Risk Mitigation for Unicompartmental Knee Arthroplasty

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Case

A 62-year-old female presented with a 4-year history of right knee pain that had failed conservative management (Fig. 4.1a–c). She had a medical history notable for colitis, diabetes (diet-controlled), hypertension, iron deficiency, scleroderma, and lupus. On examination, she was 5′5″ and 225 pounds, for a BMI of 37.4 kg/m^2. She had tenderness to palpation at the medial but not lateral joint line, and she had a negative patellar grind test. Range of motion was 0–100, and she was ligamentously stable and neurovascularly intact. She was indicated for medial unicompartmental knee arthroplasty (UKA) and sent for preoperative laboratories.

Preoperative laboratories were normal with the exception of a HbA1C of 11.0. This was a surprise to the patient, but she admitted that she was not following the diet that had been recommended to her as the best means through which to control her diabetes. Surgery was delayed. With the help of an endocrinologist and her primary care provider, she started metformin and glimepiride (two oral hypoglycemics). Within 4 months, her HbA1c had fallen to 7.1. She was reindicated for medial UKA, and the procedure and postoperative recovery were without incident. One year postoperatively, she has an excellent result (Fig. 4.1d–f).

Introduction

The vast majority of literature regarding medical and surgical complications of knee arthroplasty has been written about patients undergoing total knee arthroplasty (TKA) rather than medial, lateral, or patellofemoral UKA. This is largely because TKA is much more common than UKA, and the research is therefore more easily powered and potentially more relevant analyzing TKA[1]. A secondary explanation is that due to the more invasive nature of TKA compared to UKA, TKA is thought to have overall higher rates of postsurgical complications [2].

Nevertheless, due to the similar nature of UKA to TKA, much of the TKA research likely applies to UKA. Each section of this chapter will first cover key takeaways from the TKA literature, with respect to optimization of the knee arthroplasty host, and will then highlight literature specific to UKA and compare and contrast it with the literature published for TKA. We will conclude with our own recommendations as derived from the literature.

With respect to optimization, this chapter breaks down potential areas of optimization

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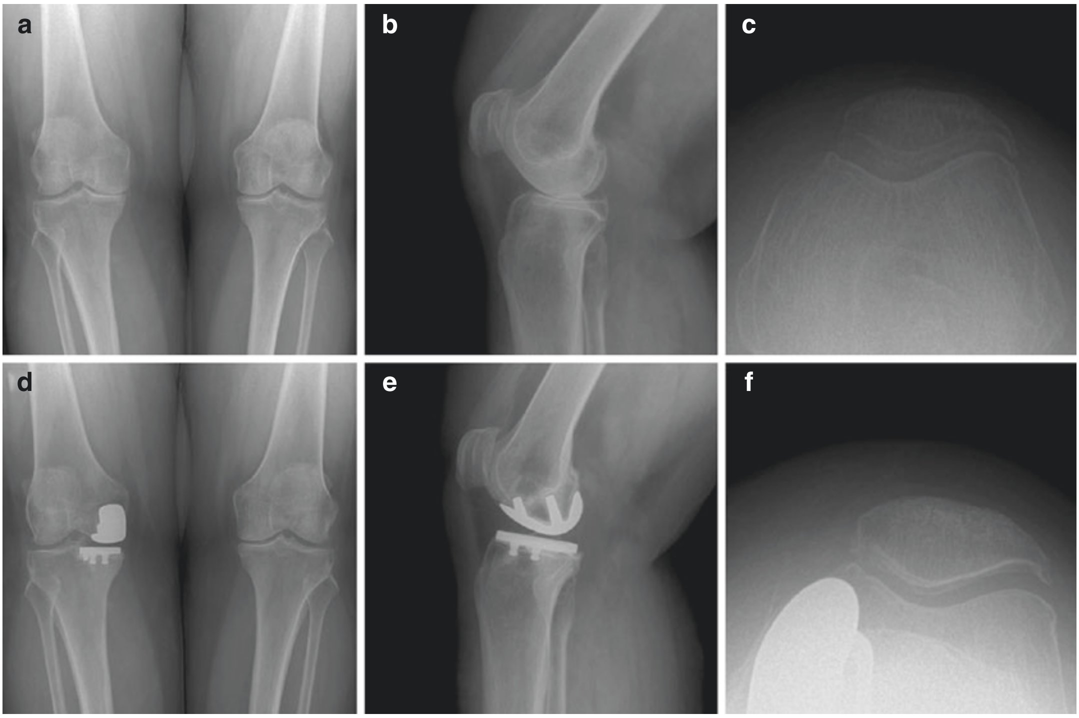

