Perioperative Hypoalbuminemia is a Risk Factor for Wound Complications Following Posterior Lumbar Interbody Fusion

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Research article

Abstract

Abstract Background: Although serum albumin levels are increasingly used as an indicator of nutritional status in the clinic, the relationship between perioperative hypoalbuminemia and wound complications after posterior lumbar interbody fusion in the treatment of lumbar degenerative disease remains ambiguous. The aim of this study was to evaluate perioperative serum albumin in relation to postoperative wound complications after posterior lumbar interbody fusion in the treatment of single-segment lumbar degenerative disease. Methods: We reviewed patients who underwent single-segment posterior lumbar interbody fusion surgery from December 2014 to April 2017 in the Department of Orthopedics at the First Affiliated Hospital of Chongqing Medical University. Perioperative (preoperative and early postoperative) serum albumin levels were assessed in all patients and were used to quantify nutritional status. We divided the patients into a surgical wound dehiscence (SWD) group and a normal wound healing group, and into an surgical site infection(SSI)group and a non-SSI group. To evaluate the relationship between perioperative serum albumin level and postoperative wound complications, we conducted univariate and multiple logistic regression analyses. Results: A total of 554 patients were enrolled in the study.The univariate and multiple logistic regression analysis of these differences showed that preoperative serum albumin <3.5 g/dl and postoperative serum albumin:<3.0 g/dl were significantly related to SWD ($P<0.05$). There were also significant differences between the surgical site infection (SSI) groups in terms of preoperative serum albumin <3.5 g/dl($P=0.001$), postoperative serum albumin <3.5 g/dl ($P<0.023$) and <3.0 g/dl($P<0.001$).Additionally, the increased hospitalization costs and length of hospitalization were statistically significant for patients with perioperative hypoproteinemia. Conclusions: For patients who underwent single-segment posterior lumbar interbody fusion surgery, we need to pay more attention to steroid use,perioperative hypoalbuminemia, which are more likely to be associated with increased wound complications, hospitalization costs and length of hospitalization after surgery. Adequate assessment and management of these risk factors will help reduce wound complications and hospital stays for surgical patients and will save medical costs. Keywords: hypoalbuminemia,malnutrition,risk factors,single-segment lumbar fusion,postoperative incision complications,retrospective studies.

Background

Nutritional status is a key factor in patient prognosis in various medical contexts[1–4]. An estimated 4.3% of community-dwelling adults suffer from malnutrition, and the prevalence of malnutrition among medical inpatients ranges from 20–45%[5–11].Malnutrition can be identified in various ways, including serological marker evaluation, anthropometric measurements, and nutrition scoring tools. Among the numerous methods to define malnutrition, the one most frequently used is the serum albumin level. Albumin less than 3.5 g/dL is recognized as hypoalbuminemia (malnourished)[12–14].

The perioperative malnutrition of surgical patients is related to various postoperative adverse outcomes, including infection, acute kidney injury (AKI) and mortality. Wound complications are the most common

problems for surgeons, and understanding the impact of perioperative malnutrition on postoperative wound complications and outcomes is of great significance.

Lumbar fusion is one of the most common spinal procedures. Although this is a relatively safe operation with a high success rate, there is still a risk of postoperative complications and a need for revision surgery. The common wound complications are wound infection, wound dehiscence, wound hematoma and wound hernia. The incidence of complications after spinal fusion ranges from 1−20%[15−16].Wound complications increase patient suffering, hospital length of stay, readmission rate, medical expenses, and mortality and places a heavy burden on patients' families and social health systems. Although progress has been made in the effective prevention of infection through antimicrobials, strengthening wound area management, strengthening operating room and instrument disinfection control, strict suturing during surgery, postoperative drainage and other methods reduce the possibility of complications, though it is still difficult to avoid wound complications in some spinal patients after surgery.

In recent years, with the gradual increase in patients with lumbar degenerative diseases, we found that perioperative malnutrition also increased year by year. Perioperative malnutrition may be linked to age, poor eating, pain, long-term bed rest and other factors. Obese patients who are overweight may still be malnourished[17−19].Despite the growing body of literature on the effects of hypoalbuminemia on postoperative outcomes in other surgical fields, few studies to date have investigated the relationship between perioperative hypoalbuminemia and postoperative wound complications in patients following degenerative lumbar spine surgery. The authors analyzed 554 patients from the First Affiliated Hospital of Chongqing Medical University who underwent posterior lumbar interbody fusion to explore whether the perioperative albumin level can be used as an indicator to evaluate postoperative wound complications.

