Should Body Mass Index Be Considered a Hard Stop for Total Joint Replacement?

An Ethical Dilemma

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KEYWORDS

• BMI • Obesity • Arthroplasty • Complication • Ethics

KEY POINTS

- Elevated body mass index (BMI) values past certain cutoffs have been found to correlate with increased risks for surgical complications in total joint arthroplasty.
- Mixed data exist regarding patient-reported outcomes in obese versus versus nonobese patients after joint arthroplasty.
- Using a hard BMI cutoff to include or exclude patients from surgery presents an ethical dilemma and involves an evaluation of both patient care goals and surgeon or institutional motives.

Total joint arthroplasty (TJA) is one of the most common surgeries performed in the United States. Current projections show that the number of total knee arthroplasty (TKA) and total hip arthroplasty (THA) performed each year will continue to rise per year by 2030.[1] Despite the several economic downturns since the turn of the century, the rate of increase in TJA has remained stable.[1] With this rise in the incidence of TJA, obese patients have a higher likelihood of seeking TJA for end-stage knee osteoarthritis (OA) than nonobese patients.[2,3] In the United States, approximately 1 in 3 Americans are considered overweight while 2 in 5 carry the diagnosis of obesity. This number has tripled since the 1960s and appears to be continuing to rise.[4,5]

It has been shown that primary TJA improves quality-adjusted life years to levels similar to patients without arthritis.[6] This allows patients a new lease on life, restoring the ability to perform activities such as daily activities, hiking, or traveling without the same pain and disability associated with hip or knee OA. Given this dramatic improvement in quality of life, TJA is often seen as a life-altering intervention on patients' lives.

These interventions are not without risk and there is constant discussion in the arthroplasty community regarding risk mitigation in those undergoing TJA. Apart from improvements in technique and perioperative protocols, patient optimization has been used in hopes of improving patient outcomes. Controlling diabetes, heart disease, autoimmune disease, and weight loss has been used in patient optimization.[7] One such strategy that has been suggested to mitigate these risks associated with obesity is the implementation of a cutoff based on body mass index (BMI).

BMI is calculated by dividing a patient's weight in kilograms by the square product of his or her height in meters. The metric was first

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described by a Belgian statistician, Adolphe Quetelet, in the nineteenth century to quickly approximate the "average" individual using the nineteenth-century Belgian population as a sample group.[8] By the middle of the twentieth century, the Metropolitan Life Insurance Company developed ideal height-weight tables based on actuarial data linking mortality and body weight— these tables, and the BMI derived from them, have since become the standard definition for normal and abnormal weights.[9] This calculation has since been used as a surrogate for a patient's adiposity and, by extension, their health, and since its acceptance into the medical field, obesity has been further classified by the World Health Organization based on BMI (Table 1).[4] With regards to the field of orthopedics, obesity is a known risk factor for the development of OA and subsequent increased lifetime risk of TJA.[10,11] An elevated BMI has been demonstrated to increase the risk of OA in both the hip and knee in a dose-dependent manner.[11]

Further, obesity, and especially morbid obesity, has been shown as a risk factor for complications following joint arthroplasty. Studies have demonstrated a significant correlation between morbid obesity (BMI $\geq$40 or a BMI $\geq$35 with an obesity-related health issue) and infection rates, wound complications, and other non-orthopedic complications such as genitourinary complications, total hospital costs, length of stay (LOS), and in-hospital death after primary TJA.[12]

Morbid obesity, as defined earlier, has been recommended by the American Association of Hip and Knee Surgeons as a BMI cutoff for which surgeons should consider delaying elective TJA until a patient can lose weight. As a result, there is a natural restriction of access to care. Of the patients who are forced to delay their surgeries due to obesity, 20% ever go on to receive their total joint procedure.[13]

Table 1
World Health Organization classification of weight status

Weight Status	Body Mass Index
Underweight	<18.5
Normal range	18.5–24.9
Overweight	25.0–29.9
Obese	$\geq$30
Obese class I	30.0–34.9
Obese class II	35.0–39.9
Obese class III	$\geq$40

However, BMI oversimplifies patient body composition. In a study based on National Football League athletes, 97% of all athletes are considered overweight by traditional BMI standards and over 50% of them would be considered obese.[14] This simple formula is unable to differentiate those who are heavier than average due to muscle mass from those who are heavier due to their adiposity. Much of the literature regarding patient risk of OA and complications after TJA does not delineate those who have increased adiposity, the dangerous truncal obesity, and those who have increased muscle mass creating an elevated BMI.

