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Serum Albumin Levels in Elderly Patients Undergoing Surgical Treatment for Hip Fracture: A Prospective Observational Study

Ramesh Aryal[1], Pranodan Poudel[1], Nitesh Raj Pandey[1], Rajendra Aryal[1], Prashanna Dip Karki[1], Bibek Banskota[1]

[1]Department of Orthopedics, B&B Hospital, Lalitpur, Nepal

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Abstract

Background: Hypoalbuminemia is common in older adults with hip fracture and may reflect nutritional reserve, inflammation, chronic disease, and acute illness. This study described preoperative serum albumin and examined its associations with perioperative outcomes in patients undergoing hip-fracture surgery.

Methods: This prospective observational study was conducted at B&B Hospital, Nepal. Preoperative albumin was classified as low (<3.5 g/dL) or normal (≥3.5 g/dL). Categorical variables were compared using Fisher exact tests where appropriate, and continuous variables using Welch two-sample t-tests. An exploratory parsimonious logistic regression assessed ICU/HDU admission, adjusting for age and preoperative ambulatory status.

Results: Mean age was 77.57 ± 10.90 years and 36/51 (70.6%) were female. Low albumin was present in 37/51 (72.5%). ICU/HDU admission occurred in 31/37 (83.8%) patients with low albumin and 5/14 (35.7%) with normal albumin (p=0.0016). Postoperative transfusion occurred in 37/37 (100%) and 11/14 (78.6%), respectively (p=0.0175). In the exploratory ICU/HDU model, the adjusted OR for low albumin was 2.67 (95% CI 0.49–14.48; p=0.255). No deaths were recorded.

Conclusion: Low preoperative serum albumin was common and was associated with ICU/HDU admission and postoperative transfusion.

Keywords: elderly; albumins; hip fractures; malnutrition; postoperative complications

Address of correspondence

Ramesh Aryal, Department of Orthopedics, B&B Hospital, Gwarko, Lalitpur, Nepal.

Tel: +977-9867868526, Email: rameshary al204843@gmail.com

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Introduction

Hip fractures represent a significant health burden in the elderly, with incidence escalating due to prolonged life expectancy and associated comorbidities such as osteoporosis and frailty.[1] These injuries predominantly affect individuals over 60 years, leading to substantial morbidity, including immobility, pain, and dependency. Elderly patients are particularly susceptible to postoperative complications, heightened morbidity, and mortality, often exacerbated by underlying physiological vulnerabilities.[1,2]

Malnutrition is prevalent among older adults sustaining hip fractures and adversely influences treatment outcomes.[3] Identified as a patient's poor nutritional status, malnutrition serves as an important and modifiable prognostic factor for various medical conditions, including orthopedic surgeries.[4] Serum albumin, with decreased levels indicating malnutrition, is widely recognized as a crucial biomarker for assessing nutritional status.[5] Low serum albumin has prognostic value for mortality and morbidity in hip fracture patients, correlating with higher rates of complications such as pneumonia, sepsis, urinary tract infections, delirium, pressure sores, and extended hospital stays.[6] Due to its modifiability, early nutritional interventions targeting hypoalbuminemia could enhance recovery, yet there is a paucity of data in the Nepalese context.

This study aimed to evaluate the effect of serum albumin levels on outcomes in elderly patients undergoing hip fracture surgery. Specific objectives included identifying the prevalence of preoperative low serum albumin, 30-day mortality rates among hypoalbuminemic patients, complications in this group, and associated demographic characteristics.

Methods

Study design and setting. This prospective observational study was conducted in the Orthopaedic Department of B&B Hospital, Gwarko, Lalitpur, Nepal, over a 10-month period. Consecutive patients undergoing surgical treatment for hip fracture were enrolled. Patients with pathological or impending fractures, neglected hip fractures, previously diagnosed hypoalbuminemia receiving treatment, medical unfitness for surgery, or revision hip surgery were excluded. Institutional Review Committee approval was obtained from B&B Hospital (B&BIRC-24-192), and written informed consent was obtained from the participants.