Methods

We retrospectively reviewed data that were collected for 787 consecutive patients with lumbar degenerative disease who underwent posterior lumbar interbody fusion (PLIF) between December 2014 and April 2017. The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki and the Ethics Committee of the First Affiliated Hospital of Chongqing Medical University, Chongqing, China, and all patients provided informed consent concerning the use of their medical records.

The inclusion criteria for the patients were: 1) patients age 18 or above; 2) patients in good condition who can tolerate surgery; 3) only patients with a diagnosis of primary single-segment lumbar degenerative disease, lumbar disc herniation, lumbar spinal stenosis, or spondylolisthesis; 4) patients undergoing posterior lumbar interbody fusion (PLIF) surgery; and 5) patients with complete follow-up data.

The exclusion criteria for the patients were the following: 1) patients with multisegment lumbar degenerative disease, 2) patients with previous lumbar surgery, and 3) patients with incomplete laboratory data.

According to the above screening criteria, 554 patients were included in this study. There were 314 females and 240 males. The mean age of the patients was 58.5 years (range, 22–85), and at least 1 year of follow-up data were available for all patients. All operations were performed in standard vertical stratospheric operating rooms. We performed antibiotic prophylaxis 24 hours before and after the operation, and all patients were encouraged to wear braces after surgery. All operations were performed by the members of the same medical team (from the authors).

The preoperative baseline variables included albumin level, age, body mass index (BMI), sex, diabetes, tobacco use, and steroid use. Considering that early bed rest in patients with lumbar spondylolisthesis may lead to postoperative wound complications, we also included the preoperative diagnosis in the evaluation index.

We assessed two wound-related complications: poor wound healing and SSI. Poor wound healing refers to delayed healing of the wound due to inflammatory reactions at the healing site, such as redness, induration, hematoma and effusion, including patients with positive or negative drainage culture. Sixty-nine patients (12.5%) in our study were included in this group.

A surgical site infection (SSI) is an infection of the tissues, organs, or spaces exposed by surgeons during the performance of an invasive procedure. Patients with clear histological culture results were included in the SSI (n = 19; 3.4%) group in our study. During the hospital stay and follow-up, the surgeons remained vigilant for any signs of wound complications (drainage, atherosclerosis, skin necrosis, and dehiscence)in these patients. A surgical site infection occurring within 1 year after surgery was considered an infectious complication.

We attempted to explore the relationship between perioperative serum albumin levels and postoperative wound complications, so we included preoperative serum albumin and postoperative short-term albumin levels obtained within 7 days or surgery. Operative variables included operative time and intraoperative blood loss. Postoperative variables included postoperative drainage amount, length of hospital stay and hospitalization costs. Albumin less than 3.5 g/dL was recognized as hypoalbuminemia (malnourished); albumin less than 3.0 g/dL was recognized as malnourished to a level that required intravenous albumin supplementation[9–11].

Statistical Analysis

Statistical analyses were performed using SPSS 24.0 for Windows. Data are shown as the mean ± standard deviation (SD) and median (interquartile range, IQR). Logistic regression analysis was conducted to analyze the risk factors for poor wound healing and SSI. Univariate logistic regression found factors with $p < 0.05$ that were added to multivariate logistic regression analysis. Odds ratios (ORs) and 95% confidence intervals (CIs) were determined when statistically significant differences ($p < 0.05$) were found. All p-values were two-sided.

Results

A total of 554 patients were included in this study. There were 237 men and 317 women (women outnumbered men in this study population), and the mean age was 56.9 years. The incidence of poor wound healing after lumbar spine fusion was 12.45% (69/554), and the incidence of SSI was 3.43% (19/554), which is consistent with other related reports. Microorganisms were isolated from all 19 patients with SSI by open debridement, ultrasound-guided biopsy, superficial exudate, and drainage culture (Table 1.2). There were 13 (2.4%) patients with malnutrition before surgery (preoperative albumin < 3.5 g/dL), 314 (56.4%) patients with albumin < 3.5 g/dL within 7 days after surgery, and 114 (20.6%) patients with albumin < 3.0 g/dL within 7 days after surgery.

