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Preoperative Serum Albumin Level as a Predictor of Postoperative Complication After Spine Fusion

Owoicho Adogwa, MD, MPH,* Joel R. Martin, MS,* Kevin Huang, BA,* Terence Verla, MPH,* Parastou Fatemi, BS* Paul Thompson, MS,* Joseph Cheng, MD, MS,† Maragatha Kuchibhatla, PhD,‡ Shivanand P. Lad, MD, PhD,*Carlos A. Bagley, MD,* and Oren N. Gottfried, MD*

Study Design. Retrospective cohort study.

Objective. To investigate the association between preoperative baseline serum albumin and postoperative surgical complication.

Summary of Background Data. The prevalence of malnutrition in the hospitalized patient population has only been recently recognized. Preoperative hypoalbuminemia (serum albumin <3.5 g/dL) has been shown to be associated with increased morbidity and mortality rates. The prognostic implications and significance of hypoalbuminemia after spine fusion surgery remain unknown. In this study, we assess the predictive value of preoperative nutritional status (serum albumin level) on postoperative complication rates.

Methods. The medical records of 136 consecutive patients undergoing spine fusion at Duke University Medical Center were reviewed. Preoperative serum albumin level was assessed on all patients and used to quantify nutritional status. Albumin less than 3.5 g/dL was recognized as hypoalbuminemia (malnourished). Patient demographics, comorbidities, and postoperative complication rates were collected. Patients were also stratified into 2 groups based on their cause, namely elective degenerative/deformity *versus* nonelective cases. The association between preoperative serum albumin level and postoperative complication was assessed *via* logistic regression analysis.

Results. Overall, 40 (29.4%) patients experience at least 1 postoperative complication. Patients undergoing elective surgery had more complications based on preoperative albumin levels (malnourished patients: 35.7% *vs*. nourished patients: 11.7%, $P = 0.03$), whereas those undergoing nonelective surgery had similar complication rates (malnourished patients: 46.5% *vs*. nourished patients: 42.1%, $P = 0.75$). For patients undergoing elective spinal surgery, logistic regression with and without propensity score adjustment for risk factors, demonstrated that preoperative serum albumin level was a significant predictor of postoperative complications (OR: 4.21; 95% CI: 1.09–16.19; $P = 0.04$) and (OR: 4.54; 95% CI: 1.17–19.32; $P = 0.04$), respectively.

Conclusion. Preoperative hypoalbuminemia is an independent risk factor for postoperative complications after elective spine surgery for degenerative and deformity causes, and should be used more frequently as a prognostic tool to detect malnutrition and risk of adverse surgical outcomes.

Key words: spinal fusion, treatment outcome, serum albumin, postoperative complications, hypoalbuminemia, retrospective studies, risk factors, adult, cohort studies, nutritional status.

Level of Evidence: 2

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The substantial prevalence of malnutrition in the hospitalized patient population has only recently become more widely recognized. As many as 40% of adult hospitalized patients are malnourished; and an estimated 4.3% of community-dwelling adults are undernourished.[1–4] Moreover, preoperative malnutrition has been associated with a number of poor postsurgical outcomes, including infection, acute kidney injury, and mortality.[5–13]

Despite the growing body of literature on the effects of hypoalbuminemia on postoperative outcomes in other surgical fields, few studies to date have investigated preoperative hypoalbuminemia in patients undergoing spine surgery.[2,14,15] As such, we designed a retrospective cohort analysis to assess the impact of preoperative hypoalbuminemia on complication rates after spinal fusion surgery in 2 groups of patients who are stratified by risk: (1) patients undergoing elective surgery for degenerative and deformity causes and (2) patients undergoing surgery for higher-risk causes, including traumatic and neoplastic causes.

MATERIALS AND METHODS

The primary aim of this study was to assess whether poor preoperative nutritional status is associated with greater

From the *Division of Neurosurgery, Department of Surgery, Duke University Medical Center, Durham, NC; †Department of Neurosurgery, Vanderbilt University Medical Center, Nashville, TN; and ‡Department of Biostatistics and Bioinformatics, Duke University Medical Center, Durham, NC.

