

Postoperative hypoalbuminemia is an independent predictor of 1-year mortality after surgery for geriatric intertrochanteric femoral fracture

A retrospective cohort study

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Abstract

Preoperative hypoalbuminemia from malnutrition is associated with increased morbidity and mortality after geriatric hip fracture surgery. However, little is known regarding the correlation between postoperative hypoalbuminemia and mortality. This study aimed to evaluate whether postoperative hypoalbuminemia could predict 1-year mortality after intertrochanteric femoral fracture surgery in elderly patients.

The medical records of 263 geriatric patients (age ≥ 65 years) who underwent intertrochanteric femoral fracture surgery between January 2013 and January 2016 in a single hospital were reviewed retrospectively. The patients were allocated to 2 groups based on lowest serum albumin levels within 2 postoperative days (≥ 3.0 g/dL [group 1, $n=46$] and <3.0 g/dL [group 2, $n=217$]). Data between the non-survival and survival groups were compared. Multivariable logistic regression analysis was conducted to identify the independent predictor for 1-year mortality.

The 1-year mortality rate was 16.3% after intertrochanteric femoral fracture surgery. Multivariable logistic regression analysis revealed that postoperative hypoalbuminemia was significantly associated with 1-year mortality (adjusted odds ratio, 8.03; 95% confidence interval, 1.37-47.09; $P=.021$). The non-survival group showed a significantly increased incidence of postoperative hypoalbuminemia (95.4% vs 80.0%, $P=.015$) and intensive care unit admission (11.6% vs 2.7%, $P=.020$), older age (82.5 ± 5.8 years vs 80.0 ± 7.2 years, $P=.032$), lower body mass index (20.1 ± 3.2 kg/m² vs 22.4 ± 3.8 kg/m², $P<.001$), and increased amount of transfusion of perioperative red blood cells (1.79 ± 1.47 units vs 1.43 ± 2.08 units, $P=.032$), compared to the survival group.

This study demonstrated that postoperative hypoalbuminemia is a potent predictor of 1-year mortality in geriatric patients undergoing intertrochanteric femoral fracture surgery. Therefore, exogenous albumin administration can be considered to improve postoperative outcomes and reduce the risk of mortality after surgery for geriatric hip fracture.

Abbreviations: AKI = acute kidney injury, BMI = body mass index, BP = blood pressure, CI = confidence interval, DM = diabetes mellitus, ICU = intensive care unit, OR = odds ratio, POD2_alb = serum albumin level within 2 postoperative days, PT/INR = prothrombin time international normalized ratio, RBC = red blood cell, SCr = serum creatinine.

Keywords: geriatric, intertrochanteric femoral fracture, mortality, postoperative albumin

Editor: Daryle Wane.

SUC and JHR contributed equally to this work.

The authors have no funding and conflicts of interest to disclose.

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

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How to cite this article: Choi SU, Rho JH, Choi YJ, Jun SW, Shin YJ, Lee YS, Shin HJ, Lim CH, Shin HW, Kim JH, Lee HW, Lim HJ. Postoperative hypoalbuminemia is an independent predictor of 1-year mortality after surgery for geriatric intertrochanteric femoral fracture: a retrospective cohort study. *Medicine* 2021;100:51(e28306).

Received: 24 September 2020 / Received in final form: 25 November 2021 / Accepted: 26 November 2021

<http://dx.doi.org/10.1097/MD.00000000000028306>

1. Introduction

Hip fracture is one of the risk factors for mortality after orthopedic surgery; other risk factors include age, acute kidney injury (AKI), chronic renal failure, pulmonary embolism, and congestive heart failure.^[1,2] Previous studies reported that the risk factors that contribute to mortality after hip fracture are malnutrition, reduced daily activities, anemia, high American Society of Anesthesiologists class, low body mass index (BMI), poor mental status, and high serum creatinine levels.^[3–5] Elderly patients undergoing hip fracture surgery commonly have underlying diseases, such as pulmonary disease, cerebrovascular accident, and cardiovascular disease, and present with severe postoperative complications, such as pneumonia, heart failure, and death.^[2,6,7] The 1-year mortality rates after hip fracture surgery vary from 19% to 33%.^[8,9]

Most elderly patients show malnutrition, which is related to postoperative wound dehiscence, surgical site infection, pneumonia, and urinary tract infection after orthopedic surgery.^[10–13] Human albumin is a characteristic serum marker for the estimation of malnutrition, which is considered as serum albumin level <3.5 g/dL.^[14] Albumin is the plasma protein with a 66-kDa molecular weight that is synthesized in the liver and secreted into the blood stream and extravasated from the intravascular to the interstitial space.^[11,15] Human albumin is the main determinant of plasma oncotic pressure. It plays an important role in regulating fluid distribution between body compartments.^[16] It has been widely used to treat several diseases, including trauma, hemorrhage, surgical blood loss, hypovolemia, chronic liver disease, hemodialysis, and hypoalbuminemia.^[17,18] The physiological function of albumin includes free radical scavenging, capillary membrane permeability, metabolite transport, and modulation of plasma volume by preserving the colloid oncotic pressure.^[19]