Fig. 4.1 (**a**–**c**) Anterior-posterior, lateral, and sunrise views of a right knee showing medial compartment osteoarthritis with well-preserved lateral and patellofemoral facets. (**d**–**f**) Same views one year s/p medial compartment unicompartmental knee arthroplasty

into the following *modifiable* patient factors that are predisposing of early postoperative adverse events:

- Obesity
- Diabetes
- Malnutrition
- Atherosclerosis
- Tobacco use
- Intra-articular injections
- Hypercoagulability

Obesity

Defining the Epidemic

Body mass index (BMI) is an imperfect, but easy-to obtain, measure of the extent to which a patient's weight correlates with his or her overall size. It is calculated by dividing the patient's weight by the patient's height (by convention reported in kg/m^2). The World Health Organization classifies BMI as follows: <30 kg/m^2 normal; 30–35 kg/m^2 overweight; 35–40 kg/m^2 obese; 40–50 kg/m^2 morbidly obese; and ≥ 50 kg/m^2 super obese.

The obesity epidemic has rapidly spread throughout the world, and in particular the United States, with more than 1 in 3 adult Americans now classified as obese [3]. More to the point, among a population of patients undergoing UKA captured in the American College of Surgeons National Surgical Quality Improvement Program (NSQIP), more than 1 in 4 patients qualified as obese at a minimum [4].

Impact of Obesity on Short-Term Outcomes

Obesity complicates arthroplasty in terms of anesthetic options, positioning, exposure, and closure. There is overwhelming evidence of its association with complications following TKA: Obesity has been shown to increase operative time [5], overall complications [5], renal complications [6], wound-healing complications [6–8], deep infection [6, 7], urinary tract infection [9, 10], cardiac arrest [11], reintubation [11], reoperation [11], superficial infection [11], death [11], readmission [12], length of stay [12], venous thromboembolism (VTE) [13], and blood loss [14]. On the whole, these associations appear to present themselves most strongly with BMI rising above 40 kg/m^2, and strengthen somewhat linearly beyond that point. For example, while patients who qualify as morbidly obese (BMI ≥ 40 kg/m^2) have about 1.5 times the odds of a postoperative complication [15], superobese patients (BMI ≥ 50 kg/m^2) have 3.1 times the odds of complication [16].

Less work has examined the impact of obesity specifically with respect to UKA; however, the work that has been conducted suggests that the above-noted associations similarly apply. For example, in a large study of the NSQIP, greater BMI was independently predictive of overall complications and prolonged length of hospitalization [2]. Similar findings were confirmed using Medicare and private payer databases [17].

Impact of Obesity on Long-Term Outcomes

A second concern is that rates of failure for UKA may be higher in patients with greater BMI. The theory is that the increased load on the knee may contribute to increased prosthetic wear, progression of arthritis in the un-resurfaced compartments, subsidence, fracture, and loosening. This concern is supported by a study of 40 UKAs with BMI ≥ 35 kg/m^2 versus 33 UKAs with BMI < 35 kg/m^2 that demonstrated 5 revisions to TKA among the high BMI group, but none among the low BMI group [18]. However, several larger studies have contradicted these results, finding no difference between obese and normal-weight patients in terms of mid-term and long-term results [19–21].

Does Lowering BMI Prior to Surgery Decrease the Risk of Early Complications?

