Ninety-Day Costs, Reoperations, and Readmissions for Primary Total Knee Arthroplasty Patients With Varying Body Mass Index Levels

Karthikeyan E. Ponnusamy, MD, Jacquelyn D. Marsh, PhD, Lyndsay E. Somerville, PhD, Richard W. McCalden, MD, MSc, FRCSC, Edward M. Vasarhelyi, MD, MSc, FRCSC *

Division of Orthopaedic Surgery, Department of Surgery, Schulich School of Medicine & Dentistry, Western University, London, Ontario, Canada

A B S T R A C T

Background: We compared 90-day costs and outcomes for primary total knee arthroplasty patients among nonobese (body mass index [BMI] 18.5-24.9), overweight (25-29.9), obese (30-34.9), severely obese (35-39.9), morbidly obese (40-49.9), and super-obese (50+) cohorts.
Methods: We conducted a retrospective review of an institutional database of total knee arthroplasty patients from 2006 to 2013 with a minimum of 3-year follow-up. Sixty-five super-obese patients were identified, and five other cohorts were randomly selected in a 2:1 ratio (total, n = 715). Demographics, 90-day outcomes (costs, reoperations, and readmissions), and outcomes after 3 years (revisions and change scores for Short-Form Health Survey [SF-12], Knee Society Scores, and Western Ontario and McMaster Universities Arthritis Index) were aggregated.
Results: The 90-day costs were significantly greater in the morbidly obese ($11,568 ± $1,960) and super-obese ($14,021 ± $7,903) cohorts relative to the smaller BMI cohorts ($9,938 − $10,352). The increased cost from readmissions was the main driver of costs. The outcome change scores were similar across all the BMI cohorts for Knee Society Scores, SF-12 Mental Health Composite Score, and Western Ontario and McMaster Universities Arthritis Index, but not for the SF-12 Physical Health Composite Score. At the midterm follow-up, there was no statistical difference in repeat surgery or aseptic revision rates. Septic revisions were significantly greater in the super-obese cohort relative to the other cohorts (6.2% vs 0.8-3.1%).
Conclusion: Health-care policy based purely on the economic costs may place morbidly obese and super-obese patients at risk of losing arthroplasty care, thereby denying them access to the comparable quality of life improvements.

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Total knee arthroplasty (TKA) rates are rapidly increasing because of the aging population and increasing obesity levels [1]. In fact, the growth rate for TKAs is much faster than total hip arthroplasties because the knee is more prone to obesity-induced arthritis [2]. The risk for developing knee arthritis due to obesity demonstrates a positive correlation with higher body mass index (BMI) categories having a much higher risk for TKA than lower BMI categories [3]. Similarly, the risks of infection and revision after undergoing an arthroplasty are greater with higher BMIs [4]. Despite these concerns, the potential benefits of a TKA are comparable across BMI groups [5]. Some surgeons have established maximum BMI thresholds ranging from 35 to 45, outside of which they will not provide arthroplasty care. One of the driving forces for the introduction of BMI limits is the increased use of quality measurement of hospital and surgeon performance, based on the short-term complication profile, without accounting for the differential patient's case acuity.

The purpose of this study is to quantify the 90-day costs and midterm (3-year postoperative) functional score improvements after a TKA among nonobese (BMI 18.5-24.9), overweight (25-29.9), obese (30-34.9), severely obese (35-39.9), morbidly obese (40-49.9), and super-obese (>50) patient cohorts [6]. We hypothesized that the super-obese patients would have the greatest 90-day costs, while demonstrating comparable functional score improvements relative to the other BMI groups.

Methods

After obtaining our institution's research ethics board approval, we conducted a retrospective review of our prospective institutional database and identified patients who had a primary TKA from 2006 to 2013. All surgeons performing the procedures were high-volume, fellowship-trained arthroplasty surgeons. Patients with a unilateral, primary TKA were included who had a diagnosis of osteoarthritis, rheumatoid arthritis, or post-traumatic arthritis. Exclusion criteria included simultaneous bilateral arthroplasty, acute fracture, or skeletal dysplasia. We calculated the BMI from heights and weights measured during the preoperative assessment and prospectively recorded this in our database. Based on the World Health Organization classification of obesity, patients were categorized into 6 BMI groups: <25 (nonobese), 25-29.9 (overweight), 30-34.9 (obese), 35-39.9 (severely obese), 40-49.9 (morbidly obese), and >50 (super-obese) [6]. There were 65 patients identified with a BMI greater than 50 who met the eligibility criteria, and they were defined as the super-obese cohort. The other BMI cohorts were generated with a 2:1 random selection using a random number table (130 patients in each of the other BMI groups, total of 715 patients).