Implicitly tied to this ethical dilemma is the changing landscape of surgeon reimbursement in the United States. Compensation is moving toward a value-based model where reimbursement is tied to patient-reported outcomes, 90-day readmissions, and surgical complications, both for the surgeon and hospital. This movement logically encourages surgeons and institutions to select patients who are more likely to have a lower complication risk and a more predictable outcome.[15] Unfortunately, this limits access to care for obese patients who are more prone to unpredictable or adverse outcomes. These restrictions to care raise an ethical dilemma for the surgeon: do these cutoffs truly serve the patient?

ARGUMENT FOR BODY MASS INDEX CUTOFF

While an imperfect measurement, BMI does provide useful information and has been borne out in the literature to be an independent risk factor for complications regarding TKA. When discussing surgery, risk stratification and counseling are 2 important tools that help synthesize literature into a personalized assessment of a patient and the possible pitfalls regarding arthroplasty procedures. There does appear to be a correlation between increasing BMI and increasing risk of complications.

Delaying surgery until a patient can lose weight is an option. The US health care has many options for those seeking to lose weight. Nutritionists, weight-loss clinics, bariatrics, and medicines are all readily available. Despite these multitudes of options, most obese patients who are denied surgery do not seek out these weight-loss options and even fewer ever lose enough weight to fall under the morbid obesity classification.[13,16] Weight loss may also delay surgery as the decreased load on the joint, particularly the knees may improve symptoms

and allow a patient to keep their native joint longer.[17] Despite the physical and mental toll OA has on a patient's life, delaying surgery until a patient is thoroughly optimized does not make the patient's condition too advanced for arthroplasty. With all the benefits of weight loss to a patient's overall health, it does not necessarily mean that their risk profile changes substantially. Patients who lose weight rapidly preoperatively have similar risk profiles as if they had not lost the weight, indicating that perhaps the risks of being obese and undergoing TJA take an unknown amount of time to lower once weight has been lost.[18]

Complications typically encountered related to obesity include wound complications, infection, and mechanical failure of the implant. Wound complications, both superficial and deep, in their most benign form, cause stress to patients and surgeons in the immediate perioperative period. At their worst, they can lead to prosthetic joint infection (PJI), additional surgery, and even loss of limb. Compared to nonobese patients, those who are obese carry an increased risk of surgical site infections (SSIs), and those who are morbidly obese carry the greatest risk, experiencing 3 times the risk of SSIs compared to nonobese patients, though this risk remains under 5%.[19]

PJI is possibly the most catastrophic complication seen in arthroplasty. These patients often undergo multiple operations, extended antibiotic therapy, and invasive procedures with the hope of clearing the infection. Incidence of PJI for both THA and TKA hovers around 1%.[20] Obesity itself is an independent risk factor for PJI, with an increased risk of infection 1.3 times that of patients without obesity.[21,22] Obesity itself has not panned out as being as significant of a risk factor as previously thought; however, morbid obesity has been shown as a modest risk factor for infection.[12,23] Seen in the big picture, all medical diseases can and do impact success after TJA and that includes obesity.

Aseptic loosening is also a known complication with both hip and knee arthroplasty in obese patients.[22,24,25] Thought to be the increased forces across the joint, research has demonstrated that obese patients develop increased rates of early failure and revision for aseptic loosening compared to their nonobese counterparts.[17,26] The pain and impaired function due to aseptic loosening, followed by the morbidity of revision surgery, diminish the benefits of arthroplasty for arthritis.

Obese patients also have elevated perioperative risk.[22] They have statistically longer operative times, longer LOS, and increased wound complications in the acute perioperative period.[22,27] They are also at risk for cardiopulmonary issues. Obese patients are more likely to have obstructive sleep apnea (OSA).[22,28] OSA is typically accompanied by hypertension, cardiac disease, and risk of complications from oversedation, perioperatively. Thirty-nine percent of patients with OSA undergoing TJA are at increased risk of complications versus 18% of those who do not have OSA.[22,28] There is a potentially increased risk of venous thromboembolism. Elevated estrogens released by the adipose tissue, decreased mobility due to surgery, and being slower to mobilize are risk factors present in obese patients that may not necessarily be present in nonobese patients.[22,29] The literature remains unclear regarding its true risk in obese patients. Seen in the larger picture of an elective surgery, cardiopulmonary risk of complications are serious concerns that cannot be ignored when indicating a patient for TJA.

Not only are there differences in risks during the acute perioperative period, but there are also differences postoperatively. In the postoperative period, obese patients see similar improvements in patient-reported outcome measures (PROMs) but tend to be more dissatisfied with their postoperative outcome than those without obesity.[30] In addition, they have greater resource utilization and require more narcotics than nonobese patients.[13,30] Added to this, weight loss can lessen the pain and disability of knee OA and can delay surgical intervention.[17] Since obese patients tend to be younger when undergoing TJA, delaying their TJA could reduce their number of lifetime revisions and reduce their risk of infections or complications further.

