



White Paper

Operative Techniques to Reduce Hip and Knee Arthroplasty Complications in Morbidly Obese Patients

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ABSTRACT

Obesity, defined as a body mass index (BMI) >30, is associated with an increased likelihood of osteoarthritis and need for total joint arthroplasty (TJA). Unfortunately, the morbidly obese population has a higher risk of postoperative complications. For some surgeons, patient selection criteria for TJA includes BMI <40. The associated risks are recognized by The American Association of Hip And Knee Surgeons, and many surgeons follow these guidelines. Importantly, as obese patients have been demonstrated to have equal or greater gains in functional outcomes and quality of life metrics, it is important for obese patients to have access to TJA. Through a comprehensive literature review and structured interviews with leading surgeons in the field, we provide guidance for orthopedic surgeons treating patients with BMI >40 to minimize risks, including tailored preoperative, intraoperative, and postoperative considerations.

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Introduction

Obesity, defined as body mass index (BMI) > 30, is a global challenge. Prevalence is high and continues to increase, especially in high-income countries like the United States [1]. As of 2013, 2.1 billion individuals were overweight or obese, and the United States made up 13% of the world's obese population [2]. More than one-third of the US population currently meets the standards for obesity [1]. Obesity is associated with comorbidities such as chronic kidney disease [3,4], type 2 diabetes mellitus [5], depression [6], stroke [7], coronary artery disease [8] and osteoarthritis [2,9]. Rates of obesity are not distributed equitably in the American population: Rates are higher in Hispanics, Blacks, and women [10–12].

Additionally, in part due to the increased load on joints, obesity is associated with lower extremity osteoarthritis [13] and a greater likelihood of arthroplasty [14–16]. This relationship between obesity and osteoarthritis is bidirectional: Obesity is associated with osteoarthritis, and osteoarthritis is associated with weight gain [13,14]. This vicious cycle is extremely challenging to break without a multipronged intervention. Osteoarthritis is a leading

cause of disability in the US population and is expected to continue to rise as the population ages [13].

Total joint arthroplasty (TJA) is a life-changing surgery. Total knee (TKA) and total hip arthroplasty reduce pain and improve mobility and function [17,18]. TJA represents a potential treatment for obese patients to manage their osteoarthritis, but current exclusion criteria recommendations (BMI <40) have created barriers that limit surgery for patients most in need of these procedures. Morbidly obese patients have lower baseline function and mobility, but after TJA, they have been found to have equal or greater changes in validated outcome scores [19–21], function [22], and satisfaction [23] than patients with BMIs <40.

Preoperative exclusion criteria draw on both a consensus document from a group of leading experts at The American Association of Hip And Knee Surgeons [24] and a body of research demonstrating that obesity presents an independent risk for complications following TJA [25–27]. These include wound complications, infection, deep vein thrombosis (DVT), airway accessibility difficulties, and revision surgery [28]. Additionally, the aforementioned comorbidities that accompany obesity are independently associated with increased postoperative complications [29–32]. Therefore, obesity presents a complex perioperative risk profile across a significant portion of the patient population. Collectively, the increased risk of poor outcomes and

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cost associated with undertaking TJA in obese patients [33] has led to the development, for many surgeons and insurance carriers, of a hard stop guideline to TJA for patients with a BMI >40.

Unfortunately, the current payment model for TJA, especially with bundled payments, has shifted selection of patients to those who benefit the health system's bottom line. Cost-savings have focused on decreasing postdischarge spending, particularly utilization of post-acute rehabilitation facilities or skilled nursing facilities [34–36]. This leads to “cherry picking” patients who are healthier and “lemon dropping” patients who are at high risk of incurring costly postdischarge plans [37].

Here we present recommendations to the preoperative, intraoperative, and postoperative care for obese patients that are currently being conducted by experts in the field of arthroplasty who specialize in treating morbidly obese patients. We present this list of possible considerations as an argument that BMI >40 should not serve as a strict cutoff to this life-changing surgery and that, with the right optimization resources, the surgery can be conducted safely.

Problem statement

Currently, those with elevated BMI are predominantly being excluded from life-altering TJAs despite their drastic need and the surgery's proven benefit, due to their risk profile.

Methods

Research collaboration

A cohort of health-care professionals with expertise in the field of obesity in arthroplasty came together with the aim to reduce disparities in TJA, specifically tailored to provide equitable care to those with elevated BMI. We sought to form a collaboration to combine institutional optimization paradigms, surgical and research experience, and ideal paths for the future. See below for the institutions included.

