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Total Knee Arthroplasty in Morbidly Obese Patients Treated With Bariatric Surgery

A Comparative Study

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Abstract: Our objective was to compare outcomes (anesthesia time, total operative time, tourniquet time, duration of hospital stay, 90-day complication rate, and transfusion rates) of patients with total knee arthroplasty (TKA) who underwent bariatric surgery before or after TKA. One hundred twenty-five patients were included: TKA before bariatric surgery (group 1; n = 39), TKA within 2 years of bariatric surgery (group 2; n = 25), and TKA more than 2 years after bariatric surgery (group 3; n = 61). Patients with TKA more than 2 years after bariatric surgery had shorter anesthesia and total operative and tourniquet times than other groups; differences were significant between groups. Ninety-day complication and transfusion rates approached but did not meet statistical significance. Ninety-day complication rates and duration of hospital stay did not differ significantly between the 3 groups. The level of evidence was level II (cohort study).
Keywords: total knee arthroplasty, morbidly obese, bariatric surgery, outcomes.
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Obesity has become one of the most serious public health problems of the 21st century and is widely recognized as a leading cause of multiple medical comorbidities and preventable deaths worldwide [1-5]. In addition to the negative pathophysiologic consequences of obesity, excessive weight predisposes patients to develop degenerative joint disease [2,6,7]. With the rate of obesity on the rise in society, the staggering projections of primary and revision total knee arthroplasties (TKAs) that will be required by the year 2030 put forth by Kurtz et al [8] may indeed be an underestimate. Bariatric surgery, aimed at achieving weight loss by gastric bypass or gastric banding, is a method that has been found to be effective at decreasing body mass index (BMI), in addition to reducing many of the associated comorbidities [9-13]. With the knowledge that morbid obesity is associated with a higher complication rate in TKA, the idea of referring patients to a bariatric surgeon for weight loss surgery, followed by TKA after sufficient weight reduction, has emerged as an attractive alternative to TKA alone in the treatment algorithm for the obese patient. This study investigated the complication rate after TKA in patients who had undergone bariatric surgery previously for weight loss. Our hypothesis was that patients undergoing weight loss surgery before TKA would have fewer perioperative complications when compared with patients undergoing TKA before weight loss surgery. We also hypothesized that operative times and duration of hospital stay would be shortest in the group that had undergone bariatric surgery more than 2 years before TKA.

Materials and Methods

A retrospective review of prospectively gathered data was undertaken using our institutional registry. Before data review, institutional review board approval was obtained. The database was searched from 1996 through June of 2008, allowing for follow-up from 22

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months to 14 years. Criteria for inclusion were patients fit for operative therapy and having undergone both bariatric surgery for weight loss as well as TKA. Patients who underwent gastric bypass or gastric banding procedures were included. Patients who underwent unicompartmental arthroplasty as well as bariatric surgery were excluded (8 patients).

The focus on this study was on the perioperative complication rates; therefore, hospital and clinic medical records within 90 days were reviewed, looking for acute problems that occurred in the 90-day postoperative period. Study end points included total operative time, tourniquet time, all perioperative complications, transfusion rates, and hospital duration of stay. In addition, we evaluated the rate of revision at final follow-up (range, 22 months to 14 years).

In an attempt to identify the optimal timing of when bariatric surgery and TKA were performed in relation to each other, the subjects were divided into 3 groups. Group 1 underwent TKA before bariatric surgery and included 39 knees. Group 2 underwent TKA 2 years or less after bariatric surgery and included 25 knees. Finally, group 3 underwent TKA more than 2 years after bariatric surgery and included 61 knees. We chose to distinguish groups 2 and 3 from each other, with the idea that patients who undergo gastric bypass surgery are relatively catabolic and have a metabolic imbalance in the first 2 years, which may lend to disparate outcomes. As an overall perspective, all 3 of these groups were then compared with the overall institutional complication rate for 17 784 TKAs during a 23-year period [14,15].

Statistical Analysis

Pairwise comparison tests were undertaken for these groups using both analysis of variance (ANOVA) and 2-sample *t* test, assuming unequal variances. To analyze survival free of revision, log-rank *P* value for a difference in risk of revision among the 3 groups was used.

Results

One hundred twenty-five patients met the inclusion criteria and were included in this study. No patients were lost to follow-up. Patient demographic data included age, sex, BMI, and weight and height at TKA (Table 1). Significant differences were noted in BMI ($P = .015$), weight ($P < .001$), and height ($P = .021$) across the 3 groups by ANOVA; comparison of each group to each other is shown in the table. Patients who underwent TKA before bariatric surgery (group 1) differed significantly from the other 2 groups (TKA within 2 years of bariatric surgery [group 2] or >2 years after bariatric surgery [group 3]) in BMI, weight, and height. No differences in distribution were observed. A trend was noted in age differences between the groups ($P = .055$ by ANOVA).