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Address correspondence and reprint requests to Oren N. Gottfried, MD, Division of Neurosurgery, Department of Surgery, Duke University Medical Center, Box 4528, Durham, NC 27701; E-mail: oren.gottfried@dm.duke.edu

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postoperative complication rates. Following institutional review board approval by Duke University Hospital System, Durham, NC, 136 patients undergoing spine fusion surgery at Duke University Medical Center during the study period 2011–2013 met the inclusion criteria and were enrolled in this retrospective study. The inclusion criteria included: (1) age 18 years or more; (2) anterior and/or posterior spinal fusion using instrumentation at all locations on the spine (occipital-cervical, cervical, thoracic, lumbar, and lumbosacral); and (3) documented preoperative albumin level.

Serum albumin levels were assessed in all patients prior to surgery as a proxy for nutritional status. A cutoff point of 3.5 g/dL was used to stratify patients into 2 cohorts: a hypoalbuminemic (malnourished) group and a nonhypoalbuminemic (nourished) group. Patients were then stratified into 2 groups according to their cause for surgery. The first group consisted of patients undergoing elective spinal surgery for degenerative disease or deformity, whereas the second group consisted of patients undergoing urgent or emergent surgery for more acute pathology, including trauma and neoplastic causes.

Clinical variables were collected for each patient, including age, sex, body mass index (BMI), diabetes, insulin use, chronic obstructive pulmonary disease, coronary artery disease, peripheral vascular disease, tobacco use, chronic steroid use, prior spinal fusion, and preoperative creatinine levels. Intraoperative variables assessed included estimated blood loss, surgical approach (anterior, posterior, combined approaches, minimally invasive technique), intraoperative steroid use, blood transfusion, surgical location, total operation length, urine output, and number of levels fused.

We assessed postoperative complications for each patient included in the study. Complications assessed included: urinary tract infection, pneumonia, deep and superficial surgical site infections, other types of infections, sepsis, deep vein thrombosis, pulmonary embolism, stroke, myocardial infarction, and cardio/pulmonary arrest. Patient records were examined to include all complications reported during the inpatient visit and also any subsequent readmissions and outpatient visits for the 12 months after their surgery.

Statistical Analysis

The primary aim of this study was to assess whether poor preoperative nutritional status is associated with greater postoperative complication rates. All baseline covariates were compared across our 2 cohorts to examine any potential baseline differences between cohorts. Parametric data were expressed as the means ± standard deviation and compared *via* the Student *t* test. Nonparametric data were expressed as median (interquartile range) and compared *via* the Mann-Whitney *U* test. Nominal data were compared with the χ^2 test. All tests were 2 sided and were statistically significant if the *P* value was less than 0.05. Independent variables associated with poor treatment outcomes ($P < 0.05$) in univariate analyses were then included in a multivariate logistic regression model. Significance of the results in logistic regression was assessed at $\alpha = 0.05$ (JMP 6; SAS Institute, Cary, NC).

RESULTS

One hundred thirty-six patients (77 males, 59 females) were enrolled in the study. Overall, the mean ± standard deviation of age was 53.8 ± 17.0 years (malnourished patients: 51.8 ± 18.6 yr *vs*. nourished patients: 55.2 ± 15.7 yr; $P = 0.24$). Across all patients, we observed an average BMI of 28.4 ± 6.4 kg/m^2 (malnourished patients: 27.3 ± 5.6 *vs*. nourished patients: 29.3 ± 6.9; $P = 0.07$). Twenty (14.7%) patients were smokers, 13 (9.6%) patients reported chronic steroid use, and a significant number of patients presented with medical comorbidities (12.5%, diabetes; 2.2%, insulin use; 3.7%, chronic obstructive pulmonary disease; 10.3%, coronary artery disease; and 2.9%, peripheral vascular disease). The mean preoperative serum creatinine and serum albumin across all patients were 0.90 ± 0.32 mg/dL and 3.44 ± 0.82 g/dL respectively. When stratified by cause for surgery, 74 (54.4%) patients underwent elective spinal decompression and fusion for deformity and degenerative causes, whereas 62 (45.6%) patients underwent a decompression and fusion procedure for nonelective, urgent, or emergent causes, including trauma and neoplastic causes.

