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# Is There a Difference in PROMs Between Morbidly Obese Patients and Nonobese Patients Following Primary Total Knee Arthroplasty?

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ABSTRACT

*Background:* Patient satisfaction and patient-reported outcome measures (PROMs) are important for patients, surgeons, and payers in the current healthcare climate. Morbidly obese patients (body mass index [BMI] >40) have demonstrated higher incidence of complications after total knee arthroplasty (TKA) and can have difficulty obtaining access for their surgical care. The purpose of this study was to evaluate PROMs and patient satisfaction in morbidly obese patients undergoing primary TKA.

*Methods:* A total of 75 patients with BMI >40 kg/m$^2$ undergoing robotic-assisted TKA were retrospectively identified and matched 2:1 to a consecutive cohort of patients with BMI <35. The average BMI of the study cohort was 42.4 kg/m$^2$ (39.5-51.3) compared to 28.6 kg/m$^2$ (18.5-34.9) in the control group. Clinical outcomes, PROMs, and patient satisfaction were evaluated at a minimum 2-year follow-up.

*Results:* The patients of the BMI >40 cohort were less likely to be discharged home ($P = .0076$), had less active flexion at 2 years ($P = .0046$), and had worse knee scores at 2 years (0.0497). Despite this, the percentage of patients who were satisfied or very satisfied after surgery was similar between the groups (87.5% vs 91.2%, $P = .1943$).

*Conclusions:* Morbidly obese patients are less likely to be discharged directly to home and may have functional differences after primary TKA. However, morbidly obese patients have similar PROMs and are as satisfied as nonobese patients at 2 years. Morbidly obese patients with end-stage knee osteoarthritis should also be able to enjoy the benefits of primary TKA following medical and surgical optimization.



## Introduction

Total knee arthroplasty (TKA) is the most common procedure performed to address pain and disability associated with knee osteoarthritis (OA) [1]. Patient-reported outcome measures (PROMs) continue to play an important role in the current healthcare climate and in the assessment of patients after TKA surgery [2]. There is an existing belief that obesity has a negative effect on PROMs after total joint arthroplasty; however, there are limited data to support this [3]. Some studies have suggested that body mass index (BMI) has no impact on postoperative recovery and subsequent pain and function [4,5].

Increasing body weight is a risk factor for developing OA of the knee possibly due to increased mechanical loading of the joint [6,7]. This would imply that a large percentage of obese patients suffer from the debilitating effects of knee OA and may benefit significantly from surgery [8-10]. Approximately one-third of the US population is obese so this makes up a large proportion of the patient population who would benefit from TKA [11]. While some studies have found increased complications associated with obesity after TKA [12,13], others have shown a greater improvement in function from baseline in morbidly obese patients than non-morbidly obese patients [14].

A BMI cutoff of 40 is commonly used to determine candidacy for elective TKA as proposed by an American Association of Hip and Knee Surgeons' workgroup [15]. Patients above this cutoff are often

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denied surgery despite significant pain and disability from arthritis. These patients are advised to lose weight prior to surgical intervention although weight loss has not been definitively shown to reduce perioperative complications and rapid preoperative weight loss may increase complications in these patients [16,17]. While BMI cutoffs may limit complications in this patient population, they also deny many patients complication-free surgery [18]. The purpose of this study was to evaluate PROMs and patient satisfaction in morbidly obese patients with a BMI greater than 40 compared to nonmorbidly obese patients with a BMI less than 35. Our hypothesis is that morbidly obese patients can obtain significant improvements in PROMs and patient satisfaction following primary TKA comparable to nonmorbidly obese patients.

## Material and methods

This was an institutional board review–approved retrospective cohort review study. A total of 75 consecutive patients with a BMI >40 kg/m$^2$ undergoing robotic-assisted TKA were identified from a prospectively collected single-surgeon institutional database. These patients were matched 2:1 to a consecutive cohort of patients with a BMI <35 kg/m$^2$. All patients received the same implant design (Triathlon, Stryker, USA) at the same institution with the same anesthesia and postoperative protocols. The surgeries were performed between October 2016 and August 2019. The response rate for PROMs was 96% in the BMI >40 kg/m$^2$ and 99% in the BMI <35 kg/m$^2$ group. All patients in both cohorts had a minimum of 2-years clinical follow-up (range of 24-53 months in the BMI >40 group and 24-47 months in the BMI <35 group).