ARGUMENT AGAINST BODY MASS INDEX CUTOFF

The approximation of BMI for overall health can often be faulty. Multiple international groups have found that BMI as a marker for cardiovascular health is insufficient and only becomes relevant when also factoring in measurements of waist circumference.[31] This is similar to the orthopedic sentiment that the distribution of fat and muscle density of a patient may be more relevant.[15,32] Simplifying patients down to simple "obese" or "nonobese" for the sake of avoiding complications can withhold a complication-free surgery based on faulty statistics and measurements.[33,34]

Arguments for the use of a BMI cutoff for arthroplasty often include a common thread of

decreasing complication rates. However, recent studies have shown morbid obesity as a modest effect on the risk of complications.[12] While there was elevated risk of postoperative in-hospital infection, wound dehiscence, and genitourinary complications, no increased risk of major cardiovascular or thromboembolic complications were found.[12] Further, a recent review demonstrated increased risk of PJI in obese patients undergoing arthroplasty; however, this increase was found only in class III and IV obesity patients (BMI $\geq$35 and $\geq$40, respectively).[35]

While it is important to recognize the increased complication rates associated with obesity, ignoring the potential benefits of arthroplasty in this population would preclude a significant portion of the US population from this surgery. It would require refusing complication-free surgery to 16 people to avoid a single complication in patients with BMI $\geq$35.[33] It remains that arthroplasty is a durable and effective tool in the long-term management of OA, a condition that is commonly seen with obesity. In a cohort of patients with BMI $\geq$35 who underwent TKA, patients with higher BMIs reported greater improvement in PROMs compared to a cohort with a lower BMI.[23] These data suggest that these patients may stand to benefit the most from arthroplasty procedures given appropriate optimization.

While optimization often includes a recommendation of weight loss, it is unclear whether the actual loss of weight contributes to decreased complications.[34] Reviews of national databases comparing obese patients who lost 10% of total body weight prior to arthroplasty to a control group found no significant differences between the 2 groups with regards to operative time, LOS, discharge destination, or 30-day adverse events.[18] With regards to operative time, LOS, and discharge destination, statistically significant results do not necessarily correlate with real-world outcomes. Typically, the increased operating room time, LOS, and so forth correlate to increased minutes or hours, respectively.[2,12]

More recent research has also focused on disparities in health care with a BMI cutoff. In the total ankle arthroplasty literature, using BMI cutoffs has been found to disproportionately limit access to the procedure for black patients, younger patients, and female patients.[36] In the arthroplasty literature, TJA with a cutoff of BMI less than 35 kg/m2 has demonstrated lower eligibility for non-Hispanic blacks, women, individuals of lower socioeconomic status, and those with high school degrees or less.[36] These studies highlight an ethical issue and disparity with BMI cutoffs as an unwanted limitation to access of life-altering treatment.

While delaying surgery is a patient-centered decision, it's important to recognize outside factors that may play a role in a surgeon's decision-making. The reality of health care in the United States requires a critical evaluation of other non-patient factors that may cause bias in decision-making. A qualitative survey of 45 orthopedic surgeons performing TJA found some reasons given for a hard cutoff included personal complication rates, fear of losing privileges with increased complication rates, strict BMI cutoffs as institutional policies, and affected quality data without a way to notate complexity of obese patients.[15] This places the patient in the middle of an ethical battle where the surgeon must overcome their own bias and the desires of the hospital systems and payors in order to provide care to the most important piece in the health care system: the patient. While there is increased risk to obese patients, they still receive marked benefit from TJA. Obesity is no different than frailty, diabetes, heart disease, or renal disease—it is a data point that makes up a patient's risk profile, but it should not dictate a patient's access to care.

MANAGEMENT STRATEGIES

Patient counseling is paramount to a successful outcome. Specifically, unmet patient expectations have been found to be a significant contributor to postoperative dissatisfaction.[37] Given the increased rate of complications in this patient cohort, appropriate counseling and expectation management are crucial; thorough discussions using various strategies such as written materials or stratifying complications into tiers may also serve to improve patient understanding.[38] While surgeons should not feel forced into doing surgeries they feel place undue risk to patients, shared decision-making with the patient allows the patient autonomy when deciding on whether to proceed with TJA.

