Original Article

Preoperative lymphocyte percentage and neutrophil-lymphocyte ratio are useful predictors of 30-day postoperative complications after lumbar fusion

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ABSTRACT

Background: Lymphocyte percentage/count, platelet-lymphocyte ratio (PLR), and neutrophil-lymphocyte ratio (NLR) have shown prognostic significance in patients with cancer, stroke, and following cardiac surgery. However, the utility of these blood parameters for assessing the 30-day postoperative risk for lumbar fusion complications has not been established.

Methods: In this single-center-single-surgeon retrospective series, 77 consecutive patients underwent one- or two-level lumbar fusion. Lymphocyte percentage/count, PLR, and NLR were investigated as predictors of 30-day postoperative complications.

Results: Ten of 77 patients had postoperative complications. A unit increase in NLR and lymphocyte percentage was significantly associated with a 23% increase and 7% decrease, respectively, in the odds of a complication occurring. Preoperative NLR ≥ 2.32 and lymphocyte percentage ≤ 29.5% significantly discriminated between the "complication" and "no-complication" groups.

Conclusion: Patients with a preoperative lymphocyte percentage of ≤29.5% and/or NLR ≥2.32 should be closely monitored as high-risk groups susceptible to 30-day postoperative complications after lumbar fusion.

Keywords: Complications, Lymphocyte, Neutrophil, Prognosis, Spinal fusion

INTRODUCTION

The importance of preadmission/preoperative lymphocyte percentage/count, platelet-lymphocyte ratio (PLR), and neutrophil-lymphocyte ratio (NLR) as prognostic markers following cardiac surgery, stroke, and cancers has been extensively reported.[1,4-6,8] Some spine surgery studies have also reported that lymphocyte count/percentage and NLR levels obtained between 3 and 7 days postoperatively helped predict whether surgical site infections (SSIs) would occur within 30 postoperative days.[2,3,7] Here, we investigated whether preoperative lymphocyte percentage/count, PLR, and NLR are useful predictors for 30-day postoperative complications following lumbar fusion.

MATERIALS AND METHODS

Study design

In this case–control study, 77 adults underwent elective single- (37 patients) or two-level (40 patients) posterior/ posterolateral lumbar fusion performed by one surgeon (2012–2019) [Tables 1 and 2].

Statistical analysis

Statistical analysis was performed on IBM SPSS Statistics 27 (Windows). Binary logistic regression, receiver operating characteristics, and Youden's index were utilized [Table 3].

RESULTS

Correlation between 30-day postoperative complications and lymphocyte percentage and NLR

[Table 4] is a summary of the patients' baseline characteristics. Postoperative complications occurred in 10 out of 77 patients (13%); three developed SSI, three pneumonia, and one with each of the following: atelectasis, gastroenteritis, peritonitis, and transient ischemic attack [Figure 1]. A unit increase in NLR and lymphocyte percentage was significantly associated with a 23% increase and 7% decrease, respectively, in the odds of a complication occurring. There were no statistically significant associations between the occurrence of complications and the other independent variables [Figure 2 and Table 5].

Predictive value of preoperative lymphocyte percentage and NLR for determining 30-day postoperative complications

The area under the curve values for the preoperative NLR and lymphocyte percentage were in the "acceptable" range (0.7–0.8) of prognostic accuracy for postoperative 30-day complications. The optimal cutoff value for preoperative NLR and lymphocyte percentage were ≥2.32 and ≤29.5%, respectively [Figure 3]. Compared to others, patients with a preoperative NLR ≥2.32 and those with a lymphocyte percentage ≤29.5% had 5.6 times and 13.9 times greater odds of postoperative complications, respectively [Figure 4].

Table 1: Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Adult patients (≥18 years old)	History of previous lumbar spine surgery
Posterior/posterolateral lumbar fusion	Three- or more level fusion
Single- or two-level fusion	History of hematological disorders
Elective cases	Emergency cases

**Table 2:** Summary of variables investigated.

Demographic variables	Age
	Sex
	Smoking status
	Body mass index
	Charlson comorbidity index
Perioperative variables	Spinal surgical levels
Laboratory variables	Neutrophil-lymphocyte ratio (NLR: neutrophil count÷lymphocyte count)
	Lymphocyte percentage (lymphocyte count x 100÷white cell count)
	Lymphocyte count
	Platelet-lymphocyte ratio (PLR: platelet count÷lymphocyte count)
Complications	Acute kidney injury, arrhythmia, atelectasis, coma, death, deep vein thrombosis, delirium, electrolyte imbalance, epidural hematoma, gastrointestinal infection, ileus, myocardial infarction, new neuropathic pain, sepsis, surgical site infection, permanent peripheral nerve injury, peritonitis, pneumonia, pulmonary embolism, stroke, transient ischemic attack, urinary retention, and urinary tract infection