Clinical outcomes, PROMs, including Knee Society Knee Score, Knee Society Function Score, Forgotten Joint Score-12 (FJS), Knee Injury and Osteoarthritis Outcome Score for Joint Replacement, and patient satisfaction were evaluated. A five-point Likert scale (5, very satisfied; 4, satisfied; 3, neutral; 2, dissatisfied; 1, very dissatisfied) was used to assess patient satisfaction as well as percentage of patients very satisfied and satisfied with their surgery [19]. These measures were obtained at the time of the clinical appointment and surveys administered at clinic appointments or via phone call at approximately 2 years. Minimal clinically important difference (MCID) was assessed for outcome measures where preoperative and postoperative scores were analyzed including the Knee Society Knee and Function scores with an increase of between 5.3 and 5.9 for Knee Scores and 6.1-6.4 for Function scores used as a reference for achieving MCID, respectively [20]. Estimated blood loss, transfusion incidence, length of stay, percentage of patients discharged home, and preoperative and postoperative range of motion were also assessed as well as complications requiring additional surgery via electronic records chart review as well as from the institution's prospective total joint registry. The range of motion was assessed by the providers at the most recent clinic appointment.

Means and standard errors were calculated for each variable, as well as paired t-tests, to compare preoperative and postoperative patient-reported outcomes. Chi-squared analysis was used to compare proportions such as percentage of patients very satisfied and satisfied with their surgery and percentage of patients with postoperative complications. Statistical analysis was conducted via GraphPad (GraphPad Software Version v. 9.0, USA). A *P*-value <.05 was set to determine statistical significance.

The mean BMI of the study cohort was 42.4 kg/m$^2$ (39.5-51.3) compared to 28.6 kg/m$^2$ (18.5-34.9) in the control group ($P$ = .0001). There were 22 men in the BMI >40 kg/m$^2$ group and 65 men in the BMI <35 kg/m$^2$ group ($P$ = .0221). There were 53 women in the BMI >40 kg/m$^2$ group and 85 women in the BMI <35 kg/m$^2$ group ($P$ = .0452). The mean age in the BMI >40 kg/m$^2$ group was 61 years (36-79) compared to 67 (27-86) in the BMI <35 kg/m$^2$ group ($P$ = .0001). The mean length of stay in the BMI >40 kg/m$^2$ group was 2.0 days compared to 1.8 days in the BMI <35 kg/m$^2$ group ($P$ = .271). The mean follow-up was 30 months (24-47) in the BMI >40 kg/m$^2$ group and 32 months (24-53) in the BMI <35 kg/m$^2$ group ($P$ = .0950) (see Table 1).

## Results

The BMI >40 kg/m$^2$ cohort were less likely to be discharged home with 60 of 75 (80%) being discharged home compared to 137 of 150 (91%) in the BMI <35 kg/m$^2$ group ($P$ = .0076). The BMI >40 kg/m$^2$ cohort had less active flexion at 2 years, 118°compared to 121° in the BMI <35 kg/m$^2$ group ($P$ = .0046). However, the BMI >40 kg/m$^2$ gained more motion from baseline going from 110° preoperatively to 118°, while the BMI <35 kg/m$^2$ group went from 115° preoperatively to 120°. The morbidly obese group had worse Knee Scores at 2 years, 89 compared to 92 in the BMI <35 kg/m$^2$ group ($P$ = .0497). The obese group also had greater estimated blood loss than the BMI <35 kg/m$^2$ group, 97 cc compared to 65 cc ($P$ = .0002).

There was no difference in transfusion incidence between groups. One patient in the control group received a transfusion and none in the study cohort. In the BMI >40 kg/m$^2$ group, 96% of patients achieved MCID for Knee Society Function Scores and 99% achieved MCID for Knee Society Knee Scores. In the BMI <35 kg/m$^2$ group, 97% of patients achieved MCID for Knee Society Function Scores and 99% achieved MCID for Knee Society Knee Scores. There was no statistically significant difference in postoperative Knee Function scores at 2 years, 83 in the BMI >40 kg/m$^2$ group and 86 in the BMI <35 kg/m$^2$ group ($P$ = .2267). There was no statistically significant difference in postoperative FJS scores between the groups, 64 in the BMI >40 kg/m$^2$ group and 66 in the BMI <35 kg/m$^2$ group, ($P$ = .6401). There was no statistically significant difference in postoperative Knee Injury and Osteoarthritis Outcome Score for Joint Replacement scores between the groups, 84 in the BMI >40 kg/m$^2$ group and 85 in the BMI <35 kg/m$^2$ group ($P$ = .6643). There was no statistically significant difference in Likert scores between the groups, 4.47 in the BMI >40 kg/m$^2$ group and 4.59 in the BMI <35 kg/m$^2$ group ($P$ = .1593). There was no statistically significant difference in the percentage of patients satisfied or very satisfied with their surgery between the groups, 88% in the BMI >40 kg/m$^2$ group and 91% in the BMI <35 kg/m$^2$ group (see Table 2). There was no statistically significant difference in the postoperative complications between the groups: 3 patients had revisions in the BMI >40 kg/m$^2$ group, 1 due to infection and 2 due to instability, compared to 2 patients in the BMI <35 kg/m$^2$ group, 1 due to infection, and 1 due to instability ($P$ = .1004) (see Table 3). Five patients in the BMI >40 kg/m$^2$ group had lack of flexion postoperatively requiring manipulation under anesthesia compared to 13 in the BMI <35 kg/m$^2$ group ($P$ = .3011). Criteria for undergoing manipulation under anesthesia at this institution was achieving less than 105 degrees of flexion at 6 weeks following the