Sample size was calculated using the formula $N = z^2pq/e^2$, yielding a minimum of 46 participants (assuming z=1.96 for 95% confidence, p=0.029[7] for maximum variability, e=0.5 for margin of error). A total of 51 patients were enrolled consecutively. Serum albumin was measured at hospital admission using the bromocresol green method on an automated analyzer. Patients were classified as having low serum albumin (<3.5 g/dL) or normal serum albumin (≥3.5 g/dL). This threshold was selected in accordance with the study protocol and prior literature.[8]

Demographic and clinical variables included age, sex, ethnicity, weight, body mass index (BMI), documented comorbidities, preoperative ambulatory status, mechanism of injury, fracture classification, anesthesia type, operative duration, intraoperative transfusion, surgical position, postoperative transfusion, intensive care unit/high-dependency unit (ICU/HDU) admission, and length of hospital stay. Preoperative ambulatory status was categorized as community ambulator, household ambulator, or bedridden. The principal comparisons examined perioperative characteristics and outcomes according to albumin category. Mortality and postoperative complications were also reviewed as recorded in the clinical data.

Continuous variables are presented as mean ± standard deviation (SD), and categorical variables as frequency and percentage. Between-group differences in continuous variables were assessed using Welch's independent-samples t-test, with mean differences and 95% confidence intervals (CIs). Fisher's exact test was used for categorical comparisons when expected cell counts were small. An exploratory logistic regression model was fitted for ICU/HDU admission with albumin category, age, and preoperative ambulatory status as predictors. All tests were two-sided, and $p<0.05$ was considered statistically significant.

Results

The study included 51 patients, with a mean age of 77.57 ± 10.90 years (range, 45–96); 36 (70.6%) were women. Mean weight was 57.78 ± 5.90 kg and mean BMI was 25.22 ± 1.83 kg/m^2. Mean serum albumin was 3.10 ± 0.47 g/dL. Low albumin (<3.5 g/dL) was observed in 37 patients (72.5%), while 14 (27.5%) had albumin concentrations in the normal range. The most frequent fracture pattern was pertrochanteric (31/51, 60.8%), and 28 patients (54.9%) were community ambulators before injury. Low-energy trauma was recorded in 26 patients (51.0%), and general anesthesia was used in 42 (82.4%). Intraoperative transfusion was administered to 36 patients (70.6%), postoperative transfusion to 48 (94.1%), and ICU/HDU admission occurred in 36 (70.6%). Mean operative duration was 52.67 ± 14.32 minutes. Length-of-stay data were available for 46 patients, among whom the mean stay was 13.26 ± 6.78 days. (Table 1).

Patients with low albumin were older than those with normal albumin (80.54 ± 8.27 vs. 69.71 ± 13.26 years; mean difference, 10.83 years; 95% CI, 2.82–18.84; p=0.011). Mean weight, BMI, treatment-seeking interval, and operative duration did not differ significantly between groups. As expected, mean albumin was lower in the low-albumin group than

Table 1. Demographic and Clinical Characteristics (N = 51)

Characteristic	Overall (N = 51)
Demographics	
Age, years, mean ± SD	77.57 ± 10.90
Age range, years	45–96
Female sex, n (%)	36 (70.6)
Weight, kg, mean ± SD	57.78 ± 5.90
BMI, kg/m², mean ± SD	25.22 ± 1.83
Serum albumin	
Serum albumin, g/dL, mean ± SD	3.10 ± 0.47
Low albumin (<3.5 g/dL), n (%)	37 (72.5)
Normal albumin (≥3.5 g/dL), n (%)	14 (27.5)
Perioperative characteristics	
Pertrochanteric fracture, n (%)	31 (60.8)
Low-energy trauma, n (%)	26 (51.0)
General anesthesia, n (%)	42 (82.4)
Operative duration, minutes, mean ± SD	52.67 ± 14.32
Perioperative outcomes	
Intraoperative transfusion, n (%)	36 (70.6)
Postoperative transfusion, n (%)	48 (94.1)
ICU/HDU admission, n (%)	36 (70.6)
Hospital stay, days, mean ± SD	13.26 ± 6.78

in the normal-albumin group (2.90 ± 0.39 vs. 3.64 ± 0.10 g/dL; p<0.001). Among patients with recorded length of stay, mean hospitalization was longer in the low-albumin group than in the normal-albumin group (14.84 ± 7.19 days [n=32] vs. 9.64 ± 3.97 days [n=14]; mean difference, 5.20 days; 95% CI, 1.86–8.54; p=0.003). (Table 2).