Postoperative hypoalbuminemia is related to increased morbidity, such as that from AKI after orthopedic surgery.^[20,21] Kim et al.^[21] demonstrated that early postoperative albumin levels are related to AKI; however, no relationship was found between postoperative hypoalbuminemia and mortality after total knee arthroplasty. The causes of postoperative hypoalbuminemia are associated with several factors, such as preoperative hypoalbuminemia, hemodilution from fluid therapy, surgical injury, and perioperative bleeding in patients undergoing hip fracture surgery.^[22–24]

Albumin and synthetic colloids are commonly used as perioperative blood volume expanders to enhance the intravascular volume, reduce allogeneic blood transfusion, and improve hemodynamic instability.^[25] Synthetic colloids, such as hydroxyethyl starch, are associated with induction of platelet dysfunction, worsening hemostasis, and augmenting perioperative bleeding.^[26–28] Therefore, administration of exogenous albumin can augment the blood volume, improve hemodynamic instability, and decrease the risk of mortality.^[29–32] Hypoalbuminemia was independently associated with female sex, age, diabetes mellitus (DM), BMI, anemia, end-stage renal disease, and chronic obstructive pulmonary disease.^[33] Preoperative hypoalbuminemia is a strong independent risk factor for mortality after hip fracture surgery in elderly patients.^[4,34,35] However, no study has reported the association between postoperative hypoalbuminemia and mortality after hip fracture surgery. Therefore, we aimed to investigate whether postoperative hypoalbuminemia can predict 1-year mortality after surgery for geriatric intertrochanteric femoral fractures.

2. Materials and methods

2.1. Study population

Our institutional review board approved this study (2017AN0340), and informed consent was waived owing to the retrospective nature of the study. The electronic medical records of 266 elderly patients (age ≥ 65 years) who underwent intramedullary nailing for intertrochanteric femoral fracture between January 2013 and January 2016 at our hospital were identified through the electronic medical record system. Patients were excluded if they had undergone repeated surgery or were diagnosed with end-stage renal disease, requiring hemodialysis. Three patients were excluded because they had received repeated or additional surgery. The final cohort consisted of 263 patients. Information on the patients' baseline demographics, comorbidities, medications, perioperative laboratory findings, and postoperative complications was collected from computerized databases at our institution.

The included patients were allocated to 2 groups based on their lowest serum albumin levels within 2 postoperative days (lowest POD2_alb level) as follows: ≥ 3.0 g/dL (group 1, $n=46$) and <3.0 g/dL (group 2, $n=217$). Information regarding the anesthesia type (general or regional), operation time, and units of packed red blood cells (RBCs) transfusion of during surgery was collected for each patient.

The patients were administered regional or general anesthesia, according to the decision of the anesthesiologist. Electrocardiography, noninvasive blood pressure (BP), and pulse oximetry were monitored intraoperatively. Crystalloids, including lactated Ringer solution or normal saline, were used to maintain tolerable urine output (>0.5 mL/h). Intraoperative blood loss was managed by transfusion of packed red blood cells (RBCs) and synthetic colloid solution, such as 10% pentastarch (Pentaspan; Jeil, Seoul, Korea), to maintain the hematocrit level at $>25\%$.

2.2. Clinical data

Demographic data included BMI, sex, age, underlying diseases (ischemic heart disease, hypertension, DM, percutaneous coronary intervention history, cerebrovascular accident, dementia, pulmonary disease, previous cancer history, and chronic kidney disease), and preoperative medications (beta-blocker, statin, calcium-channel blocker, anticoagulant, and angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker). Preoperative laboratory data included serum creatinine and hemoglobin levels, prothrombin time/international normalized ratio (PT/INR), and platelet count. The intraoperative laboratory data included anesthetic type (general vs regional), operation time, amounts of crystalloids and synthetic colloids, use of a vasopressor, urine output, lowest systolic BP, and units of packed RBC transfusion. Postoperative laboratory data included albumin, potassium, C-reactive protein, and serum creatinine (SCR) levels on postoperative days (POD) 2 and 7.

2.3. Outcomes

The primary outcome was the 1-year mortality in elderly patients who underwent intertrochanteric femoral fracture surgery. We obtained the mortality data from the center of national population database (National Statistics Korea) for purposes of research.

