The Impact of Malnutrition on 30-Day Postoperative Complications following Surgical Fixation of Distal Radius Fractures

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Abstract

Introduction Distal radius fractures (DRFs) are increasingly managed surgically among fragility fractures due to prolonged life expectancy and surgical advancements. Yet, malnutrition can impact postoperative outcomes and complications. We sought to determine the impact of malnutrition on open reduction and internal fixation (ORIF) of DRFs during the perioperative and 30-day postoperative periods.

Materials and Methods Using the National Surgical Quality Improvement Program database, all patients who underwent ORIF of a DRF between January 1, 2008, and December 31, 2016, were identified and stratified by preoperative serum albumin levels: normal (≥3.5 g/dL; *n* = 2,546) or hypoalbuminemia (<3.5 g/dL; *n* = 439). Demographical and perioperative data were compared. Operative complications were stratified into major and minor complications, and data were analyzed using descriptive statistics and multivariate regression models.

Results Compared with patients with normal levels, a higher proportion of hypoalbuminemia patients had ASA scores > 3 (9.1 vs. 2%) and a longer mean length of stay (3.16 vs. 0.83 days). Hypoalbuminemia patients also had 625% greater odds for developing major complications during the 30-day postoperative period (odds ratio = 7.25; 95% confidence interval: 1.91–27.49).

Conclusion Malnutrition significantly affected outcomes and complications of distal radius ORIF. This study highlights the importance of prevention and treatment of malnutrition in the setting of fragility fractures.

Keywords
- distal radius fracture
- fragility
- hypoalbuminemia
- malnutrition
- open reduction internal fixation
- complications
- surgical fixation

Introduction

Distal radius fractures (DRFs) are among the most commonly treated fragility fractures, accounting for nearly 50% of all fractures encountered in the primary care setting.[1] The risk of sustaining a DRF increases with advancing age and female sex secondary to osteoporosis.[2] DRFs have a substantial socioeconomic impact, with more than 85,000 Medicare beneficiaries sustaining a DRF annually. These injuries can significantly increase patient morbidity and severely limit activities of daily living.[3] While DRFs have historically been treated nonoperatively in elderly patients, increased life expectancy and advancements in surgical techniques have made surgical fixation an increasingly used alternative in these patients.[4] This is especially true in the short-term postoperative period for patients with unstable fracture patterns, where open

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reduction internal fixation (ORIF) has been shown to achieve better radiographic outcomes and wrist range of motion than nonoperative treatment.[4,5]

Malnutrition has been implicated in multiple facets of orthopaedic care.[6-8] It is defined as serum total lymphocyte count < 1,500 cells/mm^3 and serum albumin concentration < 3.5 g/dL, as well as other biomarkers using standardized screening tools.[9] Albumin, the most abundant plasma protein, is commonly used as a marker for nutritional status due to its established inverse relationship in regard to albumin level and mortality, complications, and length of hospital stay.[10-14] The incidence of malnutrition in patients with hip fractures has been reported to be up to 88%.[15-18] Malnutrition is associated with a wide range of complications in surgical patients, such as increased length of stay (LOS), increased ventilator time, postoperative infections, and hospital readmissions.[8,19,20] Total hip arthroplasty patients with low serum albumin levels have an increased 1-year mortality,[15] whereas preoperative hypoalbuminemia (<3.5 g/dL) is an independent risk factor for an increased LOS and sustaining a postoperative 30-day complication following adult spinal deformity surgery[21] and posterior cervical spinal fusion.[7] Moreover, the frequency of fragility fractures of the distal radius in elderly patients with reduced bone mineral density (BMD) emphasizes the importance of this topic, as hypoalbuminemia and reduced BMD have been implicated in predisposing patients to fragility fractures such as DRFs, as well as potential adverse postoperative sequelae.[22]

The purpose of this study was to determine the effects of malnutrition on ORIF of DRFs during the perioperative and 30-day postoperative periods. The specific aims of the study were to evaluate (1) patient demographics, (2) perioperative factors, and (3) 30-day postoperative complications in the setting of hypoalbuminemia.

