



Preoperative Optimization in Total Joint Arthroplasty

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23.1 Introduction

23.1.1 Scope of the Problem— Periprosthetic Joint Infections

Total joint arthroplasties represent some of the most commonly performed surgeries in the United States. However, periprosthetic joint infection (PJI) is a significant problem associated with increased morbidity and healthcare costs. The incidence of PJI after primary total hip and knee replacements has been reported in the literature to range from 0.5% to up to 2% (Bozic and Ries 2005; Sculco 1993).

PJI has a significant impact on the patient, the surgeon, and the healthcare system (Bozic and Ries 2005).

- ▶ The economic burden of PJI is expected to be in excess of 1.62 billion \$ by the year 2020 (Kurtz et al. 2012).

This is crucial to address as current estimates project large increases in demand for total hip (growth of 174% by 2030) and knee arthroplasties (growth of 673% by 2030) (Kurtz et al. 2007). Similar trends are also anticipated with revision arthroplasty surgery.

23.1.2 Modifiable Versus Non-modifiable Risk Factors

It is imperative to appropriately recognize risk factor variables as modifiable versus non-modifiable. While the scope of this chapter is limited to identifying and acting on modifiable risk factors to improve rates of PJI, non-modifiable risk factors have also been recognized to affect rates of PJI. Specifically, revision surgery and non-same day surgery, i.e., surgery performed >24 h after admission, have been identified as negatively affecting rates of PJI by Maoz et al. (2015). While it is important to recognize, these risk factors are unfortunately beyond the control of the surgeon and their patients.

23.1.3 Currently Available Guidelines on Surgical Site Infections

The Centers for Disease Control and Prevention (CDC) provided new guidelines that have important updates and recommendations for the prevention of surgical site infections (SSI). These include guidelines from the use of antiseptic soap the night before surgery to maintaining appropriate oxygenation and glycemic control in the perioperative period (Berrios-Torres et al. 2017).

However, as noted by Parvizi et al., the lack of evidence in many of the areas prevents it from being a comprehensive guide (Parvizi et al. 2017).

Thus, it is essential that we attempt to further understand and minimize the risk factors that can affect rates of PJI. In this review, the effects of both patient as well as perioperative modifiable risk factors that can affect PJI are analyzed.

23.2 Patient-Modifiable Risk Factors and Current Evidence

23.2.1 Diabetes

Diabetes and poor glycemic control have not only been associated with increased risk of surgical site infection in a variety of procedures but are also negatively implicated in PJI in multiple studies. Analysis of these studies has shown diabetes to increase the odds ratio by 2.28 times in one of the largest series (Marchant Jr. et al. 2009).

Hemoglobin A1c (Hgb A1c) has been regularly used as a prognostic indicator of long-term glycemic control in patients and may take 3 months to reflect significant changes. Patients with good glycemic control should ideally have Hgb A1C levels <7.0. Hgb A1c, a simple test, has frequently been used as a routine screening test which allows the provider to gain insight into the patient's glycemic control over the past 3 months (Stryker et al. 2013).

- ▶ However, perioperative glucose levels may serve as a better adjunct in predicting PJI as opposed to Hgb A1c alone (Iorio et al. 2012). Additionally, other markers such as serum fructosamine have also been proposed to serve as an adjunct to measuring glycemic control (Shohat et al. 2017).

The stress due to surgery results in an increased production of hormones antagonizing insulin and predisposes patients to hyperglycemia. Thus, it is important that perioperative glycemic control be strictly enforced. Surgical stress-related postoperative hyperglycemia, even in patients without a diagnosis of diabetes, can increase the risk of developing surgical site infection in a dose-related manner.

- ▶ Thus, the authors recommend that blood glucose levels be maintained between 110 and 180 mg/dL (optimal cutoff of around 137 mg/dL) (Kheir et al. 2018) in the perioperative period through frequent blood sugar checks and initiation of diabetic management protocols postoperatively (Gallagher et al. 2017).

23.2.2 Obesity

Obesity has been correlated with higher rates of osteoarthritis and eventual increased use of arthroplasty (Workgroup of the American Association of Hip and Knee Surgeons Evidence Based C 2013). Studies have shown that patient satisfaction and functional improvement in the obese patient population is similar to the nonobese group; however, obese patients are at higher risk of postoperative complications, specifically PJI (Mason et al. 2014).