2.4. Statistical analysis

All data were presented as mean \pm standard deviation for continuous variables, and numbers (percentages) for categorical variables. Baseline, intraoperative, and postoperative characteristics were analyzed using the Student *t* test or Mann–Whitney *U* test for continuous variables, and Fisher exact test or χ^2 test for categorical variables. The cut-off POD2_alb level of 3.0 g/dL was determined using the Youden index. Univariate and multivariable logistic regression analyses were performed to detect the factors that significantly predicted 1-year mortality. A stepwise process was used to acquire the final multivariable logistic regression, and adjusted odds ratios (ORs) with the 95% confidence intervals (CIs) were estimated after identifying significant factors in the univariate analysis. SAS (version 9.2; SAS Institute, Cary, NC) was used for all statistical analyses. Statistical significance was set at $P < .05$. A receiver-operating characteristic curve was created using the DeLong method to investigate the power of predicting postoperative albumin level for 1-year mortality after surgery for intertrochanteric femoral fracture, with statistical significance set at an area under the curve of >0.5 .

3. Results

The baseline demographic data of all the patients are presented in Table 1. A total of 263 patients were included. The study flow diagram is presented in Figure 1. The patients included 73 men (27.8%) and 190 women (72.2%). The mean age was 80.37 ± 7.08 years. The underlying medical diseases were DM (34.6%), hypertension (72.4%), ischemic heart disease (21.3%), percutaneous coronary intervention history (8.0%), cerebrovascular accident (20.9%), dementia (15.2%), pulmonary disease (13.7%), prior cancer history (9.5%), and chronic kidney disease stage ≥ 3 (25.8%).

Among the patients, 46 (17.5%) were allocated to group 1, whereas 217 (82.5%) were allocated to group 2. Baseline demographics between the 2 groups had no significant differences. The perioperative laboratory data of all the patients are shown in Table 2. Preoperatively, the patients in group 2 showed significantly increased PT/INR than those in group 1 (1.06 ± 0.09 vs 1.03 ± 0.07 , $P = .018$). The intraoperative data showed that the 2 groups did not differ regarding anesthetic technique and operation time, but those in group 2 had significantly more crystalloids (462.70 ± 303.20 mL vs 384.8 ± 184.70 mL, $P = .025$) and transfused intraoperative packed RBCs (0.11 ± 0.52 units vs 0.00 ± 0.00 units, $P = .003$) than those in group 1.

The 1-year mortality rate after intertrochanteric femoral fracture surgery was 16.3% (Table 3). The non-survival group revealed significantly increased incidence rates of postoperative hypoalbuminemia (95.4% vs 80.0% $P = .015$), intensive care unit (ICU) admission (11.6% vs 2.7%, $P = .020$), and increased transfusion amount (unit) of perioperative packed RBCs (1.79 ± 1.47 units vs 1.43 ± 2.08 units, $P = .032$) as compared with the survival group. In demographic data, the non-survival group showed older age (82.5 ± 5.8 years vs 80.0 ± 7.2 years, $P = .032$) and lower BMI (20.1 ± 3.2 kg/m² vs 22.4 ± 3.8 kg/m², $P < .001$) as compared with the survival group. In laboratory data, the non-survival group showed significantly higher preoperative PT/INR (1.08 ± 0.10 vs 1.04 ± 0.08 , $P = .007$), SCr level (1.13 ± 0.56 mg/dL vs 0.91 ± 0.35 mg/dL, $P = .017$) and SCr level on POD2 (1.08 ± 0.53 mg/dL vs 0.93 ± 0.44 mg/dL, $P = .04$), and significantly lower intraoperative systolic BP (SBP; 84.1 ± 17.5 mm Hg vs 90.3 ± 17.6 mm Hg, $P = .035$) and lowest POD2_alb level (2.57 ± 0.24 g/dL vs 2.74 ± 0.33 g/dL, $P < .001$) as compared with the survival group.

Multivariable logistic regression analysis demonstrated that postoperative hypoalbuminemia (lowest POD2_alb level < 3.0 g/dL) (adjusted OR, 8.03; 95% CI, 1.37–47.09; $P = .021$), BMI (adjusted OR, 0.76; 95% CI, 0.67–0.87; $P < .001$), beta-blocker

Table 1
Demographic data of all patients.