Materials and Methods

Database

The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database was queried to determine the effects of malnutrition on the outcomes of DRFs treated with an ORIF. The ACS NSQIP is a validated, prospectively collected database that consists of deidentified perioperative clinical data of surgical patients from more than 600 institutions in the United States.[23-27] At the participating hospitals, ACS-trained clinical reviewers collect and maintain data during the preoperative and perioperative periods using operative reports, medical charts, and patient interviews. The data include patient demographics, medical comorbidities, and laboratory and intraoperative data including the Current Procedural Terminology (CPT) codes for the surgical procedures and the International Classification of Disease, 9th and/or 10th Revision, diagnosis codes for the surgical diagnosis. It additionally includes data up to 30 days postoperatively, which consists of discharge dispositions, readmissions, reoperations, and mortality.[24,28] In this database, complications are classified as either major (death; intracranial, cardiac, pulmonary, or renal complication; symptomatic venous thromboembolism; any surgical site infection; sepsis; or reoperation) or minor (superficial surgical site infection, urinary tract infection, pneumonia, or others).[29] Due to the deidentified nature of the dataset, this study was exempted from review by our Institutional Review Board.

Patient Population

All patients who underwent an ORIF of a DRF between January 1, 2008, and December 31, 2016, in the NSQIP database were queried using CPT codes 25607, 25608, and 25609. Only patients who had preoperative serum albumin levels were included (n = 2,985). Patients were stratified into two groups for statistical analysis: (1) normal serum albumin level group (≥ 3.5 g/dL; n = 2,546) and (2) hypoalbuminemia group (< 3.5 g/dL; n = 439).

Demographics and Perioperative Data

The demographics analyzed included age, sex, body mass index (BMI), which was calculated from height and weight variables, and race (white versus nonwhite). A modified Charlson comorbidity index score,[30] which has demonstrated similar efficacy to the original score,[31,32] was calculated with comorbidities assigned the following points: chronic obstructive pulmonary disease (COPD) (1 point), congestive heart failure (CHF) (1 point), renal failure and/or end-stage renal disease (2 points), on a ventilator (2 points), ascites (3 points), and disseminated cancer (6 points). The modified Charlson comorbidity index scores were reported as 0, 1, or ≥2 points. The American Society of Anesthesiologists (ASA) scores were categorized as ≤3 or >3, and the type of anesthesia was reported as general or nongeneral. Wound classification indicating clean, clean/contaminated, contaminated, or dirty/infected wounds was collected. Additionally, data regarding the hospital LOS were collected.

Postoperative Complications

The postoperative complications were stratified into major and minor complications.[33,34] The major complications included stroke, pulmonary embolism, cardiac arrest, myocardial infarction, acute renal failure, unplanned reintubation, sepsis, and septic shock. The minor complications included superficial surgical site infection, deep surgical site infection, organ space infection, pneumonia, urinary tract infection, renal insufficiency, deep vein thrombosis, wound dehiscence, and need for blood transfusion.

Statistical Methods

The data analysis was performed using SPSS version 24.0 (IBM Corp., Armonk, New York, United States). Descriptive statistics were performed for the study variables, chi-square or Fisher's exact test were used for categorical variables, and Student's t-tests were used for continuous variables. Multivariate logistic regression models were developed to control for variables with $p < 0.05$ in the univariate testing phase to evaluate the effect of individual risk factors including hypoalbuminemia on the incidence of 30-day major and minor postoperative complications.

Results

Demographics and Preoperative Comorbidities

Patients in the hypoalbuminemia group were older (67 vs. 62 years; $p < 0.001$) and of the female sex (83.8 vs. 77.6%; $p = 0.004$). There were no significant differences in terms of BMI, race, or modified Charlson scores between study groups. Patients in the hypoalbuminemia group were significantly more likely to have diabetes mellitus, COPD, hypertension, ventilator dependence, dialysis, preoperative steroid use, bleeding disorders, preoperative blood transfusion requirement, smoking, dyspnea, ascites, and CHF (►**Table 1**).

