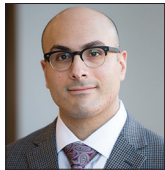*Original Article*

Prolonged length of stay and discharge disposition to rehabilitation facilities following single-level posterior lumbar interbody fusion for acquired spondylolisthesis

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ABSTRACT

Background: Acquired lumbar spondylolisthesis is often treated with interbody fusion. However, few studies have evaluated predictors for prolonged length of stay (LOS) and disposition to rehabilitation facilities after posterior single-level lumbar interbody fusion for acquired spondylolisthesis.

Methods: The American College of Surgeons National Quality Improvement Program database was queried for adults with acquired spondylolisthesis who underwent single-level lumbar interbody fusion through a posterior approach (posterior lumbar interbody fusion (PLIF) or transforaminal lumbar interbody fusion [TLIF]). We utilized multivariate logistic regression analysis to identify predictors of prolonged LOS and disposition in this patient population.

Results: Among 2080 patients identified, 700 (33.7%) had a prolonged LOS (≥4 days), and 306 (14.7%) were discharged postoperatively to rehabilitation facilities. Predictors for prolonged LOS included: American Society of Anesthesiologist (ASA) class ≥3, anemia, prolonged operative time, perioperative blood transfusion, pneumonia, urinary tract infections, and return to the operating room. The following risk factors predicted discharge to postoperative rehabilitation facilities: age ≥65 years, male sex, ASA class ≥3, modified frailty score ≥2, perioperative blood transfusion, and prolonged LOS.

Conclusion: Multiple partial-overlapping risk factors predicted prolonged LOS and discharge to rehabilitation facilities after single-level TLIF/PLIF performed for acquired spondylolisthesis.

Keywords: Acquired spondylolisthesis, Discharge, Interbody fusion, Length of stay, Lumbar surgery

INTRODUCTION

Some surgeons utilize single-level posterior-based lumbar interbody fusion (posterior lumbar interbody fusion [PLIF] or transforaminal lumbar interbody fusion [TLIF]) to treat single-level degenerative/acquired lumbar spondylolisthesis. However, these procedures may carry increased perioperative morbidity when compared with laminectomy alone, leading to more prolonged length of stay (LOS) and increased postoperative discharges to rehabilitation facilities (rehab).[1,2,5]

Here, we evaluated the risk factors for postoperative prolonged LOS and discharge to rehabilitation facilities for patients undergoing single-level TLIF and PLIF for acquired degenerative spondylolisthesis.

Table 1: Current procedural terminology codes utilized for inclusion and exclusion criteria.

CPT code	Description
Included codes a. 22630 b. 22633	a. Arthrodesis, posterior interbody technique, including laminectomy and/or discectomy to prepare interspace (other than for decompression), single interspace; lumbar b. 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, and lumbar
Excluded codes a. 22558 b. 22632 c. 22634	a. Anterior lumbar interbody fusion b. Multilevel lumbar interbody fusion a) Multilevel lumbar interbody fusion

MATERIALS AND METHODS

We retrospectively analyzed patients in the American College of Surgeons Surgical Quality Improvement Program (ACS-NSQIP) database who underwent single-level lumbar posterior-TLIF/PLIF between 2012 and 2016. Inclusion criteria included patients age 18 years and older, and a primary diagnosis of "Acquired Spondylolisthesis" (ICD-9 code 738.4) undergoing PLIF/TLIF [Table 1].

Clinical data

Multiple clinical criteria, including operative data, the length of surgery, postoperative course, LOS, and discharge data – including discharge to rehabilitation facilities – were evaluated [Table 2].

Statistical analysis

Univariate analysis and subsequent stepwise multivariate logistic regression models with backward elimination were used to identify the association of independent variables with prolonged LOS and discharge to rehab. Statistical significance was defined as a probability value <0.05 and all statistical

Table 2: Baseline demographics and complications for normal LOS versus prolonged LOS.