It seems logical that by putting an obese patient on a weight-loss regimen and offering surgery only once that patient's BMI has reached a certain level, a surgeon could lower the risk of postoperative complications. Unfortunately, we are aware of no level-1 study that has attempted to evaluate whether weight loss through nutritional or surgical intervention decreases the rate of postoperative complications following any type of knee arthroplasty procedure. A number of retrospective studies have found that bariatric surgery prior to TKA can improve outcomes following TKA [22–26]; however, these studies are limited by lack of appropriate control, retrospective designs, and small sample sizes. Fortunately, a randomized controlled trial specifically attempting to answer the question of whether bariatric surgery prior to TKA reduces complications and improves function after TKA is currently underway [27]. We will tentatively apply findings of this study to UKA, as we are aware of no such study planned specifically for UKA at this time.

Our Recommendation

In our practice, we initially recommend against UKA for most patients with BMI greater than 40 kg/m^2 (obese category) due to the increased risk of potentially devastating postoperative complications. Such patients are provided with nutritional information from our office and also referred to a nutritionist. Such patients are also offered the opportunity to meet with a bariatric surgeon to consider surgical options prior to UKA. Patients who are able to decrease their BMI below 40 kg/m^2 are offered surgery. Patients who present with BMIs well above 40 kg/m^2 may also be offered surgery if they can demonstrate a meaningful reduction in their BMI, even if not achieving 40 kg/m^2.

Diabetes

The Epidemic

Possibly in conjunction with the increasing prevalence of obesity, the spread of diabetes mellitus has come at a shocking rate, with approximately 1 in 10 Americans affected [28]. Interestingly, about a quarter of those affected are undiagnosed. As such, the arthroplasty consult may represent an important point of diabetic diagnosis and general health intervention for patients with this commonly comorbid disease. Among an NSQIP population, diabetes was present in 1 of 7 patients undergoing UKA [29].

Hyperglycemia Increases the Risk of Surgical Site Infection

Overwhelming evidence exists to suggest that diabetes and perioperative hyperglycemia increase the risk of surgical site infection following TKA [30–32]. Interestingly, however, these same studies tended not to find any specific association between HbA1c values and surgical site infection. HbA1c is a proxy for blood glucose levels, so this finding is somewhat surprising. Nevertheless, it is clear that hyperglycemia near the time of surgery inhibits the immune response and/or wound-healing potential, increasing the propensity for bacteria to colonize and persist in the joint.

To our knowledge, similar associations for UKA have not been demonstrated. Likely this is due to lower overall infection rates and a lower sample size in parallel studies. Despite the lack of research specifically supporting the association, we operate under the assumption that diabetes does increase the risk for surgical site infection in UKA, albeit perhaps not as powerfully.

We are aware of no level-1 study that has demonstrated that control of diabetes decreases the risk of surgical site infection in any form of knee arthroplasty. Indeed, the ethics of such a study may be questioned in the presence of such convincing evidence that perioperative hyperglycemia contributes to infection risk.

Our Recommendation

We obtain a HbA1c in every patient considering UKA. For most patients with HbA1c > 8.0, surgery is delayed and patients are referred to their primary care provider, a nutritionist, and/or an endocrinologist. In most cases, medical therapy is initiated, and we have seen remarkable responses in HbA1C in several patients (see case at beginning of chapter). Surgery is offered once HbA1c is below 8.0. For patients with HbA1c well above 8.0 on presentation, surgery may be offered if a meaningful reduction in HbA1c can be demonstrated, even if the threshold of 8.0 is not quite reached.

Nutritional Status and Albumin

Markers of Nutritional Status

Recent literature has emphasized the fact that "malnutrition" is a multifaceted concept that is in no way limited to low calorie intake [33]. Rather, even obese patients (with excessive calorie intake) may be protein- or micronutrient-malnourished. The best laboratory measure of these forms malnutrition has been debated, but authors have emphasized the use of serum albumin using 3.5 g/dL as a reasonable cutoff for protein malnutrition [33–35]. Other serum markers used in orthopedics include total lymphocyte count, vitamin D, and transferrin [33]. The prevalence of malnutrition, defined using the albumin cutoff of 3.5 g/dL, in the total joint arthroplasty (TJA) population is about 1 in 6 [35]; we have not seen this number documented in the literature for the population undergoing UKA.

