SPSS)® version 24 (IBM Inc., 2016). The boxplot for length of hospital stay was created with R version 3.3.2 (R Core Team, 2016), in which outliers were ignored.

3 | RESULTS

3.1 | Demographics of study population

In our final analysis, 2,840 patients were included. Reported comorbidities, demographics and operative times are shown in Table 1. Cases included involved neuroplasties (including but not limited to neurolysis, transposition, and/or decompression), suturing of nerves and nerve grafting. Median, ulnar and cranial nerve neuroplasty cases were not

registered in NSQIP. CPT codes for transection or induced avulsion of nerves and excisional nerve procedures were also not registered. A total of 628 brachial plexus patients were selected for subgroup analysis. Most cases were injuries treated with neuroplasty and suturing of nerves.

3.2 | Any complication

Overall, any postoperative complication occurred in 4.4% of the population (Table 2). In brachial plexus cases specifically, 7.0% had any complication. One person died within 30 days postoperatively; no reason for death was coded. Blood transfusion was the most common hematologic complication occurring in 0.8% of all patients, more than half them were after brachial plexus surgery. DVTs occurred in only 4 patients, of which 2 were brachial plexus cases. The most common

TABLE 1 Demographics of study population

Characteristic (%)	Definition	Total (n = 2,840)	Any complication (n = 124)	No complication (n = 2,716)	Odds ratio	95% CI	P-Value
Age (years)	18–50	64.8	66.4	64.7	Ref.		
	51–65	25.5	21.3	25.7	0.81	0.52–1.27	.36
	66–75	6.9	7.4	6.9	1.05	0.52–2.12	.90
	76+	2.9	4.9	2.8	1.73	0.73–4.10	.21
	Missing	0.3					
Sex	Female	55.0	58.1	54.8	Ref.		
	Male	45.0	41.9	45.2	0.88	0.61–1.26	.48
BMI	18–25	33.0	28.3	33.2	Ref.		
	<18	0.8	0.0	0.8	N/A	N/A	N/A
	25–35	52.6	54.2	52.5	1.21	0.79–1.85	.38
	>35	13.6	17.5	13.4	1.53	0.88–2.68	.13
	Missing	4.0					
ASA classification	I–II	81.0	71.0	81.4	Ref.		
	III–V	18.6	29.0	18.1	1.84	1.24–2.75	.003
	Missing	0.4					
Smoking		26.9	28.2	26.8	1.07	0.72–1.60	.73
Hypertension		23.1	22.6	23.2	0.97	0.63–1.49	.88
Dyspnea		3.9	5.6	3.8	1.52	0.69–3.33	.30
COPD		1.8	1.6	1.8	0.89	0.21–3.71	.88
Diabetes mellitus	None	92.2	90.3	92.3	Ref.		
	Noninsulin dependent	5.1	4.8	5.2	0.96	0.41–2.22	.92
	Insulin dependent	2.7	4.8	2.6	1.92	0.82–4.51	.14
	Missing	0.7					
Bleeding disorder		2.0	4.8	1.9	2.61	1.10–6.19	.02
Open wound ^a		5.5	12.9	5.2	2.71	1.56–4.70	<.001
Preoperative steroid usage		1.5	0.0	1.6	0.96	0.95–0.96	.16

(Continues)

TABLE 1 (Continued)

Characteristic (%)	Definition	Total (n = 2,840)	Any complication (n = 124)	No complication (n = 2,716)	Odds ratio	95% CI	P-Value
Preoperative functional status	Independent	98.1	96.8	98.1	Ref.		
	Partially dependent	1.6	3.2	1.5	2.17	0.76–6.15	.15
	Unknown	0.4					
In/outpatient	Outpatient	70.6	40.3	72.0	Ref.		
	Inpatient	29.4	59.7	28.0	3.80	2.63–5.50	<.001
Emergency case		4.3	5.6	4.2	1.37	0.62–3.00	.44
Sepsis	None				Ref.		
	SIRS	0.7	1.6	0.6	2.68	0.61–11.73	.19
	Sepsis	0.1	1.6	0.0	45.53	4.10–505.63	.002
	Missing	0.5					
Wound classification	Clean	84.9	76.6	85.3	Ref.		
	Clean/contaminated	5.2	3.2	5.3	0.68	0.25–1.87	.45
	Contaminated	7.4	13.7	7.1	2.16	1.26–3.69	.005
	Dirty/Infected	2.5	6.5	2.3	3.10	1.44–6.65	.004
Operative time quartiles	<45 minutes	25.5	13.7	26.1	Ref.		
	45–75 minutes	24.6	16.9	24.9	1.29	0.68–2.47	.44
	76–150 minutes	24.7	21.8	24.9	1.67	0.90–3.08	.10
	>150 minutes	25.2	47.6	24.2	3.75	2.16–6.49	<.001