	Total (n = 263)	Group 1 [alb \geq 3.0 g/dL] (n = 46)	Group 2 [alb $<$ 3.0 g/dL] (n = 217)	P value
Age (yrs)	80.37 \pm 7.08	78.70 \pm 6.44	80.73 \pm 7.17	.077
Sex (M/F)	73 (27.76%)/190 (72.24%)	15 (32.61%)/31 (67.39%)	58 (26.73%)/159 (73.27%)	.419
BMI (kg/m ²)	22.03 \pm 3.81	22.41 \pm 3.50	21.95 \pm 3.88	.466
ASA class				.858
2	191 (72.62%)	33 (71.74%)	158 (72.81%)	
3	72 (27.38%)	13 (28.26%)	59 (27.19%)	
Diabetes mellitus	91 (34.60%)	15 (32.61%)	76 (35.02%)	.755
Hypertension	188 (71.48%)	35 (76.09%)	153 (70.51%)	.446
IHD	56 (21.29%)	11 (23.91%)	45 (20.74%)	.633
PCI history	21 (7.98%)	6 (13.04%)	15 (6.91%)	.225
CVA	55 (20.91%)	9 (19.57%)	46 (21.20%)	.805
Dementia	40 (15.21%)	9 (19.57%)	31 (14.29%)	.365
Pulmonary disease	36 (13.69%)	5 (10.87%)	31 (14.29%)	.540
Cancer history	25 (9.51%)	3 (6.52%)	22 (10.14%)	.586
CKD stage ≥ 3	68 (25.9%)	8 (17.4%)	60 (27.7%)	.1489
CCB	98 (37.26%)	22 (47.83%)	76 (35.02%)	.103
ACEI/ARB	105 (39.92%)	19 (41.30%)	86 (39.63%)	.833
Beta blocker	43 (16.35%)	10 (21.74%)	33 (15.21%)	.277
Anticoagulant	120 (45.63%)	26 (56.52%)	94 (43.32%)	.102
Statin	19 (7.22%)	2 (4.35%)	17 (7.83%)	.542

Values are expressed as mean \pm standard deviation or number (%). ACEI/ARB = angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker, ASA = American Society of Anesthesiologists, BMI = body mass index, CCB = calcium channel blocker, CKD = chronic kidney disease, CVA = cerebrovascular accident, IHD = ischemic heart disease, PCI = percutaneous coronary intervention.