Nutritional Status Impacts Short-Term Outcomes

A flurry of recent literature has suggested that serum nutritional markers impact the short-term outcome of arthroplasty procedures [34–37]. For example, Bohl et al. demonstrated that hypoalbuminemia independently predicts pneumonia, readmission, length of stay, and surgical site infection for TJA (both hips and knees) [35]. Across the literature, the most significant impact appears to be on the risk for surgical site infection.

Of course, less work has been focused specifically on UKA. An association between serum albumin, or the other nutritional markers, and postoperative complications has not been specifically demonstrated. Nevertheless, we operate under the assumption that the same biologic principles apply, and that malnourished patients undergoing UKA are likely at increased risk.

Nutritional Intervention

Nutritional interventions have yet to show improved outcomes following elective arthroplasty procedures (although they have for hip fracture surgery [38–40]). However, to conduct such a study would require a very large and possibly unobtainable sample size, given the low complication rate and overall study complexity and involvedness of the intervention. Despite the lack of evidence of efficacy, nutritional intervention prior to arthroplasty is widely employed in those thought to be malnourished.

Our Recommendation

We obtain serum albumin levels in all patients prior to UKA. For patients with serum albumin <3.5 g/dL, we recommend that surgery be delayed during an attempt to optimize nutritional status. Patients are referred to a nutritionist and we attempt to improve nutritional status over the course of at least 3 months. Albumin does not always respond, but diet and overall nutrition status may nevertheless improve. While we do not use 3.5 g/dL as a hard cutoff, we do use this as an opportunity to intervene prior to UKA to hopefully enhance the result.

Atherosclerosis

Scope of the Problem

Cardiovascular disease is a common contributor to perioperative complications among patients undergoing noncardiovascular procedures. Knee arthroplasty has historically been designated as intermediate-risk noncardiac surgery; however, cardiovascular events do occur at a meaningful rate [41]. Of patients undergoing UKA, 0.3% report preoperative angina, 5.6% report a history of angioplasty, and 4.0% report a history of myocardial infarction.

Diagnosis

Current clinical practice guidelines demand evaluation of all patients for cardiovascular disease prior to arthroplasty procedures [42]. This is typically performed by the primary care physician, and/or cardiologist, providing medical and cardiac clearance. The Revised Cardiac Risk Index (RCRI) is perhaps the most commonly used tool to estimate risk [42, 43]. Patients with functional limitations or potential cardiac symptoms should undergo noninvasive risk stratification evaluating for myocardial ischemia [42]. Myocardial perfusion imaging and stress echocardiography are both validated predictors of cardiovascular events postoperatively [42].

Medical Management

Four primary classes of medication are used to manage perioperative cardiac risk for patients undergoing UKA. First, aspirin has been shown to decrease platelet aggregation and, in doing so, reduce thrombotic risk. While aspirin is routinely used as a preventative measure for cardiovascular events among the high-risk general population, the extent to which arthroplasty patients benefit from a cardiovascular perspective is uncertain [44, 45]. It should be noted that aspirin does confer increased risk of intraoperative and postoperative bleeding, and the AAOS currently recommends discontinuation of aspirin prior to UKA [46]. For patients on daily aspirin for cardioprotective effect, aspirin can be resumed the evening of surgery. The second class of medications are statins and other lipid-lowering medications. In one analysis of over 200,000 patients undergoing noncardiac procedures, those taking lipid-lowering medications during the postoperative period had lower in-hospital mortality [47]. While such an impact has never been specifically demonstrated for arthroplasty procedures, the available evidence certainly suggests that it is safe to continue a statin during the perioperative period and that those with indications for statin use may be safely started on a statin prior to surgery. Third, beta-blockers decrease cardiac myocardial wall stress, contractility and inotropy, and increase cardiac perfusion as well as the length of diastole. These effects may help to mitigate forces predisposing to perioperative myocardial infarction. Trials of routine beta-blocker use in all patients undergoing noncardiac procedures have yielded mixed and controversial results [47–49]; hence, recommendations for routine use for all patients in the perioperative setting have diminished. However, patients who normally take a beta-blocker should receive that beta-blocker throughout the perioperative period. Other patients with cardiac ischemia or elevated RCRI may receive a recommendation for initiation of a beta-blocker prior to UKA. It is recommended that the beta-blocker be initiated well in advance of UKA, rather than on the day of surgery[42]. Finally, angiotensin-converting enzyme (ACE) inhibitors are another class of medication used to manage cardiac disease that may be initiated prior to surgery in patients at risk. Data to support their use in the arthroplasty setting is quite limited. The current recommendation is to continue ACE inhibitors during the perioperative period for patients already taking them [42].