^aOpen wound with or without infection.

ASA, American Society of Anesthesiologists; BMI, body mass index; CI, confidence interval; COPD, chronic obstructive pulmonary disease; N/A, not available; Ref., reference; SIRS, systemic inflammatory response syndrome.

complication was surgical site infection, affecting 1.6% of all patients. The median time to event for the first complication was 8 days (interquartile range [IQR]: 2.0–17.25) and 37.7% of these complications occurred during the surgical hospital stay.

Multivariable analysis for any complication in the overall group showed that ASA class III–V, open wound, contaminated wound, dirty/infected wound, inpatient procedures, and having an operative time longer than 150 minutes were all individually significant ($P < .05$) (Table 3). After Bonferroni correction, only high ASA classification and inpatient procedures remained significant. In the series of brachial plexus surgeries, insulin-dependent diabetes, inpatient status, and emergency cases were associated with any complication (Table 4). None of these predictors remained significant after Bonferroni correction.

3.3 | Surgical site infection

Surgical site infection occurred with a median time to event of 15 days (IQR: 7.0–21.0), and 91.3% occurred after discharge. Factors significantly predicting surgical site infection included BMI >35 kg/m², contaminated wound or dirty/infected wound preoperatively, and an operative time longer than 150 minutes (Table 3). High BMI and contaminated wounds remained significant after Bonferroni correction.

3.4 | Reoperation

Reoperation within thirty days occurred in 1.8% of all cases and 3.7% of patients that were operated on for brachial plexus pathology. Ages 51–65, open wound, contaminated wound, dirty/infected wound and inpatient status were all shown through multivariable analysis to be individual factors associated with reoperation (Table 5). When applying a Bonferroni correction, only inpatient procedures remain significant. 57.7% of reoperations had related CPT codes. The most common reasons for reoperation were musculoskeletal repair (16.7%), lymphatic repair (16.7%), drainage of abscess or hematoma (16.7%), and wound-related problems (13.3%) (Figure 1).

3.5 | Unplanned readmission

A total of 32.8% readmissions did not have associated diagnosis codes. Of patients who had data on readmission, 2.3% of all patients were readmitted; 2.9% of all brachial plexus patients were readmitted. The only independent predictor for readmission was undergoing an inpatient procedure (Table 5), which remained significant after Bonferroni correction. Most readmissions were due to wound-related problems (24.1%), postoperative pain (24.1%), or respiratory problems (10.3%) (Figure 1).

3.6 | Length of hospital stay

A total of 835 patients were coded for inpatient procedures. Of these, 91 patients received operations on either digital, hand, or foot nerves,

235 on nerves in arms or legs, 14 on lumbar plexus, and 480 on brachial plexus. Median lengths of hospital stay were 1 day (IQR: 0–2), 1 day (IQR: 1–3), 1.5 days (IQR: 1–4), and 3 days (IQR: 2–5), respectively (Figure 2). Length of hospital stay was statistically different between each group, except between surgeries in the arms and legs and the lumbar plexus ($P = .60$).