Table 1.2 summarizes the univariate analysis results for age, body mass index (BMI), sex, preoperative diagnosis of diabetes, smoking, chronic steroid use, preoperative serum albumin, diagnosis, operation time, bleeding volume, postoperative serum albumin, and postoperative drainage. As shown in Table 1, steroid use (P < 0.001), preoperative albumin level < 3.5 g/dl (P = 0.001), postoperative albumin level < 3.5 g/dl (P = 0.023), postoperative albumin level < 3.0 g/dl (P = 0.001) were significantly correlated with the incidence of poor wound healing (P < 0.05). Although p value of postoperative drainage (P = 0.003) was less than 0.05, OR value was close to 1 infinitely, so there was no statistical significance.

Table 2 shows that age (P = 0.010), steroid use (P = 0.003), preoperative albumin level < 3.5 g/dl (P = 0.001), a spondylolisthesis diagnosis (P = 0.001), postoperative albumin level < 3.5 g/dl (P < 0.001),postoperative albumin level < 3.0 g/dl (P < 0.001), length of stay (P < 0.001), and hospitalization expenses (P < 0.001) were significantly correlated with the incidence of SSI (P < 0.05).

The results above were included in the multivariate logistic regression, and there were statistically significant findings for preoperative hypoalbuminemia (p = 0.024, OR = 4.16 95% CI 1.203–14.44) and postoperative hypoalbuminemia (p < 0.001 OR = 5.22 95% CI 2.84–9.58) (Table 3, Fig. 1) indicating that both were risk factors for poor wound healing. Multivariate logistic regression also found that preoperative hypoproteinemia (p = 0.040 OR = 5.69 95% CI 1.08–29.88) and steroid use (p < 0.001 OR = 20.20 95% CI 4.43–92.16)were statistically significant (Table 4, Fig. 2) risk factors for SSI.

The average hospital stay length was 11 (9–14) days overall; it was 17 (13-22.5) days in the poor wound healing group, and 11 (9–13) days in the normal wound healing group. The difference between the two groups was statistically significant (P < 0.001). The hospital length of stay in the SSI group was 22 (14–32) days, and in the non-SSI group, was 11 (9–14) days; the difference between the two groups was statistically significant (P < 0.001);The average patient expenditure during hospitalization was 25.6 (± 8.7) thousand RMB overall; it was 35.0 (± 17.5) thousand RMB in the poor wound healing group, and it was 24.2 (± 5.5) thousand RMB in the normal wound healing group (P0.001); the average patient expenditure during hospitalization in the SSI group was 43.9 (± 21.3) thousand RMB, and in the non-SSI group, it was 24.9 (± 7.2) thousand RMB (P < 0.001).

Table 1
Patients' demographic characteristics

Variable	Total(N = 554)	Poor wound healing (n = 69)	Normal wound healing (n = 485)	P value
Preoperative baseline variables				
Age at surgery, mean (SD)	56.9(13.4)	60.8(14.2)	56.4(13.2)	0.950
BMI, mean (SD)	24.1(3.1)	24.2(3.8)	24.1(3.0)	0.731
Male	237(43)	30(43.5)	207(42.7)	0.076
Diabetes	60(10.8)	9(13.0)	51(10.5)	0.965
Smoker	144(26.0)	22(31.9)	120(25.2)	0.573
Steroid use	11(1.99)	5(7.25)	6(1.24)	< 0.001
Albumin level < 3.5 g/dl	13(2.35)	6(8.70)	7(1.44)	0.001
Diagnose				
Herniation	270(48.7)	33(47.8)	237(48.9)	-
Stenosis	86(15.5)	12(17.4)	74(15.3)	0.053
Spondylolisthesis	198(35.7)	24(34.8)	174(35.8)	0.397
Operative variables				
Operative time, mean (SD), min	160.8(43.9)	154.4(48.5)	161.8(43.2)	0.593
Bleeding volume, mean (SD) mL	318.5(90.8)	284.1(30.4)	311.4(89.6)	0.662
Postoperative variables				
Albumin level < 3.5 g/dl	314(56.7)	56(81.2)	258(53.2)	0.023
Albumin level < 3.0 g/dl	110(19.9)	36(52.2)	74(15.3)	0.001
Postoperative drainage median,ml, (IQR)	223.5(151.0-309.0)	205.0(120.0-300.0)	231.0(154.5-310.5)	0.003
Length of stay, day, median (SD)	11.0(9.0–14.0)	17.0(13.0-22.5)	11.0(9.0–13.0)	< 0.001
Hospitalization expenses mean (SD)	25.6(8.7)	35.0(17.5)	24.2(5.5)	< 0.001