Obesity predisposes patients to increased surgical dissections needed for exposure which results in higher surgical times. The poor vascularity of adipose tissue further compounds this problem. The consensus opinion from the workgroup of the American Association of Hip and Knee Surgeons (AAHKS) evidence-based committee emphasized delaying total joint arthroplasty in a patient with a BMI >40, especially when associated with other comorbid conditions such as poorly controlled diabetes or malnutrition (Workgroup of the American Association of Hip and Knee Surgeons Evidence Based C 2013).

Furthermore, a small minority of obese patients may develop metabolic syndrome. This is composed of a cluster of conditions arising from insulin resistance that impairs normal leukocyte function. It is defined as having a BMI >30 kg/m² with central obesity, as well as two of the following conditions: hyperlipidemia, hyperglycemia, hypertension, or diabetes (Gage et al. 2014). Zmistowski et al. have shown an increased risk of PJI (14.3% vs. 0.8%) in patients with uncontrolled metabolic syndrome compared to patients with controlled disease/the healthy cohort (Zmistowski et al. 2013).

- Patients with obesity should be screened for other characteristics that may define metabolic syndrome.

23.2.3 Malnutrition

A frequently unrecognized aspect of obesity involves malnutrition and is associated with high caloric but nutritionally poor diets.

- Malnutrition was found to be present in 42.9% of obese patients in a prospective study evaluating the role of malnutrition in total joint arthroplasty patients (Huang et al. 2013).

Laboratory tests are easily available and can help to identify patients at risk for malnutrition.

- These include a total lymphocyte count of <1500 cells/mm³, a serum albumin of <3.5 g/dL, or a trans-

ferrin level of <200 mg/dL. Of these, preoperative albumin has been found to be highly specific with a high positive predictive value for PJI (Blevins et al. 2018).

Patients with preoperative malnutrition should be encouraged to work with a dietician to help improve their nutritional intake and help prepare them for the catabolic demands required in the postsurgical period.

23.2.4 Smoking

Smoking, and its principal ingredient, nicotine, has been associated with decreased oxygen delivery to tissues secondary to microvascular constriction. Duchman et al. reported an increased risk of wound complications with both current and former smokers in a large national database study. Specifically, they found current smokers to have higher rates of wound complications than former smokers as it pertains to PJI (Duchman et al. 2015). The deleterious effects, in particular PJI, seen with smoking have also been confirmed by multiple other studies (Teng et al. 2015).

- Studies have shown that smoking cessation programs may help decrease complications associated with the use of nicotine, even if introduced as late as just 4 weeks before surgery (Lindstrom et al. 2008).

Thus, the authors recommend that patients undergoing total joint arthroplasty have a minimum period of 4 weeks of smoking cessation prior to their surgery. Smoking cessation can be confirmed via easily available laboratory tests such as the serum cotinine assay (normal value of ≤10 µg/L).

23.2.5 Vitamin D

Vitamin D has long been identified as playing a crucial role in bone health. Vitamin D deficiency, as defined by a serum 25-hydroxyvitamin D concentration ≤ 20 ng/mL, is unfortunately prevalent in the population of the United States with an overall reported rate of 41.6% (Forrest and Stuhldreher 2011). Studies have shown patients with PJI to have low levels of Vitamin D. Animal models have also demonstrated that reversal of Vitamin D deficiency can help improve rates of PJI (Hegde et al. 2017).

- Thus, the authors recommend that Vitamin D levels be obtained preoperatively and if deficient, i.e., < 20 ng/mL, supplementation be instituted.

23.2.6 *Staphylococcus Aureus* Screening

Nasal swab rapid polymerase chain reaction has allowed physicians to identify patients who are colonized with methicillin-resistant *Staphylococcus aureus* (MRSA). This helps eliminate the bacteria from the patient's nasal flora prior to surgery. Implementation of an institution-wide prescreening program allows for the identification of the carrier status of *S. aureus* among patients; this can then lead to a significant reduction in postoperative rates of surgical site infections (Kim et al. 2010).

It is the authors' recommendation that patients undergoing elective total joint arthroplasty undergo screening for *S. aureus* through nasal swabs.

- ▶ The authors recommend that patients undergo application of mupirocin nasal ointment twice daily to both nares and a daily bath with chlorhexidine for 5 days immediately prior to the scheduled surgery if the nasal swab testing is positive.
- ▶ Additionally, patients screened positive for MRSA should also receive a single dose of vancomycin along with standard perioperative antibiotics during their surgery.