4 | DISCUSSION

This study demonstrates low rates of complications for peripheral nerve surgery in extremities overall, with a somewhat higher incidence in brachial plexus surgery. Most complications occurred after hospital discharge. Length of hospital stay is correlated with site of surgery. Several factors were found to predict the occurrence of postoperative complications, which are in line with previously published studies (Benson et al., 2006; Ducic, Hill, Maher, & Al-Attar, 2011; Hilton et al., 2007; Hu, Zhang, Hutter, Xu, & Williams, 2016; Schmelzer et al., 2006;

Wood & Wood, 2003). Surprisingly, diabetes, preoperative steroid use, and smoking were found not to be associated with surgical site infection or any other complication, even though these have previously been described to increase the risk of postoperative complications (Goltsman, Munabi, & Ascherman, 2017; Ismael et al., 2011; Martin et al., 2016; Turan et al., 2011).

Only two other studies have previously described short-term complications after peripheral nerve surgery in larger series (Ducic et al., 2011; Hu et al., 2016). One study also used the NSQIP database to assess predictors of any complication and readmission (Hu et al., 2016). In contrast to our study they used a smaller and more heterogeneous group of peripheral nerve surgeries, including head and neck surgeries. The other study did not assess independent predictors for adverse events (Ducic et al., 2011). They did however demonstrate that complications are significantly less common in peripheral nerve surgery of the head and neck region (Ducic et al., 2011). To the best of our knowledge this study is the first to report 30-day adverse events and predictors

TABLE 2 Occurrence of complication and their timing

Complication	Thirty-day cumulative incidence			Occurred during initial hospitalization (%)
	No. overall (%)	No. BP (%)	Time to event overall, days, median (IQR)	
Any complication	124 (4.4)	44 (7.0)	8.00 (2.00–17.25)	37.7
Death within 30 days	1 (0.0)	0 (0.0)	7.00 (7.00–7.00)	0.0
Reoperation	52 (1.8)	23 (3.7)	10.00 (3.75–17.25)	-
Readmission	43 (2.3)	18 (2.9)	12.50 (6.75–21.00)	-
Nonroutine hospital discharge	15 (0.7)	6 (1.0)	5.00 (2.00–8.00)	-
Neurological complications				
CVA	3 (0.1)	0 (0.0)	6.00 (1.00–6.00)	33.3
Cardiovascular complications	0 (0.0)	0 (0.0)	N/A	N/A
Cardiac arrest	0 (0.0)	0 (0.0)	N/A	N/A
Myocardial infarction	0 (0.0)	0 (0.0)	N/A	N/A
Hematologic complications	25 (0.9)	14 (2.2)	1.00 (0.00–2.00)	84.0
DVT	4 (0.1)	2 (0.3)	13.00 (2.75–23.25)	25.0
Pulmonary embolism	1 (0.0)	0 (0.0)	23.00 (23.00–23.00)	0.0
Blood transfusion	22 (0.8)	12 (1.9)	0.00 (0.00–1.00)	100.0
Pulmonary complications	2 (0.1)	1 (0.2)	4.50 (1.00–8.00)	50.0
Unplanned intubation	2 (0.1)	1 (0.2)	4.50 (1.00–8.00)	50.0
Failure to wean from ventilator	1 (0.0)	1 (0.2)	3.00 (3.00–3.00)	100.0
Renal complications	0 (0.0)	0 (0.0)	N/A	N/A
Wound-related complications	49 (1.7)	8 (1.3)	15.00 (7.00–21.50)	8.2
Wound disruption	4 (0.1)	0 (0.0)	23.00 (20.50–26.25)	0.0
Any surgical site infection	46 (1.6)	8 (1.3)	15.00 (7.00–21.00)	8.7
Superficial SSI	37 (1.1)	7 (1.1)	14.00 (6.50–21.00)	8.1
Deep SSI	8 (0.3)	0 (0.0)	20.50 (9.25–26.25)	12.5
Organ Space SSI	2 (0.1)	1 (0.2)	16.50 (16.00–17.00)	0.0
Other infectious complications	13 (0.5)	6 (1.0)	8.00 (3.00–15.00)	46.2
Pneumonia	2 (0.1)	1 (0.2)	6.50 (4.00–9.00)	0.0
UTI	6 (0.2)	3 (0.5)	14.50 (4.25–19.25)	50.0
Sepsis/septic shock	6 (0.2)	2 (0.3)	7.50 (0.75–16.00)	66.7

BP, brachial plexus surgery; CVA, cerebrovascular accident; DVT, deep vein thrombosis; IQR, interquartile range; N/A, not available; No., absolute number; SSI, surgical site infection; UTI, urinary tract infection.