Literature review

Relevant background material was assessed and synthesized for each section. This represented a collaborative effort of working with our university medical librarian and knowledge leaders. Our PubMed search algorithm included the terms “obese”, “overweight”, “high BMI”, “THA”, “TKA”, “TJA”, “surgical bioethics”, “healthcare disparity”, “TJA risk factors”, “TJA complications”. We selected only articles which were directly relevant to the review. Literature was used to supplement surgeon interviews. The literature review was not meant to be exhaustive but to reflect the most appropriate literature for obese patients with BMI >40.

Interviews

In total, 7 qualitative interviews were conducted with members of the orthopedic surgical care team across 5 institutions: Hospital for Special Surgery, Yale New Haven Health, New York University Langone, Hospital of the University of Pennsylvania, and a private practice in Miami, Florida. These institutions and individuals were chosen because of their national reputations and peer-reviewed publications focused on improving access to surgery for patients who are obese and their willingness to operate on such patients with profiles that other institutions would have likely denied surgery. These experts provided both evidenced-based and individualized modifications and considerations to existing surgical protocols.

The consensus statements included here were derived by the authors by conducting standardized interviews, summarizing the results, and reviewing these viewpoints to find commonalities. Proposed solutions were shared among surgeons, and through discussion, the surgeons found common ground. All surgeons confirmed the recommendations included in this manuscript.

Considerations: the ethics of surgical decision-making

The ethical drivers of everyday medical decisions are autonomy, beneficence, nonmaleficence, and justice. Surgeons pledge an oath to adhere to these principles when they become physicians. Of paramount importance to this article is justice; the notion that all (benefits, risks, costs, resources) should be distributed equitably. This governing principle drives the primary rationale for operating on obese patients: Each person deserves to receive the care they need.

The principle of justice is also important as it pertains to resources. Apart from increased risk of poor surgical outcomes, arguments against operating on obese patients include the increased cost associated with its undertaking [38] and the increased resource utilization. Obese patients take more time, incur more costs, utilize more resources, and present a greater risk of poor outcomes. However, the notion of justice precludes us from not treating these patients; instead, it directs that despite this increased utilization of resources, we must equitably treat them like all other patients [39]. Beneficence dictates that we must act in the best interest of our patients. Here we will craft an argument that this surgery does present the greatest benefit to the patient, when making certain explicit modifications and optimizations to control for risk.

Another ethical argument is that of risk: “It is simply too risky” [39]. However, ethical tenets of autonomy state that the patient is bearing the brunt of that increased risk. The principle of autonomy dictates that if patients are able to give informed consent, we must respect their decision-making capacity. Their decision to choose a surgery that may be associated with risks cannot be exempt from our respect of autonomy (Table 1).

While maintaining these ethical tenets, it is important to weigh these ideals with the reality of the landscape. Complications that these patients may face, such as revision surgery and, at worst, amputation or death, are life-altering events. Therefore, surgeons must be judicious about their assessment of risk, as well as their experience and personal surgical ability, hospital and surgical team's capability, and their institution's advanced care services (cardiology, intensive care unit, bariatrics, general surgery, plastic surgery, medicine, etc.). One final ethical consideration is that of patient “cherry picking”—prioritizing for patients who will do better and cost less: those who will have better outcomes, decreased complications, and utilize less resources. This may be due to the influence of hospital rankings, based in part on the public reporting of patient outcomes without significant context or regard for surgical complexity [40].

Table 1
Ethical considerations when contemplating operating on patients with BMI >40.

Ethical considerations	
Autonomy	Patient bears brunt of associated risk
Beneficence	Arthroplasty provides a proven benefit to patients so it should be accessible to all patients
Nonmaleficence	Lack of intervention will lead to inexorable burden accumulation
Justice	Despite the utilization of increased resources, obese patients should not be denied surgery

Proposed solutions and recommendations

Preoperative considerations for obese patients

Body habitus

A preoperative assessment of body habitus is an essential starting point for surgical consideration. Distribution of fat has direct impact on surgical outcomes. If adiposity is predominantly central, there is a lower likelihood of postoperative complications following TJA than if fat distribution is concentrated over the incision site. The use of anthropomorphic metrics of obesity, such as knee and ankle circumferences and incisional depth, should be factored, in addition to BMI [41].