Elective Deformity and Degenerative Causes

For patients with elective deformity and degenerative causes, 14 (18.9%) of the 74 patients were found to have a preoperative serum albumin level less than 3.5 g/dL (Table 1). These patients had an average serum albumin of 2.65 ± 0.35 g/dL, compared with an average of 4.03 ± 0.34 g/dL for patients in the nourished cohort ($P < 0.01$). We found no significant baseline differences between the nourished patients and malnourished patients in terms of average age (malnourished patients: 55.1 ± 17.7 yr *vs*. nourished patients: 57.6 ± 14.2 yr; $P = 0.71$) or average BMI (malnourished patients: 27.7 ± 5.4 *vs*. nourished patients: 30.9 ± 6.9; $P = 0.19$). Furthermore, both cohorts did not differ significantly in terms of smoking status (malnourished patients: 7.1% *vs*. nourished patients: 18.3%; $P = 0.31$), sex (malnourished patients: 42.9% male *vs*. nourished patients: 50.0% male; $P = 0.63$), preoperative serum creatinine levels (malnourished patients: 0.86 ± 0.33 mg/dL *vs*. nourished patients: 0.93 ± 0.29 mg/dL; $P = 0.69$), or in any of the other measured comorbidities or factors.

Malnourished and nourished patients had similar operative variables, including estimated blood loss (malnourished patients: 1022.5 ± 1520.6 mL *vs*. nourished patients: 476.3 ± 730.9; $P = 0.11$), minimally invasive technique (malnourished patients: 21.4% *vs*. nourished patients: 30.0%; $P = 0.52$), use of surgical drain (malnourished patients: 71.4% *vs*. nourished patients: 63.3%; $P = 0.57$), intraoperative steroid use (malnourished patients: 49.2% *vs*. nourished patients: 25.0%; $P = 0.18$), and urine output (malnourished patients: 609.8 ± 473.0 mL *vs*. nourished patients: 683.0 ± 489.4 mL; $P = 0.52$). There was a slight difference in operative times between malnourished and nourished patients (malnourished patients: 327.4 ± 89.3 min *vs*. nourished patients: 240.5 ± 71.0 min; $P < 0.01$), as well as number of fusion levels (malnourished patients: 3.9 ± 2.5 *vs*. nourished patients:

TABLE 1. Preoperative Baseline Variables for Patients With Degenerative and Deformity Causes