Angiographic Management

A proportion of patients with positive noninvasive testing will benefit from angiographic intervention prior to their elective orthopedic procedures [42]. This underscores the importance of a systematic cardiac evaluation well in advance of the scheduled arthroplasty.

Our Recommendation

We require all our UKA patients to obtain preoperative clearance from a primary care physician or internist, and cardiology clearance is requested if a relationship with a cardiologist already exists or if the need is determined by the primary care physician or internist. This may result in the initiation of medical therapy or further noninvasive or invasive cardiac testing prior to UKA. We prefer and encourage patients to use the internists in the preoperative clinic at our institution for their clearance. We find that this standardizes recommendations. Moreover, all patients spending at least one night in the hospital are comanaged by an internist while an inpatient. These internists are from the same team as those clearing patients in the preoperative clinic, which we find further streamlines care. We believe strongly in this uniform clearance and comanagement system and have received few objections from patients.

Smoking

Epidemiology

Smoking is the leading cause of preventable death in the United States and results in disability and disease in nearly every organ of the body [50]. Currently, about 1 in 6 adults in the United States smoke. Among patients undergoing UKA, current smokers constitute about 1 in 10 patients [4]. Smoking is more common among men, middle-aged adults, and lower socioeconomic groups [50].

Smoking Increases Risk for Surgical Site Infection and Other Postoperative Events

Clear evidence exists that smoking increases the risk for developing a surgical site infection following an arthroplasty procedure. The risk increase has been documented as approximately 1.5-fold [51, 52]. Moreover, current smoker status appears to be more important than former smoker status: The rates of wound complication in one study were 1.8% for current smokers, 1.3% for former smokers, and 1.1% for nonsmokers, with no statistical difference between former smokers and nonsmokers [52]. Correspondingly, it has also been shown that smoking is associated with earlier time to revision of TKA [53]. But the effects do not appear to be limited to wound infection: Rates of both mortality and total complications are greater for current smokers than for nonsmokers [52]. As with the other areas, our knowledge draws primarily on the TJA literature, as few studies have specifically examined smoking and UKA.

Smoking Cessation

The good news is that smoking is one of the most modifiable risk factors for elective surgical interventions. Cessation of smoking 4 weeks or more prior to elective surgical procedures decreases total and wound-related complications [54–57]. In particular, two randomized studies have drawn this conclusion [55, 56]. Although this effect has never been demonstrated specifically for arthroplasty, wound complications are so devastating for arthroplasty patients that this evidence seems particularly important to heed in the setting of arthroplasty, including UKA.

Our Recommendation

A detailed smoking history is taken for all patients considering UKA in our clinic. For patients who endorse current smoking, extensive counseling is performed with respect to the increased risk smoking poses. Most are agreeable to attempting to cease smoking at least 4 weeks prior to surgical intervention. A large proportion are successful, although some are not. We do perform arthroplasty on current smokers who lack other risk factors, but we make every attempt at cessation before we proceed.

Intra-articular Injections

The Evidence

Intra-articular injections of steroid, hyaluronic acid, and platelet-rich plasma have increasingly been performed among patients attempting to avoid or delay knee arthroplasty. Although the evidence is conflicting [58], several studies have raised the possibility that preoperative injection of these substances may increase the risk of periprosthetic joint infection [59, 60]. Specifically, using a national database, one group of authors found an increase in the rate of periprosthetic infection when the ipsilateral knee was injected within the 3 months prior to surgery (but not within 6 months or 1 year) [59]. This study carries with it all the caveats of a large database study, including the potential for confounding by an array of factors unmeasurable with this study design.