*Statistically significant (P < 0.05).
BMI indicates body mass index; SD, standard deviation.

Table 2
Patients' demographic characteristics

Variable	Total(N = 554)	SSI (n = 19)	No-SSI (n = 535)	P value
Preoperative baseline variables				
Age at surgery, mean (SD)	56.9(13.4)	56.7(16.0)	56.9(13.3)	0.010
BMI, mean (SD)	24.1(3.1)	23.9(3.9)	24.1(3.1)	0.750
Male	237(43)	12(63.2)	225(42.1)	0.900
Diabetes	60(10.8)	2(10.5)	58(10.8)	0.300
Smoker	144(26.0)	6(31.6)	138(25.8)	0.235
Steroid use	11(1.99)	5(26.3)	6(1.1)	0.003
Albumin level < 3.5 g/dl	13(2.35)	3(15.8)	10(1.9)	0.001
Diagnose				
Herniation	270(48.7)	6(31.6)	264(49.3)	-
Stenosis	86(15.5)	6(31.6)	80(15.0)	0.180
Spondylolisthesis	198(35.7)	7(36.8)	191(35.7)	0.001
Operative variables				
Operative time, mean (SD), min	160.8(43.9)	155.5(48.2)	161.0(43.8)	0.178
Bleeding volume, mean (SD) mL	318.5(90.8)	321.1(105.7)	311.9(89.2)	0.537
Postoperative variables				
Albumin level < 3.5 g/dl	314(56.7)	16(84.2)	298 (55.7)	< 0.001
Albumin level < 3.0 g/dl	110(19.9)	10(52.6)	100(18.7)	< 0.001
Postoperative drainage median,ml, (IQR)	223.5(151.0-309.0)	148(93.0-188.0)	231(154.0-312.0)	0.116
Length of stay, day, median (SD)	11.0(9.0−14.0)	22.0(14.0−32.0)	11.0(9.0−14.0)	< 0.001
Hospitalization expenses mean (SD)	25.6(8.7)	43.9(21.3)	24.9(7.2)	< 0.001

*Statistically significant (P < 0.05).
BMI indicates body mass index; SD, standard deviation.

Table 3
Multivariate logistic regression analysis(PWH)

Variable	B	SD	OR	95% CI	P value
Albumin level < 3.5 g/dl(pre)	1.427	0.634	4.168	1.203−14.442	0.024
Albumin level < 3.5 g/dl(post)	0.540	0.364	1.716	0.841−3.503	0.138
Albumin level < 3.0 g/dl(post)	1.652	0.310	5.219	2.843−9.580	< 0.001
Age	0.016	0.011	1.017	0.995−1.039	0.133
Steroid use	1.378	0.722	3.967	0.965−16.317	0.056

Table 4
Multivariate logistic regression analysis(SSI)

Variable	B	SD	OR	95% CI	P value
Albumin level < 3.5 g/dl(pre)	1.738	0.846	5.687	1.082−29.880	0.040
Albumin level < 3.5 g/dl(post)	0.886	0.717	2.425	0.595−9.889	0.217
Albumin level < 3.0 g/dl(post)	0.695	0.576	2.003	0.647−6.196	0.228
Drainage	-0.008	0.003	0.993	0.986−0.999	0.023
Steroid use	3.006	0.774	20.203	4.429−92.155	< 0.001

Discussion

Understanding perioperative malnutrition is important for postoperative complications and outcomes. In fact, postoperative complications of the lumbar spine can lead to devastating sequelae. Although there may be a direct link between perioperative malnutrition and postoperative wound complications, there is no consensus[20−25].Serum albumin is one of the biochemical indicators of total protein depletion in patients. Our study further confirmed that preoperative hypoproteinemia and postoperative hypoproteinemia are important risk factors for wound complications following single-segment PLIF surgery.