Outcome Measures

The electronic medical record was reviewed, and the following variables were extracted: age, sex, BMI, smoking status, Charlson comorbidity index, the American Society of Anesthesiologists (ASA) score, all in-hospital resource use such as time in the operating room, anesthesia type, length of hospital stay, and perioperative complications (deep vein thrombosis/pulmonary embolism and superficial infection). During the first 90 days after surgery, we recorded emergency room (ER) visits, reoperations, and readmissions to hospitals within the local region (most hospitals within a 100-km radius from our institution). Our hospital's electronic records were reviewed for at least 3 years after the index surgery for midterm revisions (reoperation for any cause, aseptic, and septic revision). We used our institutional administrative data for all in-hospital resource utilization to determine the costs for index hospitalization, 90-day readmission, and 90-day ER visits (averaged over all patients whether they had a readmission or ER visit). The sum of these 3 components was used as the 90-day costs. All costs were inflation-adjusted to 2017 Canadian dollars.

Our institutional database has prospectively collected all patients Knee Society Scores (KSS), Short-Form Health Survey (SF-12), and Western Ontario and McMaster Universities Arthritis Index (WOMAC) preoperatively and at each visit postoperatively. The most recent postoperative score (minimum 1 year) minus the preoperative score was used to determine the change score. Scores were scaled such that lower scores meant worse function and higher scores meant greater function.

The primary outcomes of interest were 90-day costs and midterm change scores, while secondary outcomes included perioperative outcomes, 90-day complications, and midterm (3 year) revision rates.

Statistical Analysis

Demographics, clinical characteristics, and outcomes were summarized with descriptive statistics (frequencies, means, and standard deviations). The normality of continuous variables was tested using the Shapiro-Wilk test, and analysis of variance was used to analyze normally distributed, continuous variables. Kruskal-Wallis H test was used for nonparametric continuous variables. If a significant analysis of variance test result was identified, a post hoc Tukey's test was performed to identify the specific BMI cohort comparison leading to the statistical difference. The chi-square test or Fisher exact tests were used for categorical variables. Statistical significance was set at $P < .05$. Stata, version 12, software (StataCorp LP, College Station, TX) was used for data analysis.

Results

Demographics

The mean age of the larger BMI cohorts was significantly lower than the smaller BMI cohorts ($P < .01$) (Table 1). The morbidly obese and super-obese cohorts had significantly greater number of female patients than the smaller BMI cohorts. The larger BMI cohorts had higher Charlson comorbidity index and ASA scores than the smaller BMI cohorts.

Table 1
Demographics of TKA Patients by BMI Group.

Variable	Body Mass Index (BMI) Group						
	18.5-24.9 Nonobese (n = 130)	25-29.9 Overweight (n = 130)	30-34.9 Obese (n = 130)	35-39.9 Severely Obese (n = 130)	40-49.9 Morbidly Obese (n = 130)	50+ Super-Obese (n = 65)	P Value
Age, mean (standard deviation)	71.2 (10.4)	68.3 (9.2)	67.5 (9.2)	65.2 (7.8)	61.7 (7.4)	59.0 (7.1)	<.01
Sex (% female)	69.2	46.9	48.5	66.2	78.5	83.1	<.01
BMI, mean (standard deviation)	22.9 (1.8)	27.8 (1.4)	32.4 (1.5)	37.2 (1.4)	43.7 (2.7)	54.2 (3.6)	<.01
Charlson comorbidity index (CCI) (%)							<.01
0	53.8	65.4	67.7	54.6	54.6	43.1	
1	34.6	21.5	17.7	30.8	29.2	36.9	
2	8.5	10.0	13.1	11.5	8.5	6.2	
3	3.1	0.0	0.8	2.3	4.6	9.2	
4	0.0	2.3	0.8	0.0	1.5	3.1	
5	0.0	0.8	0.0	0.8	0.8	1.5	
6	0.0	0.0	0.0	0.0	0.8	0.0	
American Society of Anesthesiologists Score (ASA) (%)							<.01
1	1.5	2.3	2.3	0.8	0.8	0.0	
2	49.2	44.6	40.8	36.2	12.3	0.0	
3	45.4	50.0	50.8	57.7	77.7	70.8	
4	3.8	2.3	6.2	5.4	9.2	29.2	
Smoking (%)	8.5	6.9	6.2	5.4	7.7	3.1	.73

TKA, total knee arthroplasty.