Our Recommendation

Although we remain not entirely convinced by the conflicting reports with respect to the risk-increase associated with intra-articular injection, we believe there is enough evidence to support delaying UKA until 3 months after such an injection. Hence, before potential UKA candidates are injected in our clinic, they are warned that this will delay any subsequent UKA by 3 months.

Hypercoagulability

Etiology

Intravasation of marrow fat during cement pressurization is thought to be the major impetus for the systemic hypercoagulable state that may follow UKA. Stasis and intimal injury (from venous kinking) likely play additional incremental roles in local thrombogenesis, completing Virchow's triad. As a result, patients are predisposed to the development of venous thrombosis. The incidence of symptomatic VTE has been documented at 0.5–1.2% after UKA [4, 61].

Prophylaxis

A discussion of the merits of specific chemoprophylactic agents is well beyond the scope of this chapter. We would also refer the reader to the AAOS guidelines for prevention of VTE for specific recommendations rather than reiterating them here [46]. It should be noted, however, that there has been a general shift in the field of arthroplasty from more to less potent chemoprophylactic agents (e.g., from warfarin to aspirin). This shift has been supported by a body of literature suggesting that these less potent agents are as effective at preventing VTE but carry lower risk of bleeding, and consequently of wound healing and infectious complications [62–65]. This research has been conducted primarily in the setting of TJA. However, given the lower risk for VTE in UKA than TKA [61], the shift toward less potent agents likely makes particular sense in the case of UKA.

Risk Stratification

Although good data is sparse regarding some of the most powerful risk factors, most surgeons consider familial thrombophilia, active metastatic cancer, use of estrogen replacement therapy, smoking, or a history of VTE to be particularly worrisome. Many surgeons who routinely use less potent chemoprophylaxis will consider increasing their chemoprophylaxis above the normal regimen among patients with any of these factors.

For patients without these risk factors, several studies from the TJA literature have provided useful risk stratification systems to help surgeons understand how various other comorbid factors increase risk [66, 67]. In one validated system, patients are assigned specific point values based on the presence of age ≥ 70 years, female gender, BMI, and anemia [66]. Based on each patient's total score, the risk of pulmonary embolism can be determined. In order to find the ideal balance between VTE and bleeding risk, surgeons might consider selecting the potency of chemoprophylaxis required based on the degree of risk using systems such as this. Similar studies have not been conducted for UKA, but the studies from the TKA literature likely apply.

Our Recommendation

We recommend use of SCDs on the contralateral lower extremity on all patients undergoing UKA during the procedure and while in house for cases of inpatient UKA. We routinely initiate Aspirin 81 mg twice daily for 30 days starting the evening of surgery. We have found Aspirin 81 mg to provide an acceptable balance between bleeding risk/wound healing and the development of VTE following UKA. For particularly high-risk patients (i.e., patients with familial thrombophilia, active metastatic cancer, use of estrogen replacement therapy, smoking, or a history of VTE), we turn to our medical colleagues to help select the optimal agent. Finally, we routinely encourage early mobilization in the form of early physical therapy and ambulation.

Conclusion

With the marked strides made in the functional outcome of UKA over the last decade, an increased emphasis has been placed on mitigating the risk for early complications following UKA. Perhaps the most powerful means of doing so is through optimization of the UKA host. Obesity, diabetes, malnutrition, atherosclerosis, tobacco use, exposure to intra-articular injections, and hypercoagulability are all host factors with the potential for modification to diminish the risk for an early adverse outcome. This chapter reviews the current arthroplasty literature regarding weight loss, diabetes control, improved nutrition, atherosclerosis detection and management, smoking cessation, delay of surgery following intra-articular injection, and VTE prophylaxis. Consideration of this literature, as well as the guidelines provided by the AAOS and associated medical societies, should help the orthopedic surgeon provide a well-functioning UKA at the lowest risk.

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