Variable	All (n=2080)	Normal LOS (n=1380)	Prolonged LOS ($\geq$4 days) (n=700)	*P*-value[†]
Mean age, years	60.3	59.8	61.4	0.003*
Age ≥65 years (%)	40.8	39.2	43.9	0.039*
Mean BMI (kg/m²)	30.8	30.4	31.5	<0.001*
Obesity (%) (BMI ≥30)	50.1	47.9	54.3	0.006*
Male sex (%)	34.5	36.7	30.1	0.003*
Smoking history (%)	18.8	19.9	16.4	0.053*
ASA class	2.4	2.4	2.5	<0.001*
ASA class ≥3 (%)	43.5	40.1	50.2	<0.001*
Frailty score ≥2 (%)	17.9	16.3	21.1	0.007*
Diabetes (%)	15.4	14.4	17.4	0.073*
Hypertension (%)	55.8	54.3	58.9	0.047*
Chronic obstructive pulmonary disease (%)	5.0	4.5	6.1	0.104
Congestive heart failure (%)	0.3	0.2	0.4	0.411
Dependent functional status (%)	2.5	2.3	3.0	0.352
Preoperative anemia[‡] (%)	12.7	10.9	16.1	0.002*
Preoperative white blood count (cell/μl)	7.3	7.3	7.3	0.473
Preoperative platelet count	252	252.5	251.0	0.642
Operative time, minutes	201.5	188.6	227.0	<0.001*
Operative time ≥243 min[§] (%)	25.2	19.4	36.7	<0.001*
Perioperative blood transfusion (%)[‖]	8.2	5.3	14.0	<0.001*
Superficial or deep wound infection (%)	0.9	0.6	1.4	0.048*
Pneumonia (%)	0.8	0.1	2.0	<0.001*
UTI (%)	1.3	0.8	2.4	0.002*
Return to OR (%)	2.8	1.6	5.1	<0.001*

*Indicates the variable was initially included in multivariate logistic regression model. Variables with *P*≤0.10 were initially included in the multivariate regression model. [†]Continuous variables were compared between groups through t-tests and categorical variables through Chi-squared and Fisher's exact tests. [‡]Men with a hematocrit less than 39 and women with a hematocrit less than 36. [§]243 min was the 75th percentile for operative time. [‖]Any red blood cell transfusion within 72 h of surgery

analyses were performed using R version 3.6.1 (R Core Team, Vienna, Austria).

RESULTS

Variables associated with prolonged LOS

Of the 2080 patients in this study, 700 (33.7%) had a prolonged LOS (e.g., greater than or equal to 4 days) [Table 2]. Independent predictors of prolonged LOS included;

Table 3: Multiple logistic regression model for prolonged LOS after backward elimination for nonsignificant variables.

Variable	OR	95% CI	*P*-value
ASA class ≥3	1.40	1.15–1.69	0.001
Preoperative anemia	1.36	1.02–1.80	0.04
Operative time ≥243 min	2.22	1.80–2.74	<0.001
Perioperative blood transfusion	2.20	1.57–3.09	<0.001
Pneumonia	10.76	2.85–70.25	0.002
Urinary tract infection	3.08	1.39–7.03	0.006
Return to operating room	2.93	1.67–5.22	<0.001

Hosmer–Lemeshow goodness-of-fit *P*=0.999

American Society of Anesthesiologist (ASA) class ≥3, anemia (e.g., hematocrit <39 for males and <36 for females),[7] prolonged operative time, perioperative blood transfusion (e.g., red blood cell transfusion within 72 h of surgery start time), pneumonia, urinary tract infections (UTI), and reoperations [Table 3]. The model was appropriately calibrated (Hosmer–Lemeshow, *P* = 0.999).

Variables associated with discharge to rehabilitation centers

Among 2077 patients, 306 (14.7%) were discharged to rehabilitation centers [Table 4].

After multivariate logistic regression, analysis independent predictors of discharge to rehab included; age ≥65 years, male sex, ASA class ≥3, frailty score ≥2, perioperative blood transfusion, and prolonged LOS [Table 5]. The model was appropriately calibrated (Hosmer–Lemeshow, *P* = 0.397).

DISCUSSION

Following single-level PLIF/TLIF for degenerative lumbar spondylolisthesis, it was important to understand what risk

Table 4: Home discharge versus nonhome discharge cohort comparison.