ICU/HDU admission occurred in 31 of 37 patients with low albumin (83.8%) and 5 of 14 patients with normal albumin (35.7%; Fisher's exact p=0.0016). Poor preoperative ambulatory status, defined as household ambulation or being bedridden, was present in 22 patients with low albumin (59.5%) and one patient with normal albumin (7.1%; p=0.0011). Postoperative transfusion was recorded in all 37 patients with low albumin (100%) and 11 of 14 patients with normal albumin (78.6%; p=0.0175). Intraoperative transfusion occurred in 28 patients with low albumin (75.7%) and 8 with normal albumin (57.1%; p=0.301). No statistically significant between-group differences were detected for sex, fracture pattern, or anesthesia type.

In logistic regression adjusted for age and preoperative ambulatory status, low albumin was associated with higher estimated odds of ICU/HDU admission, although the estimate was imprecise and not statistically significant (adjusted odds ratio [aOR], 2.67; 95% CI, 0.49–14.48; p=0.255). Age was associated with ICU/HDU admission (aOR per year, 1.11; 95% CI, 1.01–1.22; p=0.038). The estimate for poor ambulatory status was also imprecise (aOR, 8.18; 95% CI, 0.83–81.01; p=0.072). In the sensitivity analysis restricted to patients aged 60 years or older (n=47), the association between low albumin and ICU/HDU admission remained uncertain (aOR, 2.83; 95% CI, 0.51–15.61; p=0.232).

Table 2. Comparison of continuous characteristics by serum albumin group

Characteristic	Low albumin (<3.5), n = 37	Normal albumin (≥3.5), n = 14	Mean difference (95% CI)	p-value
Age, years	80.54 ± 8.27	69.71 ± 13.26	10.83 (2.82 to 18.84)	0.011
Weight, kg	57.19 ± 5.88	59.36 ± 5.88	−2.17	0.252
BMI, kg/m²	25.21 ± 1.80	25.24 ± 1.98	−0.03	0.963
Delay in seeking treatment, days	2.59 ± 5.29	2.57 ± 5.29	0.02	0.989
Operative duration, minutes	52.08 ± 13.69	54.21 ± 16.32	−2.13	0.668
Serum albumin, g/dL	2.90 ± 0.39	3.64 ± 0.10	−0.74	<0.001
Hospital stay, days	14.84 ± 7.19 (n = 32)	9.64 ± 3.97 (n = 14)	5.20 (1.86 to 8.54)	0.003

Table 3. Categorical perioperative outcomes by serum albumin group

Outcome	Low albumin, n = 37	Normal albumin, n = 14	p-value
ICU/HDU admission, n (%)	31 (83.8)	5 (35.7)	0.002
Poor preoperative ambulatory status*, n (%)	22 (59.5)	1 (7.1)	0.001
Postoperative transfusion, n (%)	37 (100.0)	11 (78.6)	0.018
Intraoperative transfusion, n (%)	28 (75.7)	8 (57.1)	0.301

Table 4. Exploratory logistic regression for ICU/HDU admission

Predictor	Adjusted odds ratio	95% CI	p-value
Low albumin (<3.5 g/dL)	2.67	0.49–14.48	0.255
Age, per year	1.11	1.01–1.22	0.038
Poor preoperative ambulatory status	8.18	0.83–81.01	0.072

A reliable, adjusted estimate for postoperative transfusion could not be obtained because the outcome was nearly universal and all patients in the low-albumin group received transfusion. There was no recorded mortality.

Discussion

In this single-centre prospective cohort, low admission serum albumin was common among patients undergoing surgery for hip fracture, affecting 72.5% of participants. Low albumin was associated with older age, poorer preoperative mobility, a higher proportion of ICU/HDU admissions, postoperative transfusion, and longer hospital stay in unadjusted comparisons. However, the adjusted association between albumin category and ICU/HDU admission was imprecise and did not reach statistical significance. The findings therefore suggest that low albumin may identify patients with greater underlying vulnerability, but they do not establish an independent or causal effect on perioperative outcomes.