TABLE 3 Multivariable analysis of any complication and surgical site infection

Risk factor	Any complication			Surgical site infection			
	OR	95% CI	P	OR	95% CI	P	
BMI ^a	18–25			Ref.			
	<18			0.00	0.00–0.00	1.00	
	25–35			1.56	0.71–3.40	.269	
	>35			4.15	1.77–9.73	.001	
ASA Class	I–II	Ref.					
	III–V	1.80	1.19–2.72	.005			
Open wound		2.01	1.01–4.03	.048			
Wndclas ^b	I	Ref.		Ref.			
	II	0.72	0.25–2.06	.546	1.31	0.31–5.61	.714
	III	2.47	1.28–4.74	.007	3.47	1.47–8.18	.005
	IV	2.72	1.14–6.47	.024	4.32	1.26–14.81	.020
Outpatient		Ref.					
Inpatient		2.90	1.84–4.57	<.001			
OpTime	<45	Ref.		Ref.			
	45–75	1.17	0.61–2.28	.619	1.80	0.66–4.92	.253
	76–150	1.16	0.61–2.21	.646	1.67	0.60–4.63	.329
	>150	2.05	1.07–3.92	.030	3.47	1.37–8.90	.009
AUC		0.733	0.689–0.776	<.001	0.719	0.649–0.788	<0.001
H-L test		R ² : 4.15		P = .763	R ² : 4.17		P = .841

^aKilograms/metres².

^bClean (I), clean/contaminated (II), contaminated (III), dirty/infected (IV).

ASA Class, American Society of Anesthesiologists Classification; BMI, body mass index; CI, confidence interval; OpTime, operative time; OR, odds ratio; P, P values; Ref., reference; SIRS, systemic inflammatory response syndrome; SSI, surgical site infection; Wndclas, wound classification.

for brachial plexus surgery specifically. Reasons for readmission and reoperation have also not been reported previously.

Most patients undergoing peripheral nerve surgery in the extremities are managed in an outpatient setting. Those that require an inpatient stay are generally discharged within a few days, however, most complications occur after discharge. Wound-related complications occur most frequently, usually after 2 weeks postoperatively. Therefore a one to two-week postdischarge follow-up may be reasonable for adequate postoperative care in patients undergoing peripheral nerve surgery in extremities.

There are some limitations to using the ACS NSQIP database. First, many surgical outcome parameters relevant to the field of peripheral nerve surgery are not collected or are not apparent after thirty days. There are, for example, no data available on sensation, burning pain, or range of motion, nor are data on long term functional outcomes, pain relief, or misdiagnoses registered. In brachial plexus surgery specifically, injury to the phrenic nerve and pneumothorax are also complications of interest, yet are not registered. Nevertheless, the complications that have been described may well have direct impact on long term outcomes. For instance, it has been shown that wound healing influences

nerve regeneration (Prpa, Huddleston, An, & Wood, 2002). Prpa et al. showed in a canine study that the wound bed was essential for revascularization of a nerve graft (Prpa et al., 2002). Also, since common decompressive surgeries, such as median and ulnar nerve decompressions, transections and excisional surgeries were not coded for in NSQIP, this dataset is limited. Furthermore, management of missing data in NSQIP has been shown to influence results (Basques et al., 2017; Hamilton, Ko, Richards, & Hall, 2010; Parsons, Henderson, Ziegenfuss, Davern, & Al-Refaie, 2011). Apart from emphasizing the need to show how missing data are handled, no clear guidelines have yet been established for managing missing data (Basques et al., 2017; Hamilton et al., 2010; Parsons et al., 2011). Furthermore, the definition of inpatient procedures has been mentioned before as a point of discussion, since there seems to be some inconsistency in the use of this terminology (Bovonratwet et al., 2017). This may have influence on the creation of risk profiles for postoperative outcomes and length of hospital stay (Bovonratwet et al., 2017). Lastly, because the event rate of major adverse events was so low, this study may lack sufficient power to identify independent predictors, despite the relatively large number of patients included in comparison to the existing literature.