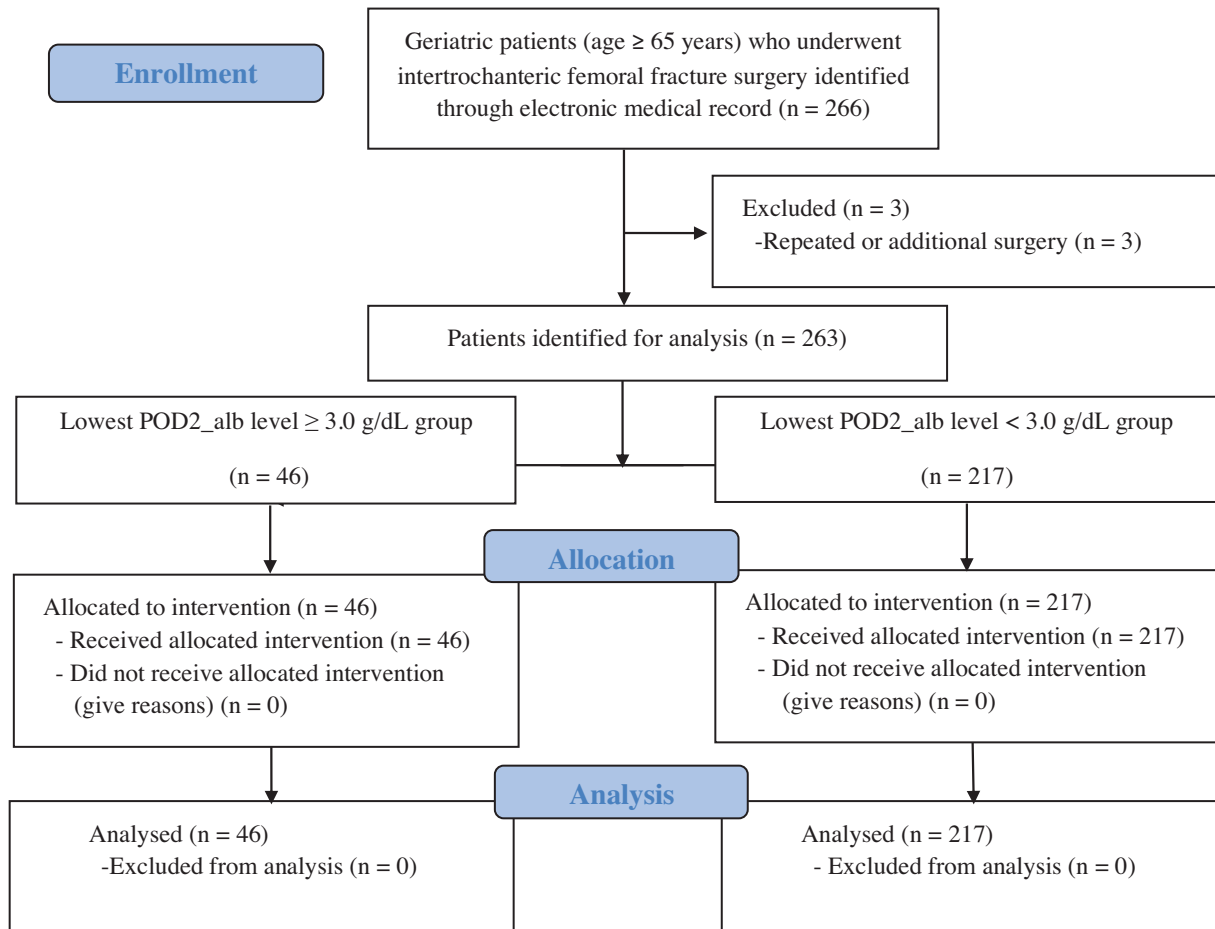


Figure 1. Study flow diagram. Lowest POD2_alb level = lowest serum albumin level within 2 postoperative days.

Table 2

Perioperative laboratory data of all patients.

	Total (n = 263)	Group 1 [alb ≥ 3.0 g/dL] (n = 46)	Group 2 [alb < 3.0 g/dL] (n = 217)	P value
Preoperative data				
Hemoglobin (g/dL)	11.30 ± 1.27	11.63 ± 1.39	11.23 ± 1.24	.051
Platelets (×103/μL)	192.7 ± 64.89	204.3 ± 61.19	190.2 ± 65.52	.182
PT/INR	1.05 ± 0.09	1.03 ± 0.07	1.06 ± 0.09	.018
SCr (mg/dL)	0.94 ± 0.40	0.88 ± 0.26	0.95 ± 0.42	.125
Intraoperative data				
Anesthetic type (GA vs RA)	153 (58.17%)/110 (41.83%)	28 (60.87%)/18 (39.13%)	125 (57.60%)/92 (42.40%)	.683
Operation time (min)	71.43 ± 35.29	79.35 ± 42.26	69.75 ± 33.50	.153
Crystalloid (mL)	449.0 ± 287.30	384.8 ± 184.70	462.70 ± 303.20	.025
Synthetic colloid (mL)	73.95 ± 158.0	65.22 ± 150.50	75.81 ± 159.90	.681
Vasopressor use	87 (33.08%)	13 (28.26%)	74 (34.10%)	.444
Urine output (mL)	166.40 ± 201.50	178.20 ± 228.30	164.0 ± 196.0	.668
Lowest SBP (mm Hg)	89.30 ± 17.68	90.07 ± 17.40	89.13 ± 17.78	.746
pRBC (unit)	0.09 ± 0.47	0.00 ± 0.00	0.11 ± 0.52	.003
Postoperative data				
Albumin (g/dL)	2.71 ± 0.32	3.21 ± 0.28	2.60 ± 0.21	<.0001
Potassium (mEq/L)	4.16 ± 0.51	4.23 ± 0.46	4.14 ± 0.51	.267
CRP (mg/dL)	98.19 ± 50.82	88.67 ± 45.40	100.1 ± 51.74	.189
SCr (mg/dL) POD 2	0.95 ± 0.45	0.93 ± 0.51	0.96 ± 0.44	.727
SCr (mg/dL) POD 7	0.98 ± 0.53	0.96 ± 0.69	0.99 ± 0.50	.792

Values are expressed as mean ± standard deviation or number (%).

CRP = C-reactive protein, GA = general Anesthesia, POD = postoperative day, pRBC = packed red blood cell, PT/INR = prothrombin time/international normalized ratio, RA = regional anesthesia, SBP = systolic blood pressure, SCr = serum creatinine.

Table 3
Characteristics of geriatric patients who underwent intertrochanteric femoral fracture surgery, stratified according to non-survival and survival groups after 1 yr.