The prevalence observed in this cohort is comparable to the high prevalence reported in some geriatric hip-fracture populations, although direct comparisons are affected by differences in patient selection, comorbidity burden, and nutritional assessment. Previous work has identified preoperative albumin as a marker associated with survival and postoperative course after geriatric hip-fracture surgery.[9] The high prevalence in the present cohort highlights the value of assessing nutritional and general health status in older patients presenting for fracture care. Context-specific approaches to evaluating health-related vulnerability are also important in settings where access to comprehensive preoperative assessment may vary.[10]

The greater frequency of ICU/HDU admission and postoperative transfusion among patients with low albumin is consistent with previous studies linking hypoalbuminemia to adverse postoperative outcomes in orthopaedic populations. Studies of total joint arthroplasty have reported associations between low preoperative albumin and postoperative morbidity, including infectious complications.[11,12] Nevertheless, in the present cohort, the adjusted estimate for ICU/HDU admission had a wide confidence interval that included no association. The small sample and limited number of patients without ICU/HDU admission constrain precision and limit the ability to distinguish the contribution of albumin from age, functional status, comorbidities, and acute illness. The high prevalence of postoperative transfusion in both groups, together with only three patients who did not receive transfusion, similarly precluded a reliable adjusted estimate for that outcome.

Serum albumin should not be regarded as a specific measure of nutritional status in isolation. Concentrations may be influenced by systemic inflammation, acute physiological stress, fluid balance, chronic disease, and nutritional reserve.[13] The association between low albumin and older age in this study is consistent with literature connecting albumin levels to cognitive and broader vulnerability among older adults with hip fracture.[14,15] The observed relationship between low albumin and poorer preoperative mobility may likewise reflect frailty and functional dependence. Previous research has linked preoperative hypoalbuminemia to poorer functional outcomes and quality of life after hip-fracture surgery.[16] Because the present study did not include a validated nutritional assessment, weight-loss history, inflammatory biomarkers, or serial albumin measurements, it cannot determine the relative contribution of malnutrition and inflammation to the observed low albumin concentrations.

The clinical relevance of hypoalbuminemia may extend beyond nutritional reserve. Recent research has described a bidirectional relationship between hypoalbuminemia and postoperative pneumonia in older hip-fracture patients, in which acute complications and inflammatory responses may further alter albumin concentrations.[17] The present study cannot evaluate such pathways because

complication-specific events and their timing were not systematically available for analysis. Similarly, although no deaths were recorded in the available mortality fields, the data do not support a definitive estimate of 30-day mortality. Prior studies have reported associations between preoperative albumin and short-term mortality after hip fracture, underscoring the importance of clearly defined follow-up and adequate sample size when evaluating mortality outcomes.[6,9]

This study has several strengths, including prospective observational data collection and the ability to compare clinically relevant perioperative characteristics by albumin category. The findings should nevertheless be interpreted in light of the modest sample size, single-centre setting, incomplete length-of-stay data, limited structured ascertainment of postoperative complications, and lack of verified time-specific mortality follow-up. Residual confounding is likely, and the exploratory adjusted model could include only a small number of predictors. Inflammatory markers, including the C-reactive protein-to-albumin ratio, may offer complementary prognostic information in older patients undergoing hip-fracture surgery.[18] Larger prospective studies with standardized nutritional and comorbidity assessments, predefined outcome measures, and complete follow-up are needed to evaluate the independent prognostic contribution of albumin.

Clinically, a low albumin concentration may be useful as one component of perioperative risk assessment, particularly when interpreted alongside age, baseline mobility, comorbidities, and the patient's acute clinical condition. Previous orthopaedic research has examined albumin as a predictor of postoperative complications in comparison with other risk measures.[19] However, the present observational findings do not demonstrate that albumin infusion or correction of the laboratory value itself improves outcomes. Nutritional assessment and individualized supportive care remain appropriate components of comprehensive care, while the effectiveness of specific albumin-directed interventions requires evaluation in appropriately designed studies.

Conclusion

Low admission serum albumin (<3.5 g/dL) was present in 72.5% of this cohort of patients undergoing surgery for hip fracture and was associated with older age, poorer preoperative mobility, higher unadjusted ICU/HDU admission and postoperative transfusion proportions, and longer hospital stay. After adjustment for age and ambulatory status, the association between low albumin and ICU/HDU admission remained uncertain. These findings support considering serum albumin as one marker of perioperative vulnerability rather than a standalone measure of nutritional status or a demonstrated causal determinant of outcomes. Larger prospective studies with standardized nutritional assessment, robust adjustment for confounding, and complete ascertainment of complications and mortality are warranted.

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