Variable	Total (N = 74)	Nourished (n = 60)	Malnourished (n = 14)	*P*
Diabetes	12 (16.2)	10 (16.7)	2 (14.3)	0.83
Insulin	1 (1.4)	1 (1.7)	0 (0)	0.63
Smoker	12 (16.2)	11(18.3)	1 (7.1)	0.31
Prior fusion (same operative area)	7 (9.5)	5 (8.3)	2 (14.3)	0.49
Chronic steroid use	6 (8.1)	4 (6.7)	2 (14.3)	0.35
COPD	0 (0)	0 (0)	0 (0)	—
CAD	3 (4.1)	3 (5)	0 (0)	0.39
PVD	3 (4.1)	3 (5)	0 (0)	0.39
Male	36 (48.6)	30 (50.0)	6 (42.9)	0.63
Age at surgery, mean (SD)	57.1 (14.8)	57.6 (14.2)	55.1 (17.7)	0.71
BMI, mean (SD)	30.3 (6.7)	30.9 (6.9)	27.7 (5.4)	0.19
Baseline creatinine, mean (SD)	0.92 (0.29)	0.93 (0.29)	0.86 (0.33)	0.69
Baseline albumin, mean (SD)	3.77 (0.64)	4.03 (0.34)	2.65 (0.35)	<0.01*
Operative variables				
Minimally invasive	21 (28.4)	18 (30.0)	3 (21.4)	0.52
Drain	48 (64.9)	38 (63.3)	10 (71.4)	0.57
Intraoperative steroid use	21 (28.4)	15 (25)	6 (42.9)	0.18
PRBC transfusion	16 (21.6)	8 (13.3)	8 (57.1)	<0.01*
Operative time, mean (SD), min	256.9 (81.7)	240.5 (71.0)	327.4 (89.3)	<0.01*
EBL, mean (SD)	579.6 (943.3)	476.3 (730.9)	1022.5 (1520.6)	0.11
UOP, mean (SD)	667.9 (483.5)	683.0 (489.4)	609.8 (473.0)	0.52
Fusion levels, mean (SD)	2.4 (1.6)	2.1 (1.0)	3.9 (2.5)	<0.01*
Laminectomy levels, mean (SD)	1.6 (1.4)	1.5 (1.1)	1.8 (2.3)	0.53
Postoperative variables				
UTI	3 (4.1)	2 (3.3)	1 (7.1)	0.52
Pneumonia	4 (5.4)	2 (3.3)	2 (14.3)	0.10
Deep surgical site infection	2 (2.7)	1 (1.7)	1 (7.1)	0.26
Superficial surgical site infection	1 (1.4)	0 (0)	1 (7.1)	0.04*
Nonspecific infection	9 (12.2)	5 (8.3)	4 (28.6)	0.04*
Sepsis	2 (2.7)	0 (0)	2 (14.3)	<0.01*
DVT	1 (1.4)	0 (0)	1 (7.1)	0.04*
PE	0 (0)	0 (0)	0 (0)	…
Stroke	1 (1.4)	1 (1.7)	0 (0)	0.63
MI	0 (0)	0 (0)	0 (0)	…
Cardio pulmonary arrest	0 (0)	0 (0)	0 (0)	…
Postoperative length of stay, mean (SD)	4.9 (5.6)	3.8 (2.9)	9.4 (10.5)	<0.01*
At least 1 complication	12 (16.2)	7 (11.7)	5 (35.7)	0.03*

The values given are number (percentage) unless indicated otherwise.

**Statistically significant ($P < 0.05$).*

BMI indicates body mass index; COPD, chronic obstructive pulmonary disease; CAD, coronary artery disease; PVD, peripheral vascular disease; EBL, estimated blood loss; UOP, urine output; UTI, urinary tract infection; DVT, deep vein thrombosis; PE, pulmonary embolism; MI, myocardial infarction; SD, standard deviation.

2.1 ± 1.0; $P < 0.01$). Finally, more malnourished patients received intraoperative blood transfusions (malnourished patients: 57.1% *vs*. nourished patients: 13.3%; $P < 0.01$).

Twelve (16.2%) patients with degenerative or deformity causes experienced at least 1 postoperative complication. The most common complications were nonspecific infections (9 patients, 12.2%), pneumonia (4 patients, 5.4%), and urinary tract infections (3 patients, 4.1%). Five (35.7%) malnourished patients had at least 1 postoperative complication, compared with only 7 (11.7%) of the nourished patients ($P = 0.03$). This difference was mostly due to differences in superficial surgical site infection (malnourished patients: 7.1% *vs*. nourished patients: 0%; $P = 0.04$), other nonspecific types of infection (malnourished patients: 28.6% *vs*. nourished patients: 8.3%; $P = 0.04$), sepsis (malnourished patients: 14.3% *vs*. nourished patients: 0%; $P < 0.01$), and deep vein thrombosis (malnourished patients: 7.1% *vs*. nourished patients: 0%, $P = 0.04$).

Unadjusted logistic regression found baseline serum albumin to be a significant independent predictor of postoperative complications in patients with deformity and degenerative causes (OR: 4.21; 95% CI: 1.09–16.19; $P = 0.04$). Logistic regression, adjusted with quintiles of the propensity score for the risk factors of postoperative complication, also showed baseline serum albumin to be a significant independent predictor of postoperative complications (OR: 4.54; 95% CI: 1.17–19.32; $P = 0.04$).