Table 3: Statistical tests utilized at a 5% significance level with the occurrence of 30-day complications as the outcome measure.

| Test	Statistical test	Independent variables	Purpose
1	Binary logistic regression	Demographic, surgical, and laboratory parameters as listed in [Table 2]	To evaluate the association between the independent variables and the development of complications
2a	Receiver operating characteristics	The variables that were statistically significant in test 1 (i.e., NLR and lymphocyte percentage)	To determine the area under the curve for the variables in predicting complications
2b	Youden's index	The variables that were statistically significant in test 1 (i.e., NLR and lymphocyte percentage)	To determine the optimal cutoff values, sensitivity, and specificity of the tested variables in predicting postoperative complications
3	Binary logistic regression	Dichotomized NLR and lymphocyte percentage derived from the cutoff values obtained in test 2b	To further estimate the association between NLR and lymphocyte percentage (dichotomized by cutoff values) and the occurrence of complications
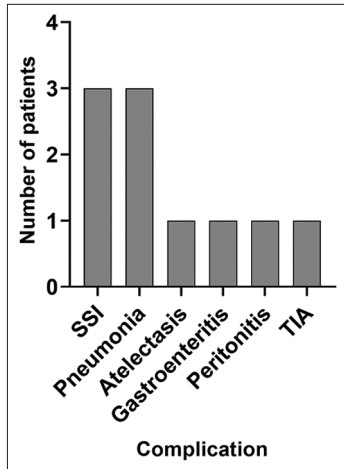
Figure 1: Incidence and types of postoperative complications ($n = 77$). SSI: Surgical site infection, TIA: Transient ischemic attack.
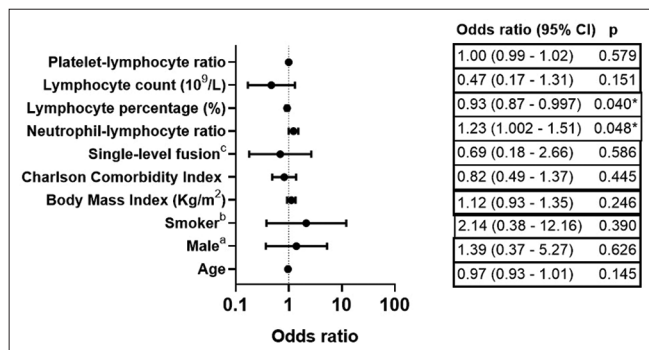
Figure 2: Odds ratio with 95% confidence interval for the occurrence of complications within 30 days after lumbar fusion according to demographic/surgical/laboratory parameters. a compared to female, b compared to nonsmokers, c compared to two-level fusion. *Statistically significant.
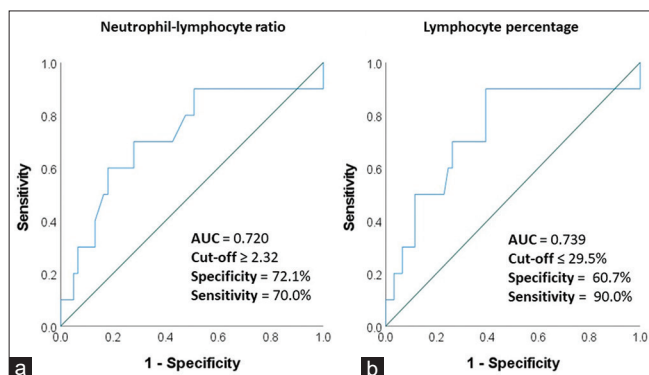
Figure 3: ROC analysis for preoperative (a) neutrophil-lymphocyte ratio and (b) lymphocyte percentage in discriminating between complication and no complication patients after lumbar fusion.
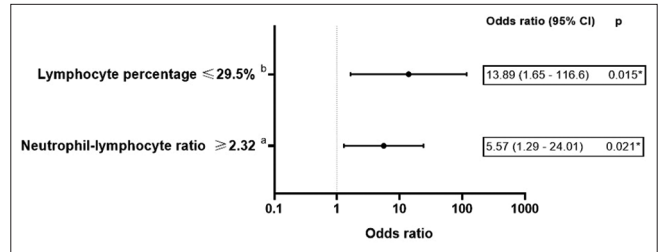
Figure 4: Odds ratio with 95% confidence interval for the occurrence of complications according to NLR and lymphocyte percentage cutoff values. a compared to NLR less than 2.32, b compared to lymphocyte percentage greater than 29.5%. *Statistically significant.

Table 4: Patient demographic and operative data.