Perioperative Factors

The hypoalbuminemia group had more patients with ASA scores > 3 (9.1 vs. 2%; $p < 0.001$) and a longer mean LOS (3.16 vs. 0.83 days; $p = 0.007$) (►**Table 2**). There were no significant differences between the two groups in terms of anesthesia type or wound class.

Postoperative Complications

Regression analysis revealed that patients with hypoalbuminemia had a 625% greater odds for developing a major complication (odds ratio [OR] = 7.25; 95% confidence interval [CI]: 1.91–27.49; $p = 0.004$) during the 30-day postoperative period. The odds of developing a minor complication was higher in the hypoalbuminemia group compared with the normal albumin group, but this was not statistically significant (OR = 1.73; 95% CI: 0.89–3.33; $p = 0.105$).

Discussion

DRFs are among the most commonly treated fragility fractures in orthopaedics. Studies have shown that 40 to 55% of hospitalized patients are malnourished or at risk of malnutrition.[35] Malnutrition has been associated with poor outcomes in surgical patients, as seen in Radman et al's study[36] and other studies in the orthopaedic literature.[37-39] This study aimed to analyze the effects of malnutrition on postoperative

Table 1 Comparison of demographic parameters and baseline comorbidities between patients undergoing ORIF for distal radius fracture with normal albumin or hypoalbuminemia

Parameter	Normal albumin	Hypoalbuminemia	*p*-Value
Age (years)	62	67	**<0.001**
Sex			
Female	77.6%	83.8%	**0.004**
Male	22.9%	16.7%	
Body mass index (kg/m^2)	28.67	28.92	0.496
Race			
White	91.5%	92.9%	0.373
Nonwhite	8.5%	7.1%	
Charlson score			
≤3	99.4%	98.6%	0.122
>3	0.6%	1.4%	
Comorbidities			
Chronic obstructive pulmonary disorder	5.1%	16.9%	**<0.001**
Ascites	0%	0.7%	**0.003**
Congestive heart failure	0.4%	1.6%	**0.007**
Renal failure	0%	0.2%	0.273
Disseminated cancer	0.6%	0.9%	0.522
Ventilator	0%	0.5%	**0.022**
Hypertension	47.7%	63.3%	**<0.001**
Dialysis	0.4%	1.6%	**0.005**
Steroid use	3.3%	7.3%	**<0.001**
Weight loss	0.3%	0.9%	0.087
Bleeding disorder	4.1%	9.1%	**<0.001**
Preoperative transfusion	0.1%	1.1%	**0.003**
Sepsis	1.7%	1.8%	0.892
Smoker	19.1%	24.8%	**0.006**
Dyspnea	4.8%	9.8%	**<0.001**
Diabetes	13.7%	20.0%	**0.001**

Abbreviation: ORIF, open reduction internal fixation.

outcomes in patients who underwent an ORIF of a DRF. Patients with hypoalbuminemia are more likely to be older and females when compared with patients with normal serum albumin levels. Our results partially corroborate findings of a previous study, which, despite identifying comparable serum albumin levels between males and females on peritoneal dialysis, showed a significantly higher impact of hypoalbuminemia in the latter group.[40] This condition was associated with a longer LOS and increased postoperative complication rates.

There are several limitations of this study worth acknowledging. First, the study used a large national database, which is subject to potential data collection and entry errors. However, the quality of the data has been previously assessed and found to have low interrater disagreement.[41] Second, serum albumin was the parameter used to define malnutrition. Other studies have used other biomarkers such as total lymphocyte count and transferrin levels to define malnutrition. Another limitation was related to the patient population. Because our inclusion criteria for this study encompasses patients who underwent ORIF after sustaining a DRF in our study period, this patient population may not necessarily be limited to only a DRF injury alone. Polytrauma patients were not specifically excluded, which could potentially impact their LOS as well as their preoperative nutritional status. In addition, the follow-up was limited to 30 days postoperatively, which is inherent by using this database.