Traumatic and Neoplastic Causes

For patients with higher-risk, nonelective causes, 43 (69.4%) of the 62 patients were found to have a preoperative serum albumin level less than 3.5 g/dL (Table 2). These malnourished patients had an average serum albumin of 2.64 ± 0.61 g/dL, compared with an average of 3.97 ± 0.43 g/dL for patients in the nourished cohort ($P < 0.01$). Like the patients with lower risk of deformity and degeneration, the nourished patients and malnourished patients did not show any significant baseline differences between them in terms of average age (malnourished patients: 50.7 ± 19.0 yr *vs*. nourished patients: 47.8 ± 18.3 yr; $P = 0.57$). However, malnourished patients had a slightly higher BMI (malnourished patients: 27.1 ± 5.7 *vs*. nourished patients: 24.2 ± 4.0; $P = 0.05$). In addition, both cohorts did not differ significantly in terms of smoking status (malnourished patients: 16.3% *vs*. nourished patients: 5.3%; $P = 0.23$), sex (malnourished patients: 72.1% male *vs*. nourished patients: 52.6% male; $P = 0.14$), preoperative serum creatinine levels (malnourished patients: 0.88 ± 0.37 mg/dL *vs*. nourished patients: 0.85 ± 0.34 mg/dL; $P = 0.88$), or in any of the measured comorbidities or factors.

Twenty-eight (45.2%) patients with traumatic or neoplastic causes experienced at least 1 postoperative complication. The most common complications were urinary tract infections (13 patients, 21.0%), nonspecific infections (11 patients, 17.7%), and pneumonia (10 patients, 16.1%). However, unlike patients with degenerative and deformity causes, a similar number of patients experienced at least 1 complication (malnourished patients: 46.5% patients *vs*. nourished patients: 42.1% patients, $P = 0.75$).

Malnourished and nourished patients had similar operative variables, including operation times (malnourished patients: 276.1 ± 102.2 min *vs*. nourished patients: 271.6 ± 127.9 min; $P = 0.67$), estimated blood loss (malnourished patients: 1456.1 ± 1522.7 mL *vs*. nourished patients: 1173.1 ± 1268.3; $P = 0.48$), intraoperative blood transfusions (malnourished patients: 60.5% *vs*. nourished patients: 36.8%; $P = 0.09$), number of surgical levels (malnourished patients: 3.6 ± 1.3 *vs*. nourished patients: 3.9 ± 1.4; $P = 0.46$), minimally invasive technique (malnourished patients: 4.7% *vs*. nourished patients: 0%, $P = 0.34$), use of surgical drain (malnourished patients: 72.1% *vs*. nourished patients: 84.2%; $P = 0.30$), intraoperative steroid use (malnourished patients: 25.6% *vs*. nourished patients: 47.4%; $P = 0.09$), and urine output (malnourished patients: 855.9 ± 569.1 mL *vs*. nourished patients: 975.0 ± 1026.2 mL; $P = 0.79$).

Unadjusted logistic regression for postoperative complication found baseline serum albumin to be a small, but insignificant, independent predictor of postoperative complications in patients with traumatic and neoplastic causes (OR: 1.20; 95% CI: 0.40–3.56; $P = 0.75$).

DISCUSSION

In this retrospective cohort study of 136 patients, we found that preoperative malnutrition (defined as serum albumin level <3.5 g/dL) was an independent risk factor for postsurgical complications for patients with elective spine surgery. Conversely, in patients undergoing spine decompression and fusion surgery for neoplastic and traumatic causes, baseline nutritional status was not independently predictive of postoperative surgical complications. This study demonstrates that optimization of patients' nutritional status is an important part of preparing patients for elective degenerative and deformity spinal surgery and as such, baseline serum albumin level can be a valuable prognostic tool for detecting malnutrition and assessing subsequent risk for adverse surgical outcomes.

