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# Malnutrition and Total Joint Arthroplasty

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## Abstract

Malnutrition is prevalent in patients undergoing elective total joint arthroplasty (TJA). Malnutrition has been shown to be an independent risk factor for multiple postsurgical complications following TJA in addition to increasing postoperative mortality. In the current healthcare environment, it is important to recognize and correct modifiable risk factors preoperatively to minimize perioperative complications and improve patient outcomes. Recently, multiple studies have been published focusing on the association between malnutrition and perioperative complications following TJA. The findings of these studies are summarized in this review. Further research is required to determine if optimization of nutritional status preoperatively influence surgical outcomes in the elective TJA patient.

## Introduction

Total hip and knee arthroplasties are highly successful procedures that improve the quality of life of hundreds of thousands of people each year.[,] These surgeries also comprise a large portion of healthcare spending in America, with joint arthroplasty accounting for 4.6% of all Medicare hospital payments in 2008. As the population ages, technology improves, and indications for surgery grow, these procedures will become even more prevalent. Concurrently, value-based alternative payment models, including bundled payment systems, are becoming more popular. New payment models hold providers and hospitals accountable for patient complications following surgery. Therefore, the ability to recognize and preoperatively correct any modifiable risk factors to minimize patient complications proves increasingly important.

One such modifiable risk factor for perioperative surgical complications is malnutrition. Malnutrition has been shown to increase the risk of surgical site infection (SSI) in total joint arthroplasty (TJA), with further study needed regarding other major post-operative complications.[,] The mechanism by which malnutrition increases the risk for surgical site infection is not entirely clear. However, malnutrition is thought to impair wound healing and prolong inflammation by reducing collagen synthesis and fibroblast proliferation.

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**Conflict of Interests**

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Additionally, malnutrition may impair the immune system's Ability to fight infection through lymphocytopenia.

Multiple surrogates for malnutrition exist, including serum markers, anthropometric measurements, and standardized scoring tools. Serum markers, such as albumin, total lymphocyte count, and transferrin, have been used as indicators of malnutrition. Most papers consider an albumin <3.5 g/dL, a total lymphocyte count <1,500 cells/$mm^3$, and/or a transferrin level <200 mg/dL as serum markers of malnutrition. Other less commonly used methods to measure nutritional status are anthropometric measurements, such as calf and arm muscle circumference or the triceps skinfold. These methods are less sensitive for marginal or acute nutritional deficiency, as it takes time for these anthropometric measurements to change appreciably in an individual with malnutrition. There are also standardized scoring tools such as the Rainey-MacDonald nutritional index, the Mini Nutritional Assessment, and the Schwarzkopf nutritional index.[9] However, serum markers, and albumin in particular, remain the most widely recognized and commonly used surrogates of malnutrition.

## Background

As mentioned previously, nutritional deficiency has been correlated with increased risk for SSIs in patients following total joint arthroplasty.[9] In 1991, Greene et al. found that patients with a total lymphocyte count <1,500 cells/$mm^3$ had a five-times greater risk for developing a major wound complication after either a total knee arthroplasty (TKA) or total hip arthroplasty (THA), and patients with an albumin <3.5 g/dL had a seven-times greater risk of major wound complication. Major wound complication was defined as superficial infection, deep infection, or wound dehiscence. This study also found that subclinical nutritional deficiency is not uncommon in patients undergoing TJA (27% in series), and many other studies have since have confirmed this finding, with a reported range of 8.5%–50% of patients undergoing primary or revision TJA with laboratory markers suggestive of malnutrition.

A study by Del Savio et al. found that the serum albumin level is inversely correlated with length of stay after THA. This study is in agreement with a study done by Nicholson et al. which found that malnourishment, as defined by an albumin <3.5 g/dL or a total lymphocyte count <1.50 cells/mm, is associated with a longer length of stay following THA or hemiarthroplasty.

More recently, several studies have been published examining the relationship between malnutrition and TJA complications. Huang et al. found a higher rate of complications in malnourished patients, defined as low albumin (<3.5 g/dL) or low transferrin (<200 mg/dL), following TJA (12% vs. 2.9%). They found malnutrition to be an independent predictor of neurovascular complications, renal complications, postoperative hematoma and seroma formation, and overall complication rate. Paradoxically, this study also found that 42% of malnourished patients were obese (BMI >30 kg/$m^2$). Yi et al. also found that malnutrition was prevalent in obese patients (32%) prior to revision TKA or THA.

In the same study, Yi et al. examined whether malnutrition is associated with periprosthetic joint infection (PJI) following TJA, in addition to whether malnourished patients are more likely to develop PJI following revision TJA for a non-infectious etiology. Patients were defined as malnourished if they had an albumin <3.5 g/dL, total lymphocyte count <1,500 cells/$mm^3$, or a transferrin <200 mg/dL. The study concluded that malnutrition is independently associated with both chronic septic failure requiring revision of a TJA and acute postoperative infection complicating a revision for non-infectious reasons. Bohl et al. came to similar conclusions using data from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) using albumin <3.5 g/dL as a marker of malnutrition.

Another study by Bohl et al. used data from the ACS-NSQIP to examine the relationship between hypoalbuminemia (albumin <3.5 g/dL) and complications following primary TKA or THA in a large number of patients (n=49,603). The study concluded that patients with hypoalbuminemia are at increased risk for SSI, pneumonia, extended length of stay, and readmission.