Comorbidity burden

As previously mentioned, obesity is highly associated with comorbidities that independently increase the likelihood of surgical complications. This constellation of comorbidities may present as metabolic syndrome. Therefore, a comprehensive assessment of glucose/HbA1c, lipid and cholesterol levels, and blood pressure needs to be conducted. Existence of comorbidities should be factored into consideration to operate on patients with BMI >40 and should be a focus of preoperative optimization.

Malnutrition

Preoperative assessment of patient nutrition status should include a review of the patient's albumin, vitamin D, and iron. A large percentage of individuals who are obese are malnourished [42]. Specifically, patients who are obese have been found to be at a 4-fold increased likelihood of having hypoalbuminemia [43]. It has been demonstrated that low serum albumin (<3 g/dL) is a predictor of poor surgical outcomes [44].

Weight loss as a percent of BMI

Current guidelines from leading experts position surgeons to require a BMI <40 to proceed with TJA [24]. However, this BMI cutoff should not act as a sole barrier for several reasons. First, some investigators have found no increased risk of complications [41], even when controlling for nutrition status [43]. In addition, for some super obese patients, the degree of weight loss required to reach the BMI <40 cutoff is challenging to achieve and maintain over time [45]. Instead, weight loss as a percent of body mass is an evidence-based option to consider: Weight loss of as little as 5% can lead to clinically meaningful improvements in the patient's metabolic profile (eg, glucose and lipid levels) [46,47] and has been found to reduce surgical complications [43,45,47–49]. Therefore, we propose to focus on a percentage change in weight loss personalized to each patient. This balances the patient's ability and the benefits of a decreased risk profile.

Optimization

Care coordinators should work with patients with BMIs >40 in the preoperative period to attempt to either bring patients to BMI <40 or work toward weight loss of 5%–10% of body mass. Vital factors to take into account include favorable factors such as central obesity, good nutritional status, low comorbidity burden and/or well-controlled comorbidities, and other factors demonstrating reasonable health status, which collectively favor pursuit of surgery in those with BMIs significantly greater than 40. Previous weight loss should also be factored in. There are many strategies that can be deployed to support patients in their weight loss goals, but the overall emphasis should be on shared decision-making, as studies show that patients are more successful at losing weight when their opinions are considered [50]. Optimization paradigms should also consider monitored monthly or bimonthly weigh-ins, with

continued support and check-ins. Additionally, optimization should be initiated early to prevent patients from being in a catabolic state at the time of surgery, as this is associated with poor wound-healing and infection [51].

What's new with nutrition, social media and phone applications, endocrine/medical weight loss, and bariatrics

Many optimization paradigms exist. These include referrals to nutritionists and weight loss programs to help patients develop a plan to reduce their weight through diet and exercise. This can be accompanied by behavioral counseling [52], which makes use of principles from smoking-cessation programs' 5 A's (assess, advise, agree, assist, and arrange) [53]. In the modern era, especially during times of isolation during the COVID-19 pandemic, diet maintenance apps, online platforms, support network chats, free workout YouTube channels, and more are successful options for those with access to the technology.

Pharmacotherapy is another option. Many institutions support metabolic weight loss clinics which utilize medications. Five medications (eg, orlistat) are currently available and have shown weight loss of 5%–15% of body mass [54]. Recently, a sixth medication (semaglutide) was approved by the Food and Drug Administration for use in weight loss. Pharmacotherapy represents an option for those with severely decreased mobility due to osteoarthritis.

Finally, bariatric surgery is a highly effective option for weight loss and reduction in comorbidity burden [55]. Importantly, bariatric surgery should be conducted in advance of surgery as patients may stay in a catabolic state for up to 2 years following bariatric surgery [56] (Table 2).

Weight loss, however, must be measured against progressive bony deformity that can negatively impact the outcome of arthroplasty surgery. Regular monitoring with serial x-rays is important to help assess the balance between continued medical optimization and bony erosion that can lead to increased surgical complexity and decreased outcomes and implant longevity.