**Table 1**
Demographics.

| Demographic | Study group (BMI >40) | Control group (BMI <35) | *P*-value |
|---|---|---|---|
| Total TKAs | 75 | 150 | NA |
| Mean BMI | 42.4 | 28.6 | <.0001 |
| Number of men | 22 | 65 | .0221 |
| Number of women | 53 | 85 | .0452 |
| Mean age at surgery | 61 y | 67 y | <.0001 |
| Mean LOS | 2.0 d | 1.8 d | .2707 |
| Mean follow-up | 30 mo | 32 mo | .0095 |

BMI, body mass index; LOS, length of stay; TKA, total knee arthroplasty.

**Table 2**
Clinical outcomes and range of motion.

| Outcome measure | BMI >40 group | BMI <35 group | *P*-value |
|---|---|---|---|
| Clinical outcome | | | |
| Preoperative KS Knee Score | 44 | 44 | NA |
| Preoperative KS Function Score | 46 | 49 | .0595 |
| >2-y KS Knee Score | 89 | 92 | .0497 |
| >2-y KS Function Score | 83 | 86 | .2267 |
| Postoperative FJS | 64 | 66 | .6401 |
| Postoperative KOOS JR | 84 | 85 | .6643 |
| Home discharge | 60 (80%) | 137 (91%) | .0076 |
| Patient satisfaction (Likert scale 1-5) | 4.47 | 4.59 | .1593 |
| % Satisfied or very satisfied | 87.5 | 91.2 | .1943 |
| ROM (degrees) | | | |
| Preoperative extension | 1 | 1 | |
| Preoperative flexion | 109 | 114 | .0001 |
| >2-y extension | 0 | 0 | |
| >2-y flexion | 118 | 121 | .0046 |

BMI, body mass index; FJS, Forgotten Joint Score-12; KOOS JR, Knee Injury and Osteoarthritis Outcome Score for Joint Replacement; KS, Knee Society; ROM, range of motion.

index surgery. 1 patient had a wound dehiscence requiring irrigation & debridement in the BMI >40 kg/m$^2$ group compared to 3 patients in the BMI <35 kg/m$^2$ group ($P = .3606$). 3 patients in the BMI >40 kg/m$^2$ group had arthrofibrosis and decreased motion despite manipulation under anesthesia requiring arthroscopic lysis of adhesions compared to 6 patients in the BMI <35 kg/m$^2$ group ($P = .5000$). Two patients in the BMI <35 kg/m$^2$ group sustained a patella fracture postoperatively compared to 0 in the BMI >40 group ($P = .1576$). Two patients had a deep vein thrombosis postoperatively in the BMI >40 kg/m$^2$ group compared to 1 patient in BMI <35 kg/m$^2$ group ($P = .1088$) (see Table 4).

## Discussion

An increased BMI places patients at an increased risk of developing OA. One study demonstrated that an increase in BMI by 5 kg/m$^2$ resulted in double the probability of needing a TKA and in patients with a BMI >40 kg/m$^2$, the relative risk of needing a TKA increases by more than 32 times when compared to an individual of normal weight [21]. Mechanisms behind this are related to an increased mechanical load on the joint as well as the chronic inflammatory state associated with metabolic syndrome and obesity [22]. With the increasing prevalence of obesity in the United States, it is estimated that primary TKA will increase by 673% to nearly 3.5 million individuals by 2030 [1].

There are studies that have shown increased complications with TKA in the morbidly obese patient population including increased rates of infection, readmission rates and aseptic loosening [12,13]. Abdel et al. [23] found that patients with a BMI >35 kg/m$^2$ had a 2-fold risk of needing revision due to aseptic tibial failure despite well-aligned components. Winiarsky et al. [24] found an increased rate of wound complications (22% vs 2%) and deep infections (10% vs 1%) when comparing TKAs in patients with morbid obesity to those of normal body habitus. Jamsen et al. [25] also found an increased infection rate in morbidly obese compared to nonobese patients in an analysis of 7181 primary hip and knee arthroplasties (4.66% vs 0.37%). These findings demonstrate that it is crucial to medically optimize these patients prior to surgery.