Studies performed at our institution have also examined the relationship between hypoalbuminemia and complications after TJA. Kamath et al. found that a preoperative albumin level <3.5 g/dL was associated with higher rates of unplanned ICU admission following TJA during the same hospitalization. A study by Walls et al. examined the association between hypoalbuminemia (albumin <3.5 g/dL) and complications following THA using ACS-NSQIP data from 2006–2013. Additionally, the study analyzed the association between obesity and complications following THA. The study demonstrated that both morbid obesity (BMI ≥40) and hypoalbuminemia are independently associated with higher incidences of 30-day postoperative complications. However, morbid obesity was only associated with a significantly increased risk of superficial SSI, whereas hypoalbuminemia was associated with a significantly increased risk of several complications, including superficial SSI, deep SSI, pneumonia, urinary tract infection, bleeding transfusion, longer length of stay, and overall mortality. Impressively, patients with hypoalbuminemia were at a 5.94-fold increased risk of mortality compared to patients with normal albumin levels following THA.

Nelson et al. published a parallel study to that of Walls et al. using ACS-NSQIP data from 2006–2013 to examine the effect of hypoalbuminemia and obesity on complications following elective primary TKA. This study found a higher rate of superficial SSI, progressive renal insufficiency, and sepsis in morbidly obese patients compared to non-obese patients after a TKA. In addition to superficial SSI and progressive renal insufficiency, hypoalbuminemic patients had a higher rate of deep SSI, organ space SSI, pneumonia, acute renal failure, cardiac arrest requiring cardiopulmonary resuscitation, septic shock, unplanned intubation, and were more likely to require a transfusion and remain on a ventilator more than 48 hours than patients without hypoalbuminemia. Additionally, as in the Walls et al. study, patients with hypoalbuminemia had a 3.19-fold increased risk of mortality in comparison to patients with normal albumin following TKA.

## Discussion

As multiple studies have demonstrated, preoperative serum albumin levels <3.5 g/dL, as a surrogate for malnutrition, increases the risk of postoperative complications following TJA. However, a causal relationship between preoperative hypoalbuminemia and patient complications cannot be deduced from these studies. Rather, general nutritional deficiency is likely the cause of both increased risk for postoperative complications and hypoalbuminemia. As hypoalbuminemia is a surrogate for general malnutrition, repleting albumin without addressing general nutritional deficiencies and concurrent co-morbid conditions is unlikely to be effective in improving patient outcomes postoperatively.

Although albumin is a reliable serum marker of nutritional status, it is not specific, in that inflammation or stress may also cause hypoalbuminemia without associated malnutrition. Therefore, controversy exists regarding the clinical significance of hypoalbuminemia. Despite this, hypoalbuminemia remains the most widely used marker of malnutrition.

The studies discussed above demonstrate that malnutrition is strongly prevalent in patients undergoing elective TJA. This is important, as malnutrition is clearly an independent risk factor for multiple postoperative complications beyond SSI, including increasing length of stay and mortality associated with TJA. In the setting of healthcare reform and value-based payment systems, addressing and eliminating modifiable risk factors preoperatively is imperative in order to decrease postoperative complications. Thus, the knowledge that many patients presenting for elective TJA are malnourished should prompt the development of standardized preoperative laboratory and nutritional protocols in high-volume TJA centers.

Paradoxically, malnutrition is not uncommon in obese individuals. This is thought to result from the consumption of food with high caloric content but low nutritional value. While malnutrition and obesity are both generally considered modifiable risk factors for patients undergoing TJA, obesity may be more difficult for patients to modify, especially in the setting of degenerative joint disease limiting exercise capability. Malnutrition may represent a risk factor more amenable to modification, and, according to the studies discussed above, may have a larger impact than weight loss in preventing the development of postsurgical complications. Thus, evaluating for malnutrition should not be overlooked in obese patients.

Given the results of prior studies, it is logical to assume that preoperative correction of malnutrition may decrease postsurgical complications in patients undergoing TJA. Although a well-controlled study has not been done addressing this specifically in TJA, similar studies have been performed in the general surgery literature. One study demonstrated a decreased rate of postsurgical complications in patients who received preoperative nutritional supplementation prior to abdominal surgery. A decrease in the postoperative complication rate with nutritional supplementation has also been demonstrated in geriatric hip fracture patients.[9] However, as mentioned above, a study assessing the effect of preoperative nutritional supplementation on complications following elective TJA has not been performed. Additionally, the optimal approach to nutritionally replete a patient prior to elective surgery is currently unknown and warrants further study in elective TJA.

In the current healthcare environment, it is important to identify high risk patients and to correct modifiable risk factors prior to surgery. It is currently unknown whether correcting nutritional deficiencies prior to surgery lowers complication rates and improves patient outcomes following TJA. Therefore, a controlled, prospective study with large patient numbers is needed to determine the effect of standardized methods of preoperative nutritional repletion in malnourished patients prior to TJA.

## Conclusion

Hypoalbuminemia (albumin <3.5 g/dL) is a commonly used surrogate for malnutrition. Preoperative hypoalbuminemia is prevalent in patients undergoing elective TJA, including in obese patients. Malnutrition has been shown to be an independent risk factor for multiple postsurgical complications in addition to increasing postoperative mortality. It is important for patients and surgeons to recognize the increased risk associated with undergoing elective TJA in a malnourished state. Further research is required to determine if optimization of nutritional status and/or correction of hypoalbuminemia preoperatively influence surgical outcomes in the elective TJA patient.

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