Based on previous reports of wound complications of posterior lumbar surgery, we performed a univariate logistic analysis to investigate the impact of related risk factors. With the subsequent multivariate logistic analysis, we were able to identify 2 independent factors of poor wound healing (preoperative serum albumin < 3.5 g/dl, postoperative serum albumin < 3.0 g/dl) and 2 independent factors of SSI (preoperative serum albumin < 3.5 g/dl, steroid use).

Previous studies have reported that various markers of preoperative malnutrition are associated with surgical site infection following various types of surgery[26].Cross MB et al pointed out that superficial

and deep SSI after orthopedic spinal surgery was associated with several markers of malnutrition, such as serological laboratory values, DM, hyperglycemia and obesity[27].Bohl DD et al investigated the relationship between preoperative hypoalbuminemia (a sign of malnutrition) and complications within 30 days after total joint replacement. Compared with patients with normal albumin concentrations, patients with hypoalbuminemia had a higher risk of surgical site infection, pneumonia, prolonged hospital stay, and readmission[28].Similarly, they retrospectively reviewed data prospectively collected by the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) to investigate the relationship between preoperative hypoproteinemia (a sign of malnutrition) and complications after 30 days of posterior lumbar fusion. They pointed out that malnutrition was an independent risk factor for infection and wound complications after posterior lumbar fusion, and it was also associated with increased length of stay and readmission[29].

Our data showed that preoperative low serum albumin (< 3.5 g/dL) was significantly associated with an increased risk of poor postoperative wound healing (P = 0.024) and SSI (P = 0.040). We combined the results of these data with previous literature and concluded that, although serum albumin concentration is used to measure nutritional status, hypoalbuminemia may be more closely related to pathological inflammatory status.

In addition, early postoperative hypoproteinemia has also been reported as a risk factor for serious postoperative complications[30–33].Lee JI et al investigated 337 patients with major oropharyngeal squamous cell carcinoma (OSCC) who underwent clean and contaminated surgery and monitored serum albumin, glucose, and hemoglobin levels during the perioperative period. The results showed that early postoperative hypoproteinemia < 2.5 g/dl was an independent risk factor for SSI in patients who underwent oral cancer surgery[34].Bohl DD et al. also reported that malnutrition increased the risk of periprosthetic joint infection (PJI) following total joint arthroplasty (TJA)[35].

We also found that low postoperative serum albumin (< 3.0 g/dL) was significantly associated with an increased risk of poor postoperative wound healing (P < 0.001). However, low postoperative albumin is affected by many factors. Ge X et al noted that the stress response, perioperative fluid overload, hemodilution, albumin redistribution, a breakdown of metabolism and other comprehensive factors cause postoperative albumin decline[36].Despite this, we still need to be wary of hypoalbuminemia with albumin levels < 3.0 g/dl after surgery.

Chronic steroid users (steroid usage for more than 10 days preoperatively) have reportedly increased their risk of infection by two- to three-fold after surgery. Singla A et al reported chronic steroid usage to be a significant risk factor for SSI in their database analysis of 360,005 patients over 65 years of age[37].Similarly, chronic steroid usage was reported to be associated with a higher risk of SSI (OR 20.20, 95% CI 4.43–92.16, P < 0.001).

In our univariate logistic analysis, we found that poor drainage after surgery can lead to poor wound healing (P = 0.003). This may be related to the poor placement of the drainage tube and blockage of the drainage tube. Irregular drainage after surgery is prone to deep congestion and hematoma, poor wound

healing and increased risk of infection.However, the OR value is infinitely close to 1,which may be related to the small sample size of SSI group,expanding the sample size is helpful for further research.We also analyzed the increased risk of SSI in those diagnosed with lumbar spondylolisthesis ($P = 0.001$), which might be related to short-term bed rest after surgery. The elderly patients also needed to be alert to SSI after the operation ($P = 0.010$). However, this should be further evaluated in future prospective experiments with increased sample sizes.

