Comparative Study of the Predictive Value of Four Different Nutritional Assessment Methods for Postoperative Complications in Lumbar Degenerative Disease: Postprint

Authors: Zeng Li, Wang Huihui, Xiaoyu Wang, Gong Weiyi, Hu Chunqiu, Hu Chunqiu

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Abstract

Background The occurrence of postoperative complications in lumbar degenerative disease (LDD) is closely associated with malnutrition, and there is currently a lack of nutritional assessment methods that can effectively, objectively, and comprehensively evaluate the nutritional status of LDD patients and predict the occurrence of postoperative complications. Objective To compare the predictive value of four nutritional assessment methods, including the Prognostic Nutritional Index (PNI), Controlling Nutritional Status Score (CONUT), Naples Prognostic Score (NPS), and High-sensitivity Modified Glasgow Prognostic Score (HS-mGPS), for postoperative complications in LDD patients, in order to develop precise nutritional intervention protocols and effectively prevent the occurrence of complications. Methods A total of 201 patients diagnosed with lumbar degenerative disease and undergoing open surgery in the Department of Spine Surgery, Xiangya Hospital, Central South University from December 2021 to July 2022 were selected as study subjects. The four nutritional assessment methods of PNI, CONUT, NPS, and HS-mGPS were applied to evaluate the preoperative nutritional status of patients. The occurrence of complications from postoperation to discharge was observed, and patients were divided into complication and non-complication groups based on the presence or absence of postoperative complications. Differences in clinical characteristic data between the two groups were analyzed and compared. Receiver operating characteristic (ROC) curves were used to calculate the optimal cutoff values for different nutritional assessment methods and compare their predictive efficacy, with MedCalc software used for area under the curve comparisons. Multivariate Logistic regression models were used to analyze the correlation between different nutritional assessment methods and the occurrence of postoperative complications. Results

Postoperative complications occurred in 60 patients, with an incidence rate of 29.85%. Comparison of clinical characteristic data revealed statistically significant differences between the complication and non-complication groups in age, gender, intraoperative blood loss, surgical segments, PNI, CONUT, and NPS scores (P<0.05). ROC curve analysis calculated the optimal cutoff values for PNI, CONUT, NPS, and HS-mGPS in predicting postoperative complications in LDD as 47.5, 2 points, 1 point, and 1 point, respectively. Intra-group comparisons based on these cutoff values showed that low PNI scores, high CONUT scores, and high NPS scores were associated with postoperative complications (P<0.01), whereas high HS-mGPS scores were not associated with postoperative complications (P=0.815). Area under the ROC curve (AUC) results showed statistically significant differences in pairwise AUC comparisons between CONUT and HS-mGPS (Z=4.961, P<0.000 1), CONUT and NPS (Z=2.534, P=0.011 3), CONUT and PNI (Z=3.455, P=0.000 6), HS-mGPS and NPS (Z=3.349, P=0.000 8), and NPS and PNI (Z=2.025, P=0.042 9) (P<0.05). The pairwise AUC comparison between HS-mGPS and PNI (Z=1.594, P=0.110 9) showed no statistically significant difference (P>0.05). Multivariate Logistic regression analysis results indicated that CONUT score (OR=2.431, 95%CI=1.376~4.295, P=0.002) and surgical segments (OR=11.924, 95%CI=5.491~25.893, P<0.001) were independent influencing factors for the occurrence of postoperative complications in LDD. Conclusion Among the four nutritional assessment methods used to predict postoperative complications in LDD patients, the CONUT score demonstrated the highest efficacy and can serve as an independent predictor for the occurrence of postoperative complications in LDD.

Full Text

Comparison of the Predictive Value of Four Different Nutritional Evaluation Methods for Postoperative Complications in Lumbar Degenerative Disease

ZENG Li[1],[2], WANG Huihui[1], WANG Xiaoyu[1], GONG Weiyi[1], HU Chunqiu[1]*

[1]School of Public Health, Anhui Medical University, Hefei 230032, China [2]Spine Surgery Department, Xiangya Hospital of Central South University, Changsha 410008, China

*Corresponding author: HU Chunqiu, Associate professor; E-mail: huchqiu@163.com

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Abstract

Background The occurrence of postoperative complications in lumbar degenerative disease (LDD) is closely related to malnutrition, and currently there is a lack of nutritional evaluation methods that can effectively, objectively, and

comprehensively assess the nutritional status of LDD patients and predict the occurrence of postoperative complications.