Patient communication

A vital aspect of preoperative assessment, optimization, and the decision to pursue surgery is the process of informed consent with the patient. These conversations can be difficult, especially in particular situations where there are significant risks and benefits to weigh and widely used practices that do not necessarily reflect the best route forward. It is important that the practicing surgeon, in coordination with appropriate members of the care team, pursues these conversations early, frankly, and respectfully. Surgeons need to concisely articulate each individualized patient's path forward. This may include whether the patient is currently an appropriate candidate for surgery, explaining why or why not; what the risks and benefits of surgery are; what the patient's next steps are to lower their risks; what the patient's responsibility is; and how the care team will help them achieve these goals. This is an iterative process that engages the patient over the course of several conversations to ensure their understanding and buy-in.

Intraoperative techniques to reduce risk

General modifications

DVT prophylaxis used most commonly today are direct oral anticoagulants or aspirin for the majority of standard-risk TJA patients. However, obesity is associated with increased risk of venous thromboembolism [57,58]. Taking a conservative approach and using more potent agents may decrease the likelihood of venous thromboembolism but should be balanced with the increased risk of wound hematoma and infection. This is especially relevant given

Table 2
Preoperative optimization strategies for patients with BMI >40.

Optimization team
• Varies widely across institution from surgeon-only to a large integrated team with nurse navigators
• Key players:
○ Nurse navigators
○ Physician associates
○ State-wide case managers
○ Social workers
○ Orthopedic surgeon
Screening
• Body habitus
○ Distribution of adiposity
○ Use of metrics, such as ankle and knee circumference
• Comorbidity metabolic syndrome burden
○ Glucose/HbA1c level
○ Lipid and cholesterol levels
○ Blood pressure
• Malnutrition
○ Nutrition status (albumin [<3.5 g/dL], vitamin D [<30 ng/dL], transferrin [<200 mg/dL], TLC [$<1,500$ cells/mm ³])
Optimization strategies
• Individualized weight loss plan:
○ Weight loss as percent of BMI (5%–10%) or BMI <40
• Monthly or bimonthly weight checks
• Behavioral counseling
• Online platforms: YouTube, dieting apps, support networks
• Pharmacotherapy (eg, lorcaserin, semaglutide)
• Bariatric surgery

TLC, total lymphocyte count.

the conflicting evidence of safety and efficacy of direct oral anti-coagulants in obese patients [59].

Interviewed leaders in the field have stated they prefer to increase the size of their surgical team in the operating room to help with patient mobilization and intraoperative assistance. Instruments and surgical tables may need to be acquired to accommodate patients with larger BMIs. Special deep retractors should be obtained, which are longer and larger to accommodate deeper surgical sites. Additionally, custom lift tables such as hover mats can be utilized to ensure patient safety and ease of patient mobilization during surgery. While most operating room tables are equipped to handle up to 600 lbs, special tables may need to be procured for superobese patients.

Total knee arthroplasty

Considerations for modification for TKA begin with implant selection. Adding a short stem augment to the primary tibial baseplate component increases surface area for load distribution, possibly allowing for longer implant survival and decreased failure rates [60].

While some interviewed surgeons prefer the modified subvastus surgical approach for primary TKA due to reported earlier straight-leg raise and knee flexion [61], other interviewed surgeons recommend a medial parapatellar approach for patients with a high BMI. However, surgeons should utilize the approach they are most familiar with. Additionally, surgeons should make a longer skin incision than usual to increase exposure.

Wound closure is a very important consideration. The prevention of infection and reduction of blood loss are of paramount importance. A constellation of suggestions from the literature for wound closure techniques include the use of bidirectional, running layers (>2–3 layers) of barbed sutures, including additional layers in thicker subcutaneous fat, which can then be reinforced in more superficial layers with interrupted sutures [62–64]. Running barbed sutures have been shown to decrease risk of infection due to their lower bacterial adherence [65], decreased time to wound closure, decreased cost [38], and decreased wound drainage and

Table 3
Intraoperative strategies for patients with BMI >40.

Both THA and TKA
• DVT prophylaxis considerations
• increase the size of the surgical team
• utilize modified instruments and obese specific surgical tables
• increase the length of the incision
• Wound closure:
○ Bidirectional, running (>2–3) layers of barbed sutures
○ Additional layers in thicker subcutaneous fat
○ Bipolar sealant
○ Negative pressure wound therapy
TKA
• Implant selection:
○ Add short stem to tibial baseplate
○ Utilize largest tibial baseplate to increase surface area
• Surgical approach:
○ Subvastus vs parapatellar
THA
• Implant selection:
○ Use largest implant and limit modularity
• Surgical approach:
○ Anterior vs posterior vs lateral approach

THA, total hip arthroplasty.

postoperative wound complications [66]. The use of bipolar sealant in heavier patients can help reinforce the wound and lower blood loss [67]. Finally, negative pressure wound therapy has demonstrated to decrease surgical site infections in obese patients [68–70].