When malnutrition is detected, timely nutritional supplementation is beneficial to patients' postoperative recovery. Oral nutritional supplements have been shown to be effective in improving nutrient intake, and they can also be given intravenously. Avenell A et al proved that oral non-protein energy, protein, vitamin and mineral supplements can prevent complications after hip fracture in the elderly[38].

The strengths of this study include the use of the same surgical procedure (PLIF) for lumbar fusion and internal fixation. Only single-segment fusion patients were included to reduce the impact of surgical procedures on the results of the study. In future research, it will be important to further explore, elucidate, and establish potential links between malnutrition and adverse incision outcomes after spinal fusion surgery.

The study was limited by the inherent problems of retrospective studies. First, as a retrospective, single institution study, all data on patient characteristics, laboratory test results, medical interventions directly related to abnormal laboratory values, and patient clinical symptoms were dependent on the inherent limitations of the files in the electronic medical record system. Second, the sample size of patients with preoperative hypoalbuminemia (13 cases) was relatively small, and a larger sample size may have been helpful for the statistical analysis. Although the serum albumin value is a valuable tool for assessing nutritional status, it is affected by many perioperative factors, so it cannot be a comprehensive assessment of the nutritional status of patients.

Conclusions

The current study showed that lower preoperative (< 3.5 g/dl) and postoperative (< 3.0 g/dl) serum albumin values were associated with poor wound healing, and lower preoperative (< 3.5 g/dl) serum albumin levels and chronic steroid use were associated with SSI after posterior lumbar interbody fusion in the treatment of single-segment lumbar degenerative disease. More attention should be paid to the nutritional status of patients to ensure they are supplemented in a timely manner and to reduce hospitalization time and costs.

Abbreviations

SSI:Surgical Site Infection;SWD:surgical wound dehiscence;AKI: Acute kidney injury;PLIF:Posterior lumbar interbody fusion;BMI:body mass index; ACS-NSQIP: American College of Surgeons National Surgical Quality Improvement Program; SD:standard deviation;IQR:Postoperative drainage

median;OSCC:oropharyngeal squamous cell carcinoma;PJI:periprosthetic joint infection;TJA:following total joint arthroplasty;

Declarations

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study is a retrospective clinical study and has been approved by The First Hospital of Chongqing Medical University Ethics Committee.All patients had signed the consent form.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures
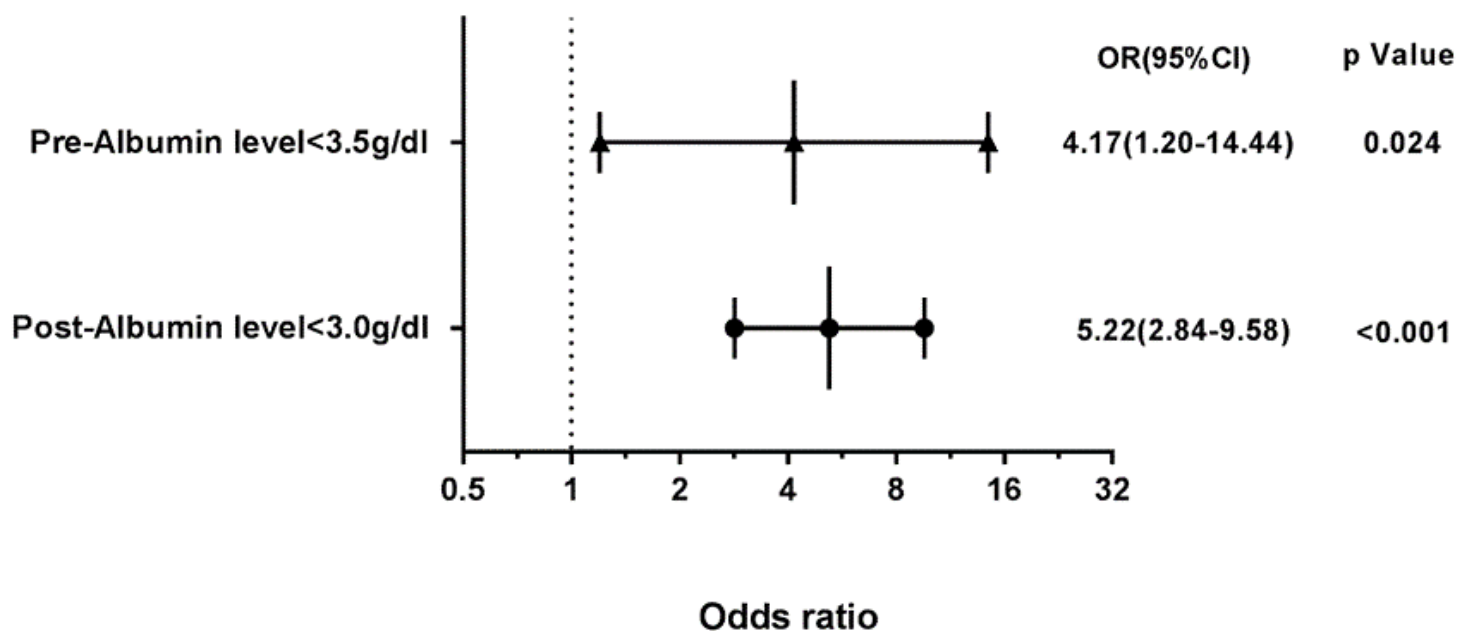
Figure 1