Objective To compare the predictive value of four nutritional evaluation methods—prognostic nutritional index (PNI), controlling nutritional status (CONUT), Naples prognostic score (NPS), and high-sensitivity modified Glasgow prognostic score (HS-mGPS)—for postoperative complications in patients with LDD, in order to formulate precise nutritional intervention plans and effectively prevent complications.

Methods A total of 201 patients diagnosed with LDD who underwent open surgery in the Spine Surgery Department of Xiangya Hospital of Central South University from December 2021 to July 2022 were selected as study subjects. Four nutritional evaluation methods (PNI, CONUT, NPS, and HS-mGPS) were applied to assess preoperative nutritional status. Postoperative complications from surgery until discharge were observed. Patients were divided into complication and non-complication groups based on the occurrence of postoperative complications to analyze and compare differences in clinical characteristics. Receiver operating characteristic (ROC) curves were plotted to calculate optimal cut-off values for different nutritional evaluation methods and compare their predictive efficacy, with area under the curve (AUC) comparisons performed using MedCalc software. Multivariate logistic regression models were used to analyze the correlation between different nutritional evaluation methods and postoperative complications.

Results Postoperative complications occurred in 60 patients, with an incidence rate of 29.85%. Comparison of clinical characteristics revealed statistically significant differences between the complication and non-complication groups in age, gender, intraoperative blood loss, surgical segments, PNI, CONUT, and NPS scores ($P<0.05$). ROC curve analysis calculated optimal cut-off values for predicting postoperative complications in LDD as follows: PNI 47.5, CONUT 2 points, NPS 1 point, and HS-mGPS 1 point. Based on these cut-off values, intra-group comparisons of different nutritional evaluation methods showed that low PNI score, high CONUT score, and high NPS score were associated with postoperative complications ($P<0.01$), while high HS-mGPS score was not associated with postoperative complications ($P=0.815$). AUC comparison results showed statistically significant differences between CONUT and HS-mGPS ($Z=4.961$, $P<0.0001$), CONUT and NPS ($Z=2.534$, $P=0.0113$), CONUT and PNI ($Z=3.455$, $P=0.0006$), HS-mGPS and NPS ($Z=3.349$, $P=0.0008$), and NPS and PNI ($Z=2.025$, $P=0.0429$). There was no statistically significant difference between HS-mGPS and PNI ($Z=1.594$, $P=0.1109$). Multivariate logistic regression analysis showed that CONUT score (OR=2.431, 95%CI=1.376-4.295, $P=0.002$) and surgical segments (OR=11.924, 95%CI=5.491-25.893, $P<0.001$) were independent influencing factors for postoperative complications after LDD.

Conclusion Among the four nutritional evaluation methods used to predict postoperative complications in LDD patients, CONUT score demonstrated the highest efficacy and can serve as an independent predictor of postoperative

complications in LDD.

Keywords Lumbar degenerative disease; Nutritional evaluation method; Prognostic nutritional index; Controlling nutritional status; Naples prognostic score; High-sensitive modified Glasgow prognostic score; Postoperative complications

Introduction

Lumbar degenerative disease (LDD) primarily includes conditions such as lumbar disc herniation, lumbar spinal stenosis, lumbar spondylolisthesis, and degenerative scoliosis. With changing lifestyles and ongoing population aging, the incidence of LDD continues to rise. Although surgery is an effective treatment for LDD, postoperative complication rates remain high, with one study reporting a 15.13% complication rate within 30 days post-surgery. The main complications include wound infection, pulmonary infection, pulmonary embolism, urinary tract infection, and deep vein thrombosis. Malnutrition is an independent risk factor for postoperative complications in patients undergoing major orthopedic surgery, impairing physiological function and increasing risks of postoperative infection, multiple organ failure, and perioperative mortality. Effective nutritional support can significantly improve nutritional status, enhance immunity, and promote recovery. However, up to 52% of patients at nutritional risk are not identified in clinical practice. Therefore, seeking a simple, effective, and accurate nutritional evaluation method to guide nutritional intervention protocols for LDD patients is particularly important.