We noted differences in anesthesia time ($P = .014$), total operative time ($P = .001$), and tourniquet time ($P = .003$) between the 3 groups. For pairwise comparisons, groups 1 and 2 had higher values for each of 3 outcomes than did group 3, and all these differences were significant. The total operative time was greater in group 1 (underwent TKA before bariatric surgery) at 183 minutes and group 2 (underwent TKA <2 years after bariatric surgery) at 191 minutes ($P = .022$) than that in group 3 (underwent TKA >2 years after bariatric surgery) at 144 minutes (Table 2). Significant differences were also noted in anesthesia time ($P = .017$ and $P = .049$) and tourniquet time ($P = .031$ and $P = .003$) between groups 1 and 2 compared with group 3 (Table 2). No significant differences were noted between groups 2 and 3.

The duration of hospital stay was similar between all 3 groups ($P = .80$), averaging 6.1 days in group 1, 5.7 days in group 2, and 6.0 days in group 3.

The 90-day complication rate was not significantly different between the 3 groups (Table 3). Group 1 had a complication rate of 21% (8/39). The 8 complications involved 2 patients with urinary tract infections, 1 with a deep venous thrombosis and requiring subsequent joint

Table 1. Demographic Characteristics of Study Subjects

	Group 1* (n = 39), Mean ± SD (Minimum, Maximum)	Group 2* (n = 25), Mean ± SD (Minimum, Maximum)	Group 3* (n = 61), Mean ± SD (Minimum, Maximum)	Group 1 vs Group 2†	Group 1 vs Group 3†	Group 2 vs Group 3†
Age (y)	55.5 ± 6.5 (41, 71)	59.3 ± 7.5 (43, 71)	59.0 ± 8.4 (46, 79)	**.042**	**.021**	.87
BMI (kg/m^2)	43.1 ± 6.3 (32.4, 58)	37.9 ± 7.5 (23.9, 58.8)	38.5 ± 9.8 (24.2, 90.5)	**.007**	**.005**	.78
Weight (kg)	121.5 ± 19.3 (86, 155)	104.1 ± 19.3 (69, 131)	101.4 ± 22.6 (62, 165)	**.001**	**<.001**	.57
Height (cm)	167.8 ± 10.4 (151, 197)	166.0 ± 8.5 (144, 177)	162.7 ± 8.5 (135, 184)	.45	**.012**	.11
Sex (F/M)‡	28/11	22/3	49/12	NA	NA	NA

NA, not applicable; F/M, female/male.

Bold font indicates statistically significant information.

* Group 1 underwent TKA before bariatric surgery for weight loss; group 2 underwent TKA less than or equal to 2 years after bariatric surgery; group 3 underwent TKA greater than 2 years after bariatric surgery.

† Significance by overall ANOVA was as follows: age ($P = .055$), BMI ($P = .015$), weight ($P < .001$), and height ($P = .021$); we show the comparisons of each group to each other using 2-sample *t* test, assuming unequal variances.

‡ There was no significant difference in gender distribution by group: $P = .28$ (χ^2 test).

Table 2. Comparison of Anesthesia Time, Operative Time, Tourniquet Time, and Length of Hospital Stay Between Groups

	Group 1* (n = 39), Mean ± SD (Minimum, Maximum)	Group 2* (n = 25), Mean ± SD (Minimum, Maximum)	Group 3* (n = 61), Mean ± SD (Minimum, Maximum)	Group 1 vs Group 2†	Group 1 vs Group 3†	Group 2 vs Group 3†
Anesthesia time (min)	231 ± 60 (131, 413)	243 ± 92 (150, 455)	203 ± 51 (94, 351)	.58	**.017**	**.049**
Operative time (min)	183 ± 57 (100, 360)	191 ± 92 (79, 404)	144 ± 48 (65, 302)	.70	<**.001**	**.022**
Tourniquet time (min)	77 ± 46 (0, 181)	90 ± 46 (0, 160)	58 ± 38 (0, 136)	.26	**.031**	**.003**
Duration of stay (d)	6.1 ± 2.3 (3, 14)	5.7 ± 1.9 (4, 11)	6.0 ± 3.0 (4, 17)	.41	.74	.62

Bold font indicates statistically significant information.

* Group 1 underwent TKA before bariatric surgery for weight loss; group 2 underwent TKA less than or equal to 2 years after bariatric surgery; group 3 underwent TKA greater than 2 years after bariatric surgery.

† Significance by overall ANOVA was as follows: anesthesia time (P = .014), operative time (P = .001), tourniquet time (P = .003), and length of stay (P = .80); we show the comparisons of each group to each other using 2-sample t test, assuming unequal variances.

manipulation, 1 with postoperative arrhythmia, 2 with postoperative wound dehiscence requiring wound revision, and a patient with postoperative respiratory distress requiring admission to the intensive care unit. Group 2 (had TKA within 2 