Variables, mean (SD) or n (%)	One-year mortality		P value
	Non-survival (n=43)	Survival (n=220)	
Demographic			
Age, yrs	82.5 (5.8)	80.0 (7.2)	.032*
Sex, female	27 (62.8%)	163 (74.1%)	.130†
BMI, kg/m ²	20.1 (3.2)	22.4 (3.8)	<.001*
Hypertension	36 (83.7%)	152 (69.1%)	.052†
Ischemic heart disease	12 (27.9%)	44 (20.0%)	.247†
Pulmonary disease	8 (18.6%)	28 (12.7%)	.305†
CKD stage ≥3	16 (37.2%)	52 (23.3%)	.056†
Calcium channel blocker	21 (48.8%)	77 (35.0%)	.086†
Beta blocker	11 (25.6%)	32 (14.6%)	.074†
Anticoagulant use	18 (41.9%)	102 (46.4%)	.588†
Statin use	0 (0.0%)	19 (8.6%)	.050‡
Laboratory			
Hemoglobin, g/dL	11.2 (1.1)	11.3 (1.3)	.443*
PT/INR-pre	1.08 (0.10)	1.04 (0.08)	.007*
Lowest POD2_alb level, g/dL	2.57 (0.24)	2.74 (0.33)	<.001*
C-reactive protein, mg/dL	104.7 (58.1)	96.9 (49.3)	.368*
SCr pre, mg/dL	1.13 (0.56)	0.91 (0.35)	.017*
SCr POD2, mg/dL	1.08 (0.53)	0.93 (0.44)	.040*
SCr POD7, mg/dL	1.16 (0.64)	0.95 (0.50)	.052*
Lowest SBP, mmHg	84.1 (17.5)	90.3 (17.6)	.035*
Synthetic colloid, mL	120.9 (231.3)	64.8 (138.2)	.224#
Vasopressor use	18 (41.9%)	69 (31.4%)	.181†
pRBC-perioperative (unit)	1.79 (1.47)	1.43 (2.08)	.032#
Postoperative outcomes			
Hospital stay, d	21.3 (11.5)	17.7 (9.3)	.060*
ICU admission	5 (11.6%)	6 (2.7%)	.020‡
POD2_alb <3.0 g/dL	41 (95.4%)	176 (80.0%)	.015†

Values are expressed as mean (standard deviation) or number (percentage).

BMI = body mass index, CKD = chronic kidney disease, ICU = intensive care unit, POD = postoperative day, pRBC = packed red blood cell, PT/INR = prothrombin time/international normalized ratio, SBP = systolic blood pressure, SCr = serum creatinine.

* P value by Student *t* test.

† P value by χ^2 test.

‡ P value by Fisher exact test.

P value by Mann-Whitney *U* test.

use (adjusted OR, 3.86; 95% CI, 1.35-11.03; $P=.012$), intraoperative synthetic colloids (adjusted OR, 1.00; 95% CI, 1.00-1.01; $P=.038$), and lowest intraoperative systolic BP (adjusted OR, 0.97; 95% CI, 0.94-0.99; $P=.008$) were independent predictors of 1-year mortality after intertrochanteric femoral fracture surgery (Table 4). The receiver-operating characteristic curve had an area under the curve of 0.659 (95% CI, 0.598-0.716; $P<.001$) for 1-year mortality and lowest POD2_alb level, indicating that postoperative hypoalbuminemia is a good predictor for mortality after surgery for geriatric intertrochanteric femoral fracture (Fig. 2).

4. Discussion

To the best of our knowledge, this study is the first to investigate the association between postoperative hypoalbuminemia and mortality after surgery for geriatric intertrochanteric femoral fractures. Our study showed a 1-year mortality rate of 16.3% after intertrochanteric femoral fracture surgery. Multivariable logistic regression analysis demonstrated that a lowest POD2_alb level <3.0g/dL, preoperative beta-blocker use, low BMI,

intraoperative synthetic colloids use, and lowest intraoperative BP were significantly associated with 1-year mortality.

Hip fractures in geriatric patients are associated with increased morbidity and mortality.^[36,37] Bhattacharyya et al^[1] reported that the 5 critical risk factors for acute inpatient mortality were hip fracture, age >70 years, chronic renal failure, congestive heart failure, and chronic obstructive pulmonary disease in a prediction model after analysis of 43,215 inpatient orthopedic surgeries. After investigating 2448 consecutive elderly patients with hip fracture, Roche et al^[2] demonstrated that among patients with ≥ 3 comorbidities, the strongest preoperative risk factors and most common postoperative complications were heart failure and chest infection. One-year mortality rates after hip fracture surgery ranged from 19% to 33%.^[8,9] Our study demonstrated that mean age of the patients was >80 years, and that they had preoperative commodities, such as hypertension, DM, chronic kidney disease, ischemic heart disease, cerebrovascular accident, dementia, pulmonary disease, and various cancers.

Early postoperative hypoalbuminemia is an independent risk factor for AKI after hip fracture surgery.^[34,38] Wiedermann et al^[39] revealed that hypoalbuminemia is an independent predictor of AKI and consequent mortality after development of AKI in medical and surgical situations. AKI has been associated with increased risks of anemia, mechanical ventilation, coagulopathy, sepsis, worse outcomes, prolonged hospital stay, and increased mortality after orthopedic surgery.^[35,40] Albumin can protect renal function by maintaining colloidal osmotic pressure and increasing renal blood flow. Albumin can also interact with nitrogen oxides to form S-nitroso-albumin, and renal vasodilation occurs when albumin interacts with platelet-activating factors to improve kidney perfusion. Damaged endothelial glycocalyx layers can result from postoperative AKI along with postoperative hypoalbuminemia.^[41] Albumin exerts an organ-protective effect by scavenging free radicals, binding to endogenous and exogenous toxins, and preserving capillary membrane permeability.^[42] Postoperative hypoalbuminemia may be caused by several factors, such as preoperative hypoalbuminemia, surgical injury, perioperative bleeding, and hemodilution due to fluid therapy.^[22,23] Lee et al^[22] reported that immediate postoperative hypoalbuminemia is associated with renal failure, wound infection, reoperation for bleeding, postoperative respiratory failure, and the need for inotropes for ICU patients undergoing off-pump coronary artery bypass graft surgery. However, in our study, it was difficult to determine whether the cause of postoperative hypoalbuminemia was preoperative malnutrition or perioperative bleeding because the baseline preoperative albumin level was not investigated.