TABLE 4 Multivariable analysis of any complication in brachial plexus pathology

Risk Factor	Any Complication		
	OR	95% CI	P
Diabetes	None	Ref.	
	N-I	3.05	0.45–20.66
	I	7.05	1.24–40.10
Outpatient	Ref.		
Inpatient	9.75	1.28–74.07	.028
Emergency	18.45	1.49–228.73	.023
AUC	0.615	0.531–0.699	.012
H-L test	R^2 : 0.327	P = .567	

AUC, area under the operating curve; CI, confidence interval; H-L test, Hosmer-Lemeshow test for goodness of fit; I, insulin dependent diabetes; N-I, noninsulin dependent diabetes; OR, odds ratio; P, P values; Ref., reference.

Despite these limitations, this study provides novel useful information regarding rates and predictors of complications, reoperation, and unplanned readmission after peripheral nerve surgery in extremities. Furthermore, typical timing of adverse events, reasons for unplanned readmission and reoperation, and length of hospital stay are described for the first time. Perioperative complication rates and predictors of any complication in brachial plexus surgery have also been described

for the first time. Studies using data like those reported by NSQIP provide more generalizable, externally-validated results that may be more representative of typical surgical management than those from tertiary-care, academic medical centers. Although frequencies are low, readmissions and reoperation are bothersome for patients and expensive for patients, hospitals, and healthcare systems. By unravelling the causes of complications and identification of patients at risk for complications,

TABLE 5 Multivariable analysis of reoperation and readmission

Risk factor	Reoperation			Readmission			
	OR	95% CI	P	OR	95% CI	P	
Age ^a	18–50	Ref.		Ref.			
	51–65	2.30	1.08–4.93	.032	1.22	0.51–2.95	.653
	65–75	1.23	0.51–2.95	.645	1.12	0.46–2.75	.805
	>75	1.10	0.42–2.86	.843	1.37	0.56–3.31	.489
Sex	Female			Ref.			
	Male			0.88	0.47–1.64	.683	
Wndinf	No	Ref.					
	Yes	2.53	0.98–6.57	.056			
Wndclas ^b	I	Ref.					
	II	0.42	0.06–3.16	.397			
	III	2.50	1.01–6.17	.047			
	IV	3.63	1.20–10.99	.023			
Outpatient	Ref.			Ref.			
Inpatient	5.34	2.93–9.75	<.001	6.87	3.56–13.28	<.001	
AUC	0.780	0.725–0.835	<.001	0.717	0.625–0.808	<.001	
H-L test	R^2 : 5.95	P = .311		R^2 : 4.13	P = .846		

^aIn years.

^bclean (I), clean/contaminated (II), contaminated (III), dirty/infected (IV).

AUC, area under the operating curve; CI, confidence interval; H-L test, Hosmer-Lemeshow test for goodness of fit; OpTime, operative time; OR, odds ratio; P, P values; Ref., reference; Wndclas, wound classification; Wndinf, open wound with or without infection.