Variable	Home (*n*=1771)	Rehab (*n*=306)	*P*-value†
Mean age	59.0	67.9	<0.001*
Age ≥65 years (%)	36.4	66.6	<0.001*
Mean BMI (kg/m²)	30.6	31.9	0.001*
Obesity (%) (BMI ≥30)	49.3	54.9	0.069*
Male sex (%)	36.8	21.6	<0.001*
Smoking history (%)	19.9	11.8	<0.001*
ASA class	2.4	2.7	<0.001*
ASA class ≥3 (%)	40.2	62.7	<0.001*
Frailty score ≥2 (%)	16.3	21.1	0.006*
Diabetes (%)	13.7	25.8	<0.001*
Hypertension (%)	52.7	74.5	<0.001
Chronic obstructive pulmonary disease (%)	4.6	7.8	0.016*
Congestive heart failure (%)	0.2	0.4	0.410
Dependent functional status (%)	2.3	3.0	0.344
Preoperative anemia (%)‡	10.9	16.2	0.002
Preoperative white blood count (cell/μl)	7.3	7.4	0.517
Preoperative platelet count	253.0	245.8	0.090*
Operative time	199.8	210.6	0.045*
Operative time ≥ 243 min (%)§	24.3	30.4	0.024*
Perioperative blood transfusion (%)‖	6.8	16.3	<0.001*
Superficial or deep wound infection (%)	0.7	2.0	0.048*
Pneumonia (%)	0.5	2.0	0.015*
UTI (%)	1.0	3.3	0.005*
Return to OR (%)	2.7	3.6	0.356
Length of stay (days)	3.0	4.9	<0.001*
Prolonged length of stay¶	29.3	58.2	<0.001*

*Indicates the variable was initially included in multivariate logistic regression model. †Continuous variables were compared between groups through t-tests and categorical variables through chi-squared and Fisher's exact tests. ‡Men with a hematocrit less than 39 and women with a hematocrit less than 36. §243 min was the 75th percentile for operative time. ‖Any red blood cell transfusion within 72 h of surgery. ¶Prolonged length of stay is considered ≥4 days as this is the 75th percentile for this variable

Table 5: Multiple logistic regression model for discharge to rehab after backward elimination of nonsignificant variables.

Variable	OR	95% CI	*P*-value
Age ≥65 years	3.12	2.38–4.10	<0.001
Male	0.48	0.35–0.65	<0.001
ASA class ≥3	1.66	1.25–2.20	<0.001
Frailty score ≥2	1.73	1.27–2.35	0.001
Perioperative blood transfusion	1.90	1.28–2.81	0.001
Length of stay ≥4 days	2.93	2.25–3.82	<0.001

Hosmer–Lemeshow goodness-of-fit *P*=0.397

factors predisposed patients to prolonged postoperative LOS and discharges to rehabilitation facilities. The following factors helped predict prolonged LOS for TLIF/PLIF: ASA class ≥3, prolonged operative time, preoperative anemia, perioperative blood transfusion, postoperative pneumonia and UTI, and return to the operating room. Postoperative risk factors predicting discharge to rehab facilities included; age ≥65 years, male sex, ASA class ≥3, frailty score ≥2, perioperative blood transfusion, and prolonged LOS.

Literature review

Prior studies of TLIF/PLIF procedures identified similar risk factors associated with discharge to rehab centers; ASA ≥3 class, age ≥65, and male gender.[4,5] Anemia and perioperative RBC transfusion were also correlated with more prolonged postoperative LOS and greater morbidity following TLIF/PLIF.[6,7]

Other variables impacting outcomes of TLIF/PLIF

Other clinical variables negatively impacted outcomes of TLIF/PLIF. First, diabetes increased the morbidity and mortality rates in this and other studies due to it negatively impacting patients' immune responses and associated chronic inflammation.[3,8] Multiple additional risk factors associated with frailty scores also contributed to poorer outcomes/increased postoperative adverse events; UTI and return to the operating room (e.g., over a two-fold increased odds of a prolonged LOS).[9] Previous series also noted that performing surgeries at major, high-volume spine center may minimize reoperations.

CONCLUSION

Approximately one-third of patients undergoing posterior single-level interbody fusions (TLIF/PLIF) for acquired spondylolisthesis experience a prolonged LOS, and nearly one-seventh (e.g., around 14.7%) are discharged to rehabilitation facilities. Surgeons can better optimize their patient selection and surgical planning for TLIF/PLIF by better understanding of these risk factors.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

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