Although there is a lack of studies assessing malnutrition in DRF patients (►**Table 3**), malnutrition has been implicated similarly in hip fracture and total hip arthroplasty patients. O'Daly et al[15] found that total hip arthroplasty patients with low albumin tended to be older than patients with normal albumin. Similar to the findings of this study, Lee et al[42] found that patients with a hip fracture/dislocation and concomitant malnutrition were more than twice as likely to develop a complication such as venous thromboembolism or infection and be readmitted as patients with normal nutritional status. Basic science studies have demonstrated that protein malnutrition can have detrimental effects on bone healing.[43] Preoperative correction of nutritional status may help lead to less complications and better fracture healing.

Table 2 Comparison of perioperative parameters between patients undergoing ORIF for distal radius fracture with normal albumin or hypoalbuminemia

Parameter	Normal albumin	Hypoalbuminemia	*p*-Value
ASA score			
≤3	98.0%	90.9%	**<0.001**
>3	2.0%	9.1%	
Anesthesia			
General	83.1%	80.9%	0.260
Nongeneral	16.9%		
Wound class			
Clean	95.4%	96.1%	0.724
Clean/contaminated	2.1%	2.3%	
Contaminated	1.8%	1.1%	
Dirty/infected	0.7%	0.5%	
Length of stay (days)	0.75	3.2	**0.006**

Abbreviations: ASA, American Society of Anesthesiologists; ORIF, open reduction internal fixation.

Table 3 List of published articles reporting the impact of hypoalbuminemia on hand-related postsurgical outcomes

Study	Journal	Year	Condition/procedure	Albumin cutoff	Outcome
Wilson et al[51]	Journal of Hand Surgery	2019	ORIF of DRF	3.5 g/dL	Hypoalbuminemia positively correlated with postsurgical complications, length of stay, readmission, and mortality
Luchetti et al[52]	Hand	2019	Hand surgery	3.5 g/dL	Hypoalbuminemia positively correlated with postoperative morbidity and mortality
Our study			ORIF of DRF	3.5 g/dL	Patients with hypoalbuminemia had higher ASA scores, longer mean length of stay, and greater odds for developing major complications during the 30-day postoperative period

Abbreviations: ASA, American Society of Anesthesiologists; DRF, distal radius fracture; ORIF, open reduction internal fixation.
Note: PubMed was queried using the search syntax "malnutrition" *and* "hypoalbuminemia" *and* "Hand."

Despite the current evidence suggesting that low serum albumin is associated with poorer outcomes,[44-46] it may not be the most reliable predictor of malnutrition. For instance, Nakano et al[47] point out that serum albumin levels may vary depending on the assay used to measure them, with the BCG (bromocresol green) assay possibly overestimating serum albumin levels. In a randomized control trial, Myint et al[48] could not demonstrate rehabilitation benefits of oral nutritional supplementation for elderly hip fracture patients. Furthermore, they did not observe a rate of change in the serum albumin level between the supplementation and control groups. However, the authors found clinical and nutritional benefits in the supplementation group, highlighting a possible benefit to testing for and correcting malnutrition in fracture patients.

Perhaps, the most effective method of treating fragility fractures such as DRFs is prevention. Targeting modifiable risk factors for preventing or delaying reduction in bone quality is a useful approach. Calcium and vitamin D are the first-line supplementation for at-risk individuals as well as individuals with dietary deficiencies. Protein consumption has also been evaluated in increasing bone strength; Langsetmo et al[49] showed a positive association between dairy protein intake and skeletal health. Regular exercise involving resistance training and high-impact exercises employed early and often can contribute to elevated peak bone mass throughout life.[50]

DRFs are a common injury pattern in the elderly with increasing annual incidence. Malnutrition, defined in this study as hypoalbuminemia, is frequently observed in elderly patients who sustained a DRF. In patients who undergo ORIF of their DRF, malnutrition can be associated with increased complications postoperatively and a longer LOS in the 30-day postoperative period when compared with patients with normal albumin levels. This study highlights the importance of prevention and treatment of malnutrition in the setting of fragility fractures. The effect of malnutrition should be considered during the decision and counseling of patients for the surgical management of DRFs.

Conflict of Interest

S.M.K. is a committee member of the American Society for Surgery of the Hand. M.C. reports stock ownership with Johnson & Johnson, Roche, Sanofi-Aventis, and Shire, outside the submitted work. All the other authors report no conflict of interest.

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