Hip arthroplasty

Considerations for modification for hip arthroplasty begin with implant selection. The largest implant sizes that fit appropriately should be chosen for longevity, and modular implants should be avoided [71].

There are many different surgical approaches for hip arthroplasty, and there is significant controversy regarding which is optimal [72]. In patients with elevated BMI, the anterior approach has been associated with increased risk of wound complications [72,73]. However, other studies have demonstrated only an increased risk of superficial wound complications in the anterior approach, but no increased risk of deep surgical site infections [74]. This reflects the conflicting nature of the existing literature on the optimal approach in obese patients. Interviewed surgeons stated that due to moisture in the ilioinguinal crease and pannus fold area in high-BMI patients, the risk of infection may be much higher while using the anterior approach in these patients, and they advocated for the posterior or lateral approaches. In terms of positioning the incision, it was recommended to adjust the incision for higher BMI patients as needed and increase incision length to improve exposure (Table 3).

Postoperative considerations for obese patients

Attentiveness to hemostasis is of vital importance in this population, as obesity has been shown to be associated with wound drainage. Additionally, postoperative hematoma increases the risk of infection. Possibilities for hemostasis management include prophylactic closed suction drains [75], negative pressure (vacuum-assisted closure) [76], or intra-articular tranexamic acid irrigation or injection [77].

It has been demonstrated that patients with higher BMI have, on average, a longer length of stay [78]. However, this does not reflect an explicit calculus based on BMI. Rather obesity acts as 1 factor in a risk-stratification algorithm.

Future directions and long-term focus

We have reviewed a set of considerations and modifications that can be undertaken for patients with BMI >40 in the preoperative, intraoperative, and postoperative period to reduce the associated risks of complications. Preoperative considerations include assessment of body habitus, comorbidity burden, nutrition status, and weight loss optimization. Intraoperative considerations include DVT prophylaxis selection, augmenting the surgical team size, providing the use of specialized instrumentation and table modifications, implant selection, surgical approach, and wound closure. Postoperative considerations include techniques to minimize the risk of postoperative wound drainage and hematoma, length of stay, and postdischarge costs.

These recommendations are timely given the ever-increasing obesity epidemic in the United States [1]. The field of orthopedics needs to become more innovative to address musculoskeletal morbidities in the obese population, which now represents >35% of the United States [1]. Given what we know about baseline function, pain, quality of the life, and the drastic improvements that TJA offers these patients [17,23], it becomes imperative that we work with these patients to address their needs. Despite this, current payment models discourage surgeons and hospitals from operating on complex patients [34–37]. Additionally, Centers for Medicare and Medicaid penalizes hospitals for increased readmission rates [79]. Collectively, this creates a system that cherry picks and lemon drops patients based on factors outside of their direct control. To combat this system, reimbursement rates for both surgeons and hospitals for patients with BMI > 40 should be increased as an incentive to reduce disparities in this population. This increased reimbursement would also reflect the higher resource and time required for these patients.

It is in the best interest of the therapeutic alliance, the Hippocratic oath, and the ever-changing demographic makeup of the American population that surgeons consider obese patients as surgical candidates. Being too strict selectively disadvantages marginalized populations, whereas being too lax creates unwarranted risks and complications. We advocate for evidence-based considerations that serve to reduce associated risks.

Conflicts of interest

R. Schwarzkopf receives royalties from Smith & Nephew; is a paid consultant for Smith & Nephew and Intelijoint; has stock or stock options in Intelijoint, Gauss Surgical, and PSI; receives research support from Smith & Nephew and Intelijoint; receives financial or material support from Smith & Nephew; is in the editorial/governing board of *The Journal of Arthroplasty* and *Arthroplasty Today*; and is a board member in American Association of Hip and Knee Surgeons and the American Academy of Orthopaedic Surgeons. D. H. Wiznia is a paid consultant for Intelijoint Surgical. M. I. O'Connor is a full-time employee of Vori Health, Inc.; is a paid consultant for BoneSupport, Inc. and Yale New Haven Center for Outcomes Research and Evaluation; and has stock and stock options in Vori Health, Inc. The other 2 authors declare no potential conflicts of interest.

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