Clinically, single nutritional indicators such as serum albumin and total cholesterol, or single inflammatory indicators such as C-reactive protein (CRP), are commonly used to assess patients' nutritional and immune status. However, due to incomplete indicators, assessment results may differ from actual patient conditions, resulting in weak clinical guidance and poor complication predictability. The prognostic nutritional index (PNI), controlling nutritional status (CONUT) score, Naples prognostic score (NPS), and high-sensitivity modified Glasgow prognostic score (HS-mGPS) are currently commonly used nutritional evaluation methods that have been widely applied to predict outcomes in cardiovascular and cerebrovascular diseases, gastrointestinal tumors, and other conditions. Studies have found that PNI can predict wound infection after spinal surgery, high CONUT scores are associated with complications such as pneumonia, delirium, sepsis, and thrombosis after spinal surgery, and both NPS and HS-mGPS are closely related to postoperative outcomes. However, few studies have compared the predictive value of different nutritional evaluation methods for postoperative complications in LDD patients. This study objectively evaluated preoperative nutritional status in LDD patients using these four scoring systems, analyzed and compared the correlation between different nutritional assessment results and postoperative complications, and aimed to identify the optimal nutritional score for accurately predicting complications in LDD patients to guide

clinical practice.

Methods

1.1 Study Subjects Patients diagnosed with lumbar degenerative disease who underwent open surgery in the Spine Surgery Department of Xiangya Hospital of Central South University from December 2021 to July 2022 were selected as study subjects. Initially, 219 patients were considered, and after applying inclusion and exclusion criteria, 201 patients were successfully enrolled. Inclusion criteria were: (1) confirmed diagnosis of LDD with surgical indications based on CT or X-ray examination; (2) complete clinical data, medical history, and examination records; (3) complications occurring between surgery and discharge; and (4) for patients with two or more LDD types, the primary diagnosis was used as the standard. Exclusion criteria were: (1) patients undergoing minimally invasive surgery; (2) patients with malignant tumors or history of radiation therapy or invasive procedures in the lumbar region; and (3) patients with pre-existing infection or lumbar tuberculosis. This study was approved by the Ethics Committee of Anhui Medical University (registration number: ChiCR2000038568).

1.2 Data Collection and Nutritional Evaluation Criteria 1.2.1 General Data Collection: Clinical data including age, gender, height, body weight, smoking history, alcohol consumption history, underlying diseases (hypertension, diabetes, coronary heart disease), surgical approach, surgical segments, intraoperative blood loss, postoperative hospital stay days, inpatient western medication costs, and total hospitalization costs were collected. In this study, smoking and alcohol history referred to prior history with continued behavior within one month before admission. Laboratory data included preoperative serum albumin (ALB), total cholesterol (TC), C-reactive protein (CRP), neutrophil count (ANC), lymphocyte count (ALC), and monocyte count (AMC).

1.2.2 Nutritional Evaluation Criteria: Based on the collected data, BMI, PNI, CONUT, NPS, and HS-mGPS were calculated. (1) BMI: BMI (kg/m^2) = weight (kg) / height (m)^2. (2) PNI: PNI = ALB (g/L) + 5 × ALC ($\times 10^{9}$/L). The optimal cut-off value was calculated using ROC curve analysis, with values above the cut-off indicating normal nutrition and values below indicating malnutrition risk. (3) CONUT score was calculated based on ALB, TC, and ALC: ALB $ $35 g/L scored 0 points; 30–34.9 g/L scored 2 points; 25–29.9 g/L scored 4 points; ALB <25 g/L scored 6 points. TC $ $4.68 mmol/L scored 0 points; 3.64–4.67 mmol/L scored 1 point; 2.60–3.63 mmol/L scored 2 points; TC <2.60 mmol/L scored 3 points. ALC $ $1.60\times10^{9}/L scored 0 points; 1.20–1.59\times10^{9}/L scored 1 point; 0.80–1.19\times10^{9}/L scored 2 points; ALC < 0.80\times10^{9}$/L scored 3 points. The total score ranged from 0–12 points: 0–1 indicated normal nutrition, 2–4 mild malnutrition, 5–8 moderate malnutrition, and 9–12 severe malnutrition. (4) NPS was calculated based on ALB, TC, neutrophil-to-lymphocyte ratio (NLR), and lymphocyte-to-monocyte ratio (LMR): ALB