With regards to preoperative medical management, a holistic approach should be employed. Medical optimization with general practitioners and appropriate specialists is a basic necessity. Preoperative nutrition and glycemic control may be assessed through albumin and hemoglobin A1c, respectively.[39,40] Likewise, controlling all other medical comorbidities along with pursuing weight loss during this period will optimize the patient preoperatively and postoperatively. Preoperative weight loss and conditioning have been

shown to decrease LOS and discharge to facilities.[18,41] Low-impact exercises such as water aerobics and stationary bike allow preoperative conditioning with minimal irritation to the arthritic joints, allowing the patient to be as physically ready as possible leading up to the surgery.

Other options for weight loss are present for patients for whom the severity of pain related to arthritis prevents them from adhering to an exercise regimen. Nutritionist support, weight-loss clinics, medications, and bariatric surgery are tools that a patient may utilize in order to lose weight. A systematic review from 2021 found that while short-term, preoperative nonsurgical weight-loss interventions may help with weight loss, their clinical significance remains unclear as patients have similar risk profiles to those who did not lose weight preoperatively.[42] Glucagonlike peptide-1 agonists have also been gaining popularity and may serve to address both weight and glycemic control and help augment the options patients may have for medical weight loss, preoperatively.[43] Bariatric surgery is an option for patients with recalcitrant obesity; however, research has found that bariatric surgery patients who underwent TKA demonstrated worse implant survivorship, mostly related to infection and instability, compared to low and high BMI controls.[44] Conversely, those who undergo bariatric surgery and are able to maintain weight loss are able to delay TJA.[17] These findings suggest that absolute weight loss at any cost may not be an appropriate optimization strategy, and reinforce the importance of a holistic approach.

PATIENTS WITH BODY MASS INDEX ≥50 KG/M^2

Special consideration should be paid to patients with BMI $\geq$50 kg/m^2, referred to as "super obesity." The increased complication risks associated with obesity in arthroplasty have been found to be BMI-dependent, with evidence demonstrating even higher rates of complication observed in the super-obese population compared with counterparts with less severe obesity.[45,46] PROMs in this population are also mixed, with reports of decreased to unchanged outcome measures when compared to normal BMI and less severely obese counterparts.[47–50]

Despite these factors, there is still evidence demonstrating that arthroplasty in the super-obese population is cost-effective given these procedures' ability to improve quality of life when compared to nonoperative management.[51] In this subgroup, arthroplasty may be indicated as a palliative procedure for OA recalcitrant to nonoperative management. Goals of treatment may shift from one of improving function to pre-arthritis status to one of pain management and giving these patients the ability to simply perform activities of daily living. Expectation management and preoperative optimization are even more important given that there is an unpredictable improvement in PROMs and the increased risk profile.

SUMMARY

Arthroplasty requires buy-in from both the patient and the surgeon. Knowing that an obese patient faces the uphill battle of optimization and a postoperative course that could be at increased risk of complications, careful counseling and frank discussions are needed. These conversations may be uncomfortable, but also necessary for any patient to consent to any arthroplasty procedure. These cutoffs may serve to only worsen health care disparities, and with recent advances to perioperative management, risk mitigation can help provide more equitable care to all patients. Complications are an unfortunate reality of arthroplasty. Despite all efforts, some patients are bound to suffer these complications. It is not the surgeon who suffers, but the patient. Complication rates, operative time, and LOS are simply statistics to a surgeon, things an administrator uses to assess the proficiency of the surgeon. By allowing outside forces to refuse surgery to our patients, we take decision-making out of the hands of the most important person.

Ultimately, a surgeon's first obligation is to the patient. All decision-making must be preempted with the most important question: "Is what I am doing (or not doing) causing harm to my patient?" While BMI does have its uses as a metric, it fails to provide meaningful data on the health and body composition of our patients, or the risk of complications. By delaying or refusing surgery based on an imperfect data point, we may be doing a disservice to a subset of our patients who would receive just as much benefit from a joint replacement than those who carry less weight. For every obese patient who does suffer a postoperative complication, there are many others who do not and are able to take back control of their lives. Arguably the most important step patients and surgeons can take is diligent optimization to reduce other comorbidities and make each patient the healthiest version of themselves as possible, knowing that there is a limit to how much a patient can be optimized. Counseling, support, and a

holistic approach to each patient are imperative as these allow each patient the autonomy and decision-making power they deserve.

CLINICS CARE POINTS

- Total joint arthroplasty has been found to improve the quality of life years of patients regardless of BMI status.
- BMI represents one data point in analyzing a patients risk stratification.
- Obesity has been shown to be a weak risk factor for complication when compared to other chronic medical conditions.
- Body mass index (BMI) does not take into account a patient's body composition which may falsely elevate a patient's risk profile.

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