23.2.7 Inflammatory Arthropathies

Patients afflicted with inflammatory arthropathies such as rheumatoid arthritis and lupus are at increased risk of postoperative infection. Multiple systematic reviews have validated the correlation between inflammatory arthropathies and periprosthetic infection. Pooled studies such as that by Kong et al. have shown that rheumatoid arthritis can increase the odds of PJI by 1.57 (Kong et al. 2017).

Many of these patients are on multiple-drug regimens that may include immunomodulators. These medications often have significant effects on wound healing and infections. For example, tumor necrosis factor alpha (TNF α) inhibitors are frequently used as a powerful agent in the management of these diseases. However, by modulating the immune system, they place patients at significant risk for developing infections. Momohara et al. reported that patients on TNF α inhibitors were found to be at higher risk for surgical site infections (Momohara et al. 2011).

Guidelines jointly published by the American College of Rheumatology (ACR) and the American Association of Hip and Knee Surgeons (AAHKS) used available evidence to make recommendations on which medications should be continued and which medications should be stopped in elective total joint arthroplasty (Goodman et al. 2017). In general, traditional

disease-modifying antirheumatic medications (DMARDs) do not need to be withheld prior to surgery.

- ▶ However, immunomodulating agents such as TNF α inhibitors place patients at an increased risk for the development of PJI and should be withheld one dosing cycle prior to surgery.

23.2.8 Urinary Tract Infections

A common type of nosocomial infection, urinary tract infections (UTI), creates a reservoir of pathogens and potentially increases patient morbidity during surgical intervention. The role of UTI in the development of PJI, however, remains controversial. Some authors have noted the development of PJI in patients with UTI (David and Vrahas 2000) while others have shown no association between UTI and PJI (Koulouvaris et al. 2009).

- ▶ It is the authors' recommendation that if the patient has symptoms of UTI such as dysuria, urgency, and frequency and has $>1 \times 10^5$ colony forming units (CFU)/mL of urine, surgery should be postponed.
- ▶ However, if the patient is asymptomatic but has 1×10^5 or more CFU/mL of urine, the authors recommend not withholding surgery and treating his UTI with a routine course of postoperative oral antibiotics.

23.2.9 Poor Oral Health

Total joint replacement patients tend to have good dental hygiene in general (Wood et al. 2016). However, there is not a lot of literature on the role of preoperative screening as well as the association between poor dental hygiene and PJI. Recent studies have questioned the need to obtain routine preoperative dental screening for hip and knee arthroplasty patients (Lampley et al. 2014).

- ▶ In general, the authors recommend a common-sense approach—patients should have a dental exam and clearance if they have evidence of decayed teeth, abscess, gingivitis, or periodontitis and should have routine cleanings done prior to surgical intervention.

23.2.10 Antibiotic Prophylaxis

Preoperative antibiotic prophylaxis is effective in reducing rates of surgical site infections and has been incor-

porated in many surgical checklists (Fernandez et al. 2001). Routine prophylactic antibiotics should be dosed in accordance with the patient's weight and should include a first-generation cephalosporin such as cefazolin. Patients allergic to β -lactam antibiotics should receive vancomycin or clindamycin in a timely fashion. Prophylactic antibiotics should ideally be administered as close to the time of the incision as possible.

- First-generation cephalosporin and clindamycin should be administered within 1 h and vancomycin within 2 h of incision.
- The authors recommend that a single dose of vancomycin be considered in addition to standard preoperative antibiotics for those who have been shown to be colonized with MRSA or those who had a prior infection with MRSA.

23.3 Conclusion

The well-known saying, a stitch in time saves nine, is certainly applicable to PJI. Targeting modifiable risk factors in the preoperative setting can help alter the risk profile for PJI postoperatively. While enacting on these variables may not completely eliminate the risk of PJI, it can certainly help improve the odds.

Take-Home Messages

- Periprosthetic joint infections pose high morbidity; however, modifiable risk factors can be optimized preoperatively to decrease risks.
- Diabetic patients should have their glycemic control optimized preoperatively, and frequent blood sugar checks and diabetic management protocols should be implemented postoperatively.
- Consideration should be given to delaying total joint arthroplasty in patients with a BMI >40, especially when associated with other comorbid conditions such as poorly controlled diabetes or malnutrition.
- Patients undergoing total joint arthroplasty should have a minimum period of 4 weeks of smoking cessation prior to their surgery.
- Strict antibiotic prophylaxis should be adhered to including the use of first-generation cephalosporins such as cefazolin. Patients with true allergies to cefazolin should receive vancomycin or clindamycin in a timely fashion.

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