$ $40 g/L, TC $ $4.68 mmol/L, NLR <2.96, and LMR $ $4.44 each scored 0 points, while values outside these ranges scored 1 point. The four indicator scores were summed, with NPS >1 indicating malnutrition risk. (5) HS-mGPS was calculated based on ALB and CRP: CRP $ $3 mg/L scored 0 points; CRP >3 mg/L with ALB $ $35 g/L scored 1 point; CRP >3 mg/L with ALB <35 g/L scored 2 points. HS-mGPS $ $1 indicated malnutrition risk.

1.3 Complications Assessment Based on the Clavien-Dindo complication grading system, complications occurring from post-surgery until discharge were collected, and patients were divided into complication and non-complication groups. Complications collected in this study included lower extremity thrombosis, urinary tract infection, pleural effusion, surgical site infection, pulmonary infection, delirium, cerebrospinal fluid leakage, gastrointestinal bleeding, sepsis, pulmonary embolism, hematuria, and hypokalemia. The total number of postoperative complications referred to patients experiencing at least one complication.

1.4 Statistical Methods Data were analyzed using SPSS 26.0 software. Normally distributed continuous data with homogeneity of variance were expressed as mean ± standard deviation and compared between groups using independent samples t-test. Non-normally distributed continuous data were expressed as median (P25, P75) and compared using Mann-Whitney U test. Categorical data were analyzed using ^{2} test. Logistic regression analysis was used to explore influencing factors for postoperative complications in LDD patients. ROC curve analysis was applied to evaluate diagnostic efficacy of each indicator. Two-sided tests were performed with $P<0.05$ considered statistically significant.

Results

2.1 Complications Postoperative complications occurred in 60 patients (29.85% incidence rate), including 21 males and 39 females. Among these, 19 patients experienced two complications, 2 patients experienced three complications, and 1 patient experienced four complications. The highest incidence was lower extremity thrombosis (41.67%, 25 cases), followed by urinary tract infection (33.33%, 20 cases), pleural effusion (20.00%, 12 cases), wound infection (18.33%, 11 cases), pulmonary infection (13.33%, 8 cases), delirium (5.00%, 3 cases), cerebrospinal fluid leakage (3.33%, 2 cases), and hematuria, gastrointestinal bleeding, sepsis, hypokalemia, and pulmonary embolism (each 1.67%, 1 case).

2.2 Comparison of Clinical Characteristics Between Groups Patients were divided into two groups based on the occurrence of postoperative complications. Statistically significant differences were found between groups in age, gender, intraoperative blood loss, surgical segments, postoperative hospital stay days, inpatient western medication costs, and total hospitalization costs

(P<0.05). No significant differences were observed in BMI, smoking history, alcohol consumption history, underlying diseases, or surgical approach (P>0.05) .

2.3 Analysis of Nutritional Evaluation Methods and Postoperative Complications ROC curve analysis calculated optimal cut-off values for predicting postoperative complications in LDD as PNI 47.5, CONUT 2 points, NPS 1 point, and HS-mGPS 1 point. Based on these cut-off values, intra-group comparisons showed that low PNI score, high CONUT score, and high NPS score were associated with postoperative complications (P<0.01), while high HS-mGPS score was not associated with postoperative complications (P=0.815) .