Variables (n=77) [a]	
Age (years)	54.5±14.5
Sex (female/male)	44/33
Smoker (yes/no)	9/68
Body mass index (kg/m^2) (n=66)	28.9±4.8
Charlson comorbidity index	2.8±2.6
Number of spinal levels operated	
1	37
2	40
Neutrophil-lymphocyte ratio (n=71)	2.76±2.57
Lymphocyte percentage (%) (n=71)	29.7±10.5
Lymphocyte count (10^9/L) (n=71)	2.1±0.7
Platelet-lymphocyte ratio (n=71)	136.5±46.0

[a]n (number of patients)=77, unless stated otherwise. Values are presented as absolute count for categorical variables and mean±standard deviation for continuous variables

DISCUSSION

We investigated the preoperative predictors of postoperative complications after lumbar fusion. Patients with preoperative lymphocyte percentage ≤29.5% and/or NLR ≥ 2.32 had a higher risk of developing postoperative complications. Other studies have reported similar findings (i.e., high baseline/preoperative NLR and lymphocytopenia were predictors of worse outcomes).[1,4-6,8] Nevertheless, spine surgery biomarker studies found no statistically significant association between preoperative NLR or lymphocyte count/percentage and the development of postoperative SSI [Table 6].[2,7] These contradictory results, as we observed in our study, could be because preoperative NLR and lymphocyte percentage predicted the development of any complication but not specifically SSI. High NLR and/or decreased lymphocyte percentage may reflect an activated immune system and a heightened systemic inflammatory response to operative

Table 5: Odds ratio for the occurrence of complications within 30 days after lumbar fusion surgery.

Variables	Complications			
	Yes[a] (*n*=10)	No[a] (*n*=67)	Odds ratio (95% CI)	*P*-value[b]
Age (years)	48.2±19.1	55.5±13.6	0.97 (0.93–1.01)	0.145
Sex				
Male	5	28	1.39 (0.37–5.27)	0.626
Female	5	39	1.00 (reference)	
Smoker				
Yes	2	7	2.14 (0.38–12.16)	0.390
No	8	60	1.00 (reference)	
Body mass index (kg/m²)	31.1±7.3	28.6±4.5	1.12 (0.93–1.35)	0.246
Charlson comorbidity index	1.2±1.3		0.82 (0.49–1.37)	0.445
Number of spinal levels				
1	4	33	0.69 (0.18–2.66)	0.586
2	6	34	1.00 (reference)	
Neutrophil-lymphocyte ratio	4.4±3.9	2.5±2.2	1.23 (1.002–1.51)	0.048*
Lymphocyte percentage (%)	23.2±13.2	30.7±9.7	0.93 (0.87–0.997)	0.040*
Lymphocyte count (10⁹/L)	1.8±0.9	2.2±0.7	0.47 (0.17–1.31)	0.151
Platelet-lymphocyte ratio	144.0±37.1	135.3±47.4	1.00 (0.99–1.02)	0.579

[a]Presented as absolute numbers for categorical variables and mean±standard deviation for quantitative variables; [b]*P*-value determined by binary logistic regression; *statistically significant at 5% significance level

Table 6: Summary of selected literature on the prognostic value of preoperative NLR and/or lymphocyte percentage.

S. No.	Authors	Type of study	Sample size	Study population	Primary outcome measures	Findings	Method to define normal NLR
1	Diem *et al.*[1]	Retrospective	52	Patients with metastatic nonsmall-cell lung cancer treated with nivolumab	OS	Preoperative NLR >6.5 was significantly associated with reduced OS	Tertiles
2	Inose *et al.*[2]	Retrospective	254	Patients undergoing spinal decompression surgery	SSI	No association between SSI and preoperative NLR or lymphocyte percentage	N/A
3	Kakhki *et al.*[4]	Retrospective	180	Patients admitted with acute stroke	Infection	Preoperative NLR >5 is associated with a significant risk of pneumonia but not UTI or sepsis after a cerebral vascular event	Arbitrary
4	Manuel *et al.*[5]	Retrospective	141	Pediatric patients undergoing the bidirectional Glenn procedure	Length of hospital stay (LOS)	Preoperative NLR >2 was significantly associated with increased LOS	Arbitrary
5	Manuel *et al.*[6]	Retrospective	116	Pediatric patients undergoing tetralogy of Fallot repair	AKI	Preoperative NLR >0.93 was significantly associated with Grade III AKI	ROC analysis
6	Shen *et al.*[7]	Retrospective	293	Patients undergoing posterior lumbar spinal surgery	SSI	No association between SSI and preoperative NLR or lymphocyte percentage	N/A

OS: Overall survival, SSI: Surgical Site Infection, AKI: Acute kidney injury

stress. This increases intraoperative cytokines that release damaging oxygen-derived free radicals, contributing to worse outcomes.[5,8]

CONCLUSION

A raised NLR (≥2.32) and/or decreased lymphocyte percentage (≤29.5%) at baseline predict the development of postoperative complications after lumbar fusion.

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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