Albumin administration improves hypovolemia, reduces the inflammatory response in hemorrhagic shock, and decreases membrane permeability by free radical scavenging.^[42,43] Albumin showed an effect on volume expansion by preserving the plasma oncotic pressure.^[30] Therefore, albumin administration in patients with postoperative hypoalbuminemia can be considered a reasonable treatment strategy. However, the benefits of exogenous albumin on organ function and fluid balance remain controversial. Lee et al^[29] reported that administration of 20% exogenous albumin immediately before surgery showed benefits on renal function, and could decrease the incidence of AKI and mortality in patients who underwent cardiac surgery. Preoperative albumin administration may be beneficial because the surgery could increase capillary permeability and cause massive fluid shifts, altering serum albumin levels.^[19,29,44] Dubois et al^[31]

Table 4**Univariate and multivariable logistic regression analyses for 1-year mortality.**

Variables	OR	Univariate			Adjusted OR	Multivariable logistic regression		
		95% CI	CI	P value		95% CI	CI	P value
Demographic								
Age	1.05	1.00	1.10	.033	1.06	0.99	1.13	.099
Sex	0.58	0.29	1.15	.120	0.58	0.23	1.46	.245
BMI	0.83	0.74	0.92	.000	0.76	0.67	0.87	<.0001
Diabetes mellitus	1.45	0.74	2.83	.275				
Hypertension	2.35	0.99	5.55	.051	1.58	0.51	4.93	.431
Ischemic heart disease	1.58	0.75	3.31	.231				
CVA	1.02	0.46	2.27	.964				
Dementia	0.71	0.26	1.92	.497				
CKD	1.95	0.98	3.89	.059	1.31	0.35	4.97	.691
Cancer history	1.73	0.65	4.63	.273				
CCB	1.77	0.92	3.43	.088	2.44	0.97	6.15	.060
ACEi/ARB	1.13	0.58	2.18	.727				
Beta blocker	2.05	0.94	4.48	.071	3.86	1.35	11.03	.012
Intraoperative								
Anesthetic type	1.26	0.66	2.43	.488				
Crystalloid	1.00	0.99	1.00	.782				
Synthetic colloid	1.00	1.000	1.00	.042	1.00	1.00	1.01	.038
Urine output	1.00	0.99	1.00	.151				
Operation time	1.00	0.98	1.01	.304				
Intraoperative pRBC	0.69	0.22	2.16	.520				
Systolic BP	0.98	0.96	0.99	.034	0.97	0.94	0.99	.008
Postoperative Laboratory								
Hemoglobin	0.90	0.69	1.17	.424				
POD2_alb <3.0 g/dL	0.14	0.04	0.46	.001	8.03	1.37	47.09	.021
Potassium	0.83	0.44	1.56	.557				
C-reactive protein	1.00	0.99	1.01	.372				
Blood urea nitrogen	1.04	1.01	1.07	.018	1.03	0.99	1.08	.164

ACEi=angiotensin converting enzyme inhibitor, ARB=angiotensin II receptor blocker, BMI=body mass index, BP=blood pressure, CCB=calcium channel blocker, CI=confidence interval, CKD=chronic kidney disease, CVA=cerebrovascular accident, OR=odds ratio, pRBC=packed red blood cells.

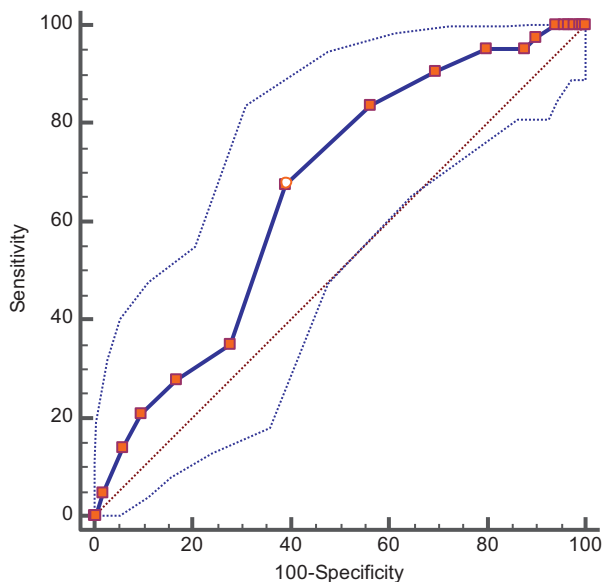


Figure 2. Receiver-operating characteristic (ROC) curve for 1-yr mortality and lowest POD2_alb level. The ROC curve revealed an AUC of 0.659 (95% CI 0.598-0.716 $P < .001$) and presented the significant predictability of lowest POD2_alb level for 1-yr mortality. AUC = area under the curve, Lowest POD2_alb level = lowest serum albumin level within 2 postoperative days.