2.4 Predictive Efficacy Assessment of Different Nutritional Evaluation Methods To evaluate predictive efficacy, ROC analysis was performed on different nutritional scores. Results showed CONUT score had the largest AUC value (0.764), followed by NPS (0.675), PNI (0.596), and HS-mGPS had the lowest AUC (0.515). CONUT score demonstrated higher specificity (90.78%) than PNI (75.18%) and NPS (56.74%), and higher sensitivity (66.67%) than PNI (43.33%) and HS-mGPS (5.0%) , [Figure 1: see original paper]. Using MedCalc software for pairwise AUC comparisons, statistically significant differences were found between CONUT and HS-mGPS (Z=4.961, P<0.0001), CONUT and NPS (Z=2.534, P=0.0113), CONUT and PNI (Z=3.455, P=0.0006), HS-mGPS and NPS (Z=3.349, P=0.0008), and NPS and PNI (Z=2.025, P=0.0429). No statistically significant difference was found between HS-mGPS and PNI (Z=1.594, P=0.1109).

2.5 Multivariate Logistic Regression Analysis of Nutritional Scores and Postoperative Complications To explore influencing factors for postoperative complications, multivariate logistic regression analysis was performed with complication occurrence (no=0, yes=1) as the dependent variable. Variables with statistical significance in univariate analysis were included as independent variables: gender (female=0, male=1), age, intraoperative blood loss, surgical segments (single=1, double=2, triple or more=3), postoperative hospital stay days, PNI ($ 47.5 = 0, > 47.5 = 1), $CONUT(2 = 0, > 2 = 1)$, $NPS($1=0, >1=1), and HS-mGPS (<1=0, $ $1=1). Multicollinearity was assessed using tolerance and variance inflation factor (VIF), showing no significant multicollinearity (tolerance >0.1, VIF <10). Regression results indicated that surgical segments and CONUT score were independent influencing factors for postoperative complications in LDD patients .

Discussion

This study found that low PNI score, high CONUT score, and high NPS score were associated with postoperative complications in LDD patients, consistent

with previous research. Patients with low PNI, high CONUT, or high NPS scores exhibit malnutrition and compromised immunity, leading to poorer postoperative outcomes. Predictive efficacy comparison showed CONUT score had the highest specificity (90.78%) and sensitivity (66.67%) among the four methods, with the largest AUC (0.764), indicating superior predictive performance for LDD postoperative complications compared to PNI, NPS, and HS-mGPS. Multivariate logistic regression further confirmed CONUT as an independent risk factor for postoperative complications. These findings suggest that preoperative CONUT score not only reflects nutritional status but also correlates with postoperative complication occurrence. Patients with high preoperative CONUT scores (>2 points) require enhanced nutritional support before surgery.

This finding aligns with international research: RYO et al. reported that high CONUT scores correlate with postoperative pneumonia and prolonged hospitalization; KATO et al. demonstrated that high CONUT is an independent factor for increased infection risk and mortality; and MAO et al. found CONUT more sensitive than PNI in predicting complications in pancreatic cancer patients. However, some studies show inconsistent results. KOBAYASHI et al. found HS-mGPS superior to CONUT and PNI in predicting wound infection after spinal surgery, while HU Xionghui et al. reported CONUT was not the optimal nutritional score for predicting postoperative complications. These discrepancies may arise from differences in study design, such as focusing on single complications, variations in surgical approaches, observation periods, and cut-off values. Additionally, multivariate analysis identified surgical segments as an independent risk factor, with 85% of patients in the complication group undergoing triple-level or more surgery, likely due to longer incisions, increased operative time, greater blood loss, higher transfusion probability, and delayed mobilization. The complication group also had significantly higher total hospitalization costs, as complications lead to prolonged stays and increased treatment expenses.

This study has limitations. Nutritional status was assessed only at admission, without dynamic evaluation during treatment or after discharge, potentially missing optimal monitoring time points. Additionally, the study did not compare the impact of inpatient medications and dietary intake on nutritional status. Finally, as a single-center study with relatively small sample size and short observation period, the stability and reliability of results may be affected, requiring further multi-center validation with larger samples and external data.

In conclusion, among the four nutritional evaluation methods for predicting postoperative complications in LDD patients, CONUT score demonstrated the highest efficacy and can serve as an independent predictor of postoperative complications in LDD.

Author Contributions: ZENG Li conceptualized the study, designed the research, collected data, and wrote the manuscript; WANG Huihui and WANG Xiaoyu performed data entry and statistical analysis; GONG Weiyi reviewed and edited the manuscript; HU Chunqiu supervised quality control.

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Note: Figure translations are in progress. See original paper for figures.