Few past studies have examined the impact of preoperative nutrition status on outcomes after spinal surgery. In a retrospective cohort study of 114 patients undergoing elective lumbar decompression and fusion, Klein *et al*[2] found that patients who were malnourished preoperatively were at a significantly higher risk for infection and postoperative complications in general. Likewise, in a retrospective cohort study of 44 patients with cerebral palsy undergoing scoliosis surgery, Jevsevar and Karlin[16] concluded that malnourished patients had a significantly higher rate of infection and longer length of hospital stay. Notably, both studies defined preoperative malnutrition as the presence of either serum albumin less than 3.5 g/dL or total lymphocyte count less than 1500/mm^3. It should be noted, however, that not all studies have consistently found this association. In a recent systematic review of the literature (including the aforementioned studies), Schuster *et al*[17] noted that only 2 of the 4 previously published studies have found an

TABLE 2. Preoperative Baseline Variables for Patients With Neoplastic and Traumatic Causes

Variable	Total (N = 62)	Nourished (n = 19)	Malnourished (n = 43)	*P*
Preoperative baseline variables				
Obese	11 (17.7)	2 (10.5)	9 (20.9)	0.32
Diabetes	5 (8.1)	1 (5.3)	4 (9.3)	0.59
Insulin	2 (3.2)	0 (0)	2 (4.7)	0.34
Smoker	8 (12.9)	1 (5.3)	7 (16.3)	0.23
Prior fusion (same operative area)	1 (1.6)	0 (0)	1 (2.3)	0.50
Chronic steroid use	7 (11.3)	2 (10.5)	5 (11.6)	0.90
COPD	5 (8.1)	1 (5.3)	4 (9.3)	0.59
CAD	11 (17.7)	2 (10.5)	9 (20.9)	0.32
PVD	1 (1.6)	0 (0)	1 (2.3)	0.50
Male	41 (66.1)	10 (52.6)	31 (72.1)	0.14
Age at surgery, mean (SD)	49.8 (18.7)	47.8 (18.3)	50.7 (19.0)	0.57
BMI, mean (SD)	26.2 (5.3)	24.2 (4.0)	27.1 (5.7)	0.05
Baseline creatinine, mean (SD)	0.87 (0.36)	0.85 (0.34)	0.88 (0.37)	0.88
Baseline albumin, mean (SD)	3.05 (0.83)	3.97 (0.43)	2.64 (0.61)	<0.01*
Operative variables				
Minimally invasive	2 (3.2)	0 (0)	2 (4.7)	0.34
Drain	47 (75.8)	16 (84.2)	31 (72.1)	0.30
Intraoperative steroid use	20 (32.3)	9 (47.4)	11 (25.6)	0.09
PRBC transfusion	33 (53.2)	7 (36.8)	26 (60.5)	0.09
Operative time, mean (SD), min	274.7 (109.7)	271.6 (127.9)	276.1 (102.2)	0.67
EBL, mean (SD)	1369.4 (1445.1)	1173.1 (1268.3)	1456.1 (1522.7)	0.48
UOP, mean (SD)	893.6 (737.6)	975.0 (1026.2)	855.9 (569.1)	0.79
Fusion levels, mean (SD)	3.7 (1.3)	3.9 (1.4)	3.6 (1.3)	0.46
Laminectomy levels, mean (SD)	1.3 (1.3)	1.5 (1.5)	1.2 (1.1)	0.37
Postoperative variables				
UTI	13 (21.0)	4 (21.1)	9 (20.9)	0.99
Pneumonia	10 (16.1)	2 (10.5)	8 (18.6)	0.43
Deep surgical site infection	2 (3.2)	1 (5.3)	1 (2.3)	0.55
Superficial surgical site infection	0 (0)	0 (0)	0 (0)	…
Other infection	11 (17.7)	5 (26.3)	6 (14.0)	0.24
Sepsis	3 (4.8)	1 (5.3)	2 (4.7)	0.92
DVT	2 (3.2)	0 (0)	2 (4.7)	0.34
PE	4 (6.5)	1 (5.3)	3 (7.0)	0.8
Stroke	4 (6.5)	1 (5.3)	3 (7.0)	0.8
MI	4 (6.5)	0 (0)	4 (9.3)	0.17
Cardio pulmonary arrest	1 (1.6)	0 (0)	1 (2.3)	0.50
Postoperative length of stay, mean (SD)	11.0 (11.8)	5.6 (5.8)	13.3 (13.1)	0.02*
At least 1 complication	28 (45.2)	8 (42.1)	20 (46.5)	0.75

The values given are number (percentage) unless indicated otherwise.