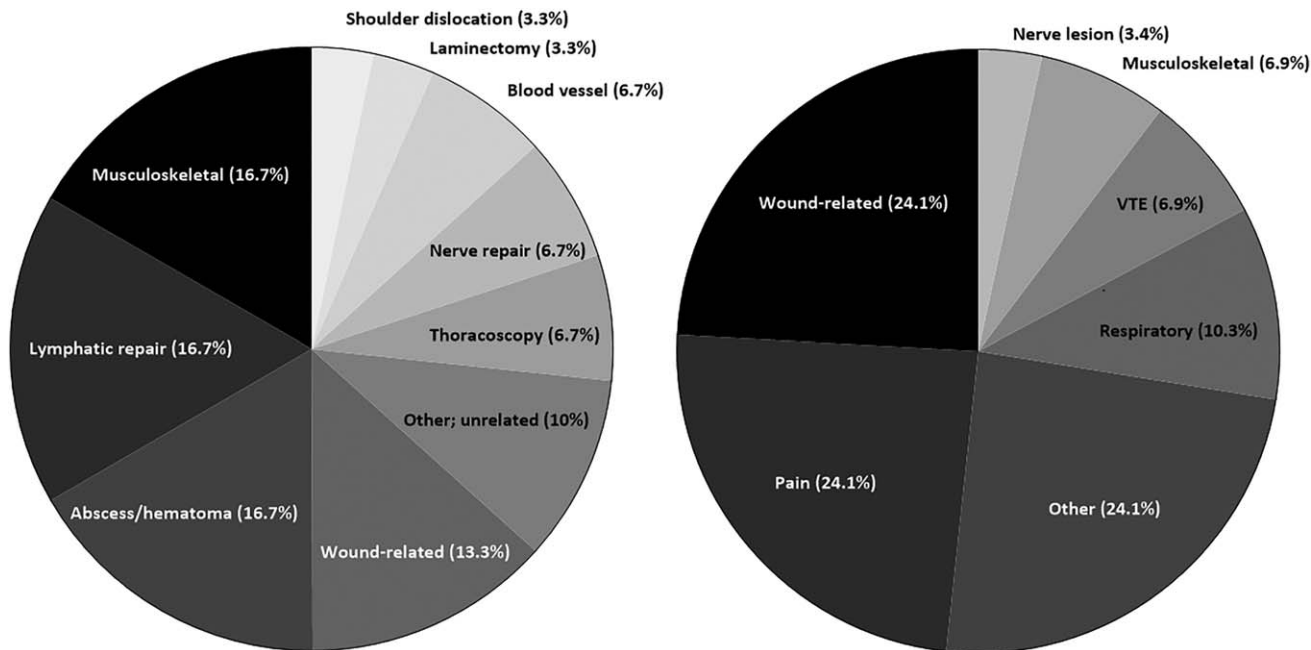


FIGURE 1 Reasons for reoperation and readmission within 30 days postoperatively after peripheral nerve surgery in extremities

preventive measures may be implemented to reduce future rates of postoperative complications.

With an eye to the future, national registries could be set up to analyse more specific complications in peripheral nerve surgery, and for complex brachial plexus surgery, which shows higher rates of complication and morbidity (Kim, Cho, Tiel, & Kline, 2003; Murovic, 2009). To improve current databases, it would be useful to include additional procedures in the NSQIP database, such as carpal tunnel release, so that complications and surgical outcomes could be evaluated even though incidence rates of adverse events are low (Benson et al., 2006; Louis et al., 1985; Schmelzer et al., 2006).

5 | CONCLUSIONS

Complications usually occur one to two weeks postoperatively after peripheral nerve surgery in extremities. Wound-related complications are the most common complications. They generally occur after hospital discharge. Preoperatively contaminated wounds, inpatient procedures, and longer operative times tend to have the most influence on adverse events. Anatomical level of operation results in significantly different lengths of hospital stay, with brachial plexus pathology having the longest length of stay.

DISCLOSURES

The authors have nothing to disclose.

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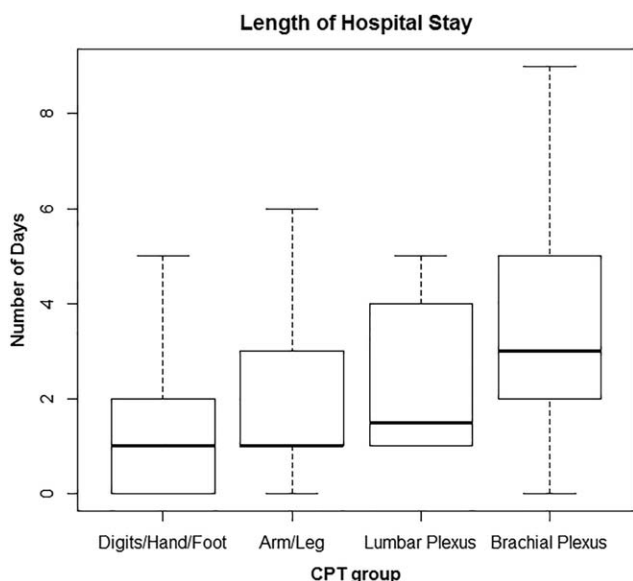


FIGURE 2 Length of hospital stay of inpatient procedures grouped by anatomical site as coded by CPT

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