reported that albumin administration improved organ function in critically ill patients with hypoalbuminemia as compared to crystalloid therapy. A meta-analysis by Haynes et al^[17] showed that albumin administration was related to higher colloid oncotic pressure, lower fluid requirements, lower pulmonary edema, and respiratory impairment, compared to crystalloid or hydroxyethyl starch therapy. However, other studies reported conflicting results, stating that albumin administration had no reducing effect on the incidence of postoperative complications in patients undergoing gastrointestinal and cardiac surgeries.^[32,45]

In the present study, patients with postoperative hypoalbuminemia showed significantly elevated preoperative PT/INR, and received significantly higher volumes of intraoperative crystalloid and RBC transfusion. Increased PT/INR and hypoalbuminemia generally indicate impaired liver function.^[46-48] However, in our study, the baseline demographic data for liver disease were not used because there were few patients with liver disease. Rather, it is suggested that trauma-induced coagulopathy (TIC) resulting from a hip fracture may have caused the elevated preoperative PT/INR. TIC refers to the overall failure of the coagulation system to maintain hemostasis after traumatic bleeding. It is caused by varying degrees of endothelial dysfunction, hyperfibrinolysis, hypofibrinogenemia, and platelet dysfunction, depending on the severity of the injury.^[49]

In the current study, the 1-year mortality rate after intertrochanteric femoral fracture surgery was 16.3%. The

non-survival group revealed increased incidence of postoperative hypoalbuminemia, increased preoperative PT/INR, lower intraoperative BPs, higher preoperative and postoperative SCr levels, higher volume of perioperative RBC transfusion, compared to the survival group. These findings suggested that deceased patients had more perioperative bleeding and received more crystalloid and packed RBCs intraoperatively. Those patients also had older age, lower BMI, and higher incidence of ICU admissions than the surviving patients. We found that a low POD 2_alb level, low BMI, preoperative beta-blocker use, intraoperative synthetic colloid administration, and lowest intraoperative systolic BP were independent risk factors for 1-year mortality after intertrochanteric femoral fracture surgery. Kim et al^[21] reported that the lowest POD2_alb level was related to postoperative AKI, and AKI was an independent risk factor for postoperative mortality. However, they found no relationship between postoperative hypoalbuminemia and mortality after total knee arthroplasty. A lower preoperative BMI predicted mortality after hip fracture surgery, and a lower intraoperative BP is strongly associated with mortality after noncardiac surgery.^[50,51] Venkatesan et al^[52] reported that preoperative chronic use of beta-blocker was associated with increased postoperative 30-day mortality. Synthetic colloid use is associated with platelet dysfunction, worsening hemostasis, and augmentation of perioperative bleeding, as well as increased morbidity and mortality.^[26–28] Therefore, perioperative albumin administration, instead of synthetic colloid solutions, could be considered to improve postoperative outcomes and reduce mortality in geriatric patients undergoing intertrochanteric femoral fracture surgery.

Our study had several limitations. First, this was a retrospective observational study; therefore, it was difficult to distinguish whether postoperative hypoalbuminemia was caused by preoperative hypoalbuminemia from malnutrition or perioperative bleeding. Further multicentric data analyses and meta-analyses will be needed to investigate the cause of postoperative hypoalbuminemia. Second, The total number of patients included in this study was small, although this single-center study yielded significant results. A previous study reported that postoperative hypoalbuminemia was associated with AKI after orthopedic surgery.^[34,38] However, our study did not demonstrate the association between postoperative hypoalbuminemia, AKI, and mortality, which can be identified in studies with large sample sizes increasing the power of the study in future.

In conclusion, this study demonstrated that the rate of 1-year mortality was 16.3% and postoperative hypoalbuminemia was a potent predictor of 1-year mortality after intertrochanteric femoral fracture surgery. Moreover, low BMI, preoperative beta blocker use, intraoperative synthetic colloid use, and intraoperative lowest systolic BP were also independent risk factors for 1-year mortality after femoral fracture surgery. Therefore, early detection of postoperative hypoalbuminemia and exogenous albumin administration can be considered to improve the postoperative outcomes and reduce the mortality after geriatric intertrochanteric femoral fracture surgery.

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