BMI indicates body mass index; COPD, chronic obstructive pulmonary disease; CAD, coronary artery disease; PVD, peripheral vascular disease; EBL, estimated blood loss; UOP, urine output; UTI, urinary tract infection; DVT, deep vein thrombosis; PE, pulmonary embolism; MI, myocardial infarction; SD, standard deviation.

association between preoperative malnutrition and surgical site infection. In case-control studies, both Apisarnthanarak *et al*[18] and Klekamp *et al*[19] did not find an increased incidence of malnourishment in patients who developed postoperative infection.

When detected, correction for malnutrition can be accomplished through a variety of means. In an otherwise healthy patient, malnutrition can be the result of a number of social and environmental factors, including poor social or financial support, psychological distress, and natural reduced caloric intake in the elderly.[20] Also, note that our study found that an average BMI of more than 27 was found for both cohorts of malnourished patients, serving as a reminder that a patient can be overweight and malnourished at the same time. First-line therapy typically consists of dietary advice, as well as meal fortification with protein and energy-rich sauces and improving the variety and taste of the food, if possible.[21] For patients resistant to more conservative management, oral nutritional supplementation has been shown to be effective at improving nutrient intake.[22] For those with medical comorbidities that predispose to chronic malnutrition, including gastrointestinal disease, cancer, or depression, optimization of their chronic medical conditions may be necessary to achieve adequate nutrition.

This study focused on serum albumin as a measure of preoperative malnutrition. Malnutrition is systemic phenomenon that affects many different organ systems and serum marker values. However, many of these affected serum values, such as total lymphocyte count, hemoglobin, and cholesterol, have been shown to be poor predictors of postsurgical complications.[23] Moreover, questionnaire-based screening instruments, such as the Mini Nutritional Assessment Short Form (Nestle Nutrition Institute, Switzerland), have not been shown to be well correlated to postoperative complications.[24] Thus, until better means become available, serum albumin remains the best option for assessing risk of postoperative complications in surgical patients.

There were a number of factors that limit the interpretation of this study. First, as a single-institution series, the generalizability of our results remains somewhat limited. In addition, as this was a retrospective study, we were limited to the accuracy and consistency of reporting within the chart and thus systemic differences in reporting may have biased our results. Relatively smaller sample sizes were noted in the malnourished elective (n = 14 patients) and nourished nonelective/neoplastic (n = 19 patients) patient populations. Thus, larger sample sizes may have helped strengthen the statistical analysis of this study. Moreover, as was previously discussed, malnutrition is a heterogeneous and systemic process that affects a variety of functions and serum marker values. Serum albumin values, although a valuable tool in assessing nutritional status, only capture 1 particular aspect of malnutrition and thus may not give a complete assessment of a patient's nutritional status. Despite this, we find evidence that preoperative malnutrition is a significant independent predictor of poor surgical outcomes. Detection and correction of malnutrition is an important part of optimizing patients for spinal surgery.

CONCLUSION

Preoperative hypoalbuminemia is an independent risk factor for postoperative complications after elective spine surgery, and should be used more frequently as a prognostic tool to detect malnutrition and risk of adverse surgical outcomes. Future multi-institutional prospective studies are needed to corroborate our findings.

➢ Key Points

- ❑ In this retrospective review of 136 patients undergoing spinal fusion, preoperative hypoalbuminemia (serum albumin <3.5 g/dL) was shown to be an independent risk factor ($P < 0.05$) for postoperative complications after elective spine surgery for degenerative and deformity causes.
- ❑ Preoperative hypoalbuminemia was not shown to be an independent risk factor ($P = 0.75$) for postoperative complications for patients undergoing spine surgery for non-elective or emergent causes, including trauma and neoplastic causes.
- ❑ This study demonstrates that optimization of patients' nutritional status is an important part of preparing patients for elective degenerative and deformity spinal surgery and as such, baseline serum albumin level can be a valuable prognostic tool for detecting malnutrition and assessing subsequent risk for adverse surgical outcomes.

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