**Table 3**
Complications requiring revision TKA.

| Complication | BMI >40 group | BMI <35 group | *P*-value |
|---|---|---|---|
| Total revisions | 3 (4%) | 2 (1.3%) | .1004 |
| Infection | 1 (1.4%) | 1 (0.7%) | .3078 |
| Instability | 2 (2.7%) | 1 (0.7%) | .1088 |

BMI, body mass index; TKA, total knee arthroplasty.

**Table 4**
Nonrevision complications.

| Complication | BMI >40 group | BMI <35 group | *P*-value |
|---|---|---|---|
| Contracture requiring MUA | 5 (6.7%) | 13 (8.6%) | .3011 |
| Wound dehiscence requiring I&D | 1 (1.3%) | 3 (2%) | .3606 |
| Capsulitis requiring arthroscopic lysis of adhesions | 3 (4%) | 6 (4%) | .5000 |
| Patella fracture | 0 | 2 (1.3%) | .1576 |
| PE/DVT | 2 (2.6%) | 1 (.06%) | .1088 |

BMI, body mass index; DVT, deep vein thrombosis; MUA, manipulation under anesthesia; PE, pulmonary embolism.

Despite these increased risks, the benefits of TKA must be weighed against the perioperative risks as these patients can still significantly benefit from surgery. Nunez et al. [26] found that morbidly obese patients had no significant difference in postoperative WOMAC scores compared to nonobese patients at 12 months. Springer et al. [27] found that restricting total joint arthroplasty to morbidly obese patients did not incentivize weight loss and while approximately 20% of patients in their study eventually met the criteria for surgery, the majority of those patients remained morbidly obese at long-term follow-up. Shapiro et al. [28] found in their study that 80% of patients initially denied total joint arthroplasty due to BMI never met target weight for surgery. Gurunathan et al. [29] found no statistically significant difference in perioperative complication rate until hospital discharge in a retrospective review of 1665 cases with patients stratified based on BMI.

Our study demonstrated no statistically significant difference in patient satisfaction between patients with a BMI >40 kg/m$^2$ and patients with a BMI <35 kg/m$^2$ at minimum of 2-year clinical follow-up with both groups having a high rate of patients being very satisfied or satisfied with their surgery (88% and 91%, respectively). With the increased emphasis on PROMs in the current healthcare climate, it is important to analyze these variables in patient populations that may be restricted from surgery such as the morbidly obese. We did not find a statistically significant difference in several PROMs including Knee Injury and Osteoarthritis Outcome Score for Joint Replacement, FJS, Likert Satisfaction, or Knee Function scores. Our study found that these patients were less likely to be discharged home and had greater estimated blood loss after surgery. However, there were no statistically significant differences in other postoperative complications, transfusion risk, or incidence of revision surgery though our sample size is likely too small to detect differences in complications.

The current study is limited in that all surgeries were performed at the same institution using the same technique, implants, and postoperative protocols. While this provides consistency, these findings may not be representative of the morbidly obese patient population undergoing surgery at other institutions with different protocols. A confounding variable in the study is that there were significantly more men in the control group than the study group. Other comorbidities such as diabetes and tobacco use were not evaluated between the groups which could confound the results if significantly different between the groups. Another limitation is that our institution is a large academic center with resources available to medically optimize patients during the preoperative and postoperative periods. Our results may not be generalizable to performing surgeries on this patient population in a small, rural setting with less resources. We have also excluded “obese” (BMI between 35 and 40 kg/m$^{2)}$ patients from the study which could have changed our results. The mean age of the BMI <35 kg/m$^2$ was higher, 67 compared to 61, in the morbidly obese group ($P = .0001$).

This may have been a confounding variable which affected our results as older age is associated with increased medical comorbidities. The study is also retrospective in nature with a relatively small number of patients in the study group. Larger, prospective studies would be needed to adequately compare complications rates between the 2 groups. However, our study was adequately powered to compare and provide an accurate assessment of patient satisfaction and PROMs with little difference between the 2 groups in these variables.

## Conclusions

While some studies have shown increased complications with performing TKA in the morbidly obese, these patients still show significant improvements in patient satisfaction and PROMs postoperatively. It is prudent to medically optimize this patient population preoperatively and educate them of the risks associated with surgery. Arbitrary BMI thresholds that deny surgery for these patients should be reassessed as weight loss alone in the preoperative period has not been shown to significantly affect outcomes in this patient population [30]. Our study demonstrated that morbidly obese patients and nonobese patients demonstrated similar PROMs and satisfaction following primary TKA. Morbidly obese patients with underlying end stage knee arthritis should be able to enjoy the same benefits of TKA following medical and surgical optimization.

## Conflicts of interest

Dr. Malkani has received IP royalties, speaker and consultant honoraria, and research support from Stryker Orthopaedics and serves as a reviewer for Journal of Arthroplasty and Journal of Knee Surgery. All the other authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2023.101169.

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