Preoperative hypoalbuminemia and postoperative hypoalbuminemia indicating that both were risk factors for SWD
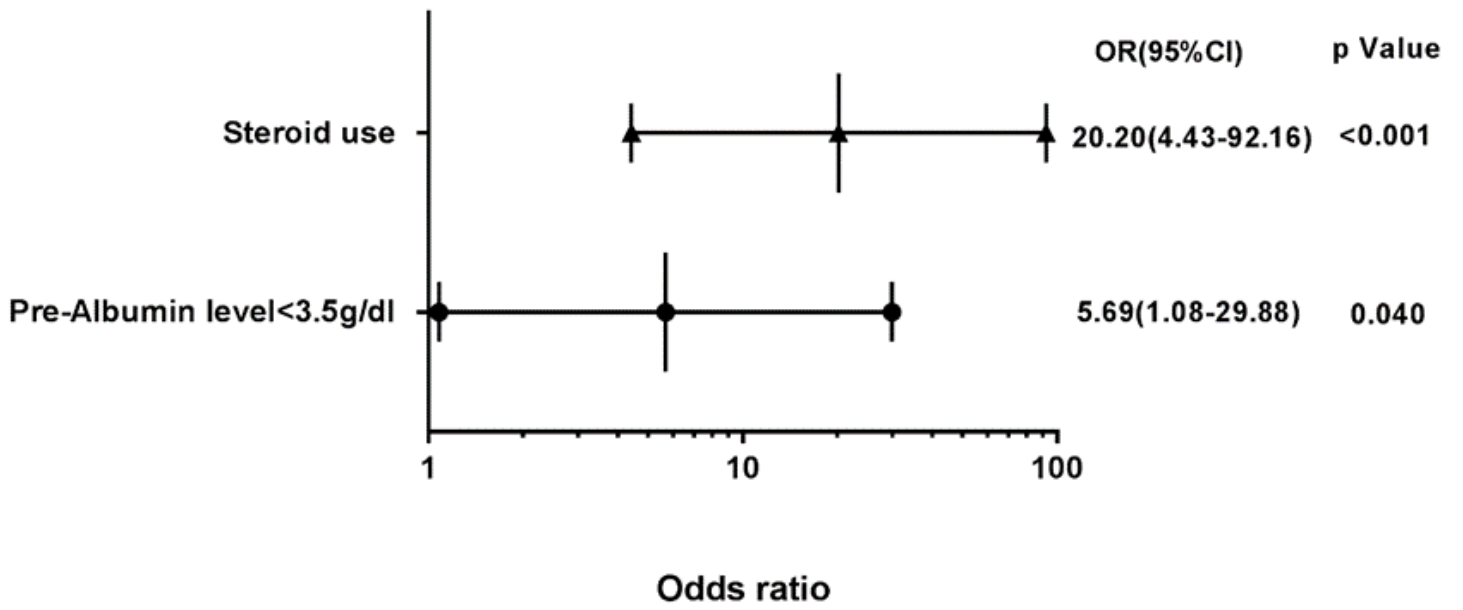
Figure 2

Preoperative hypoproteinemiaand steroid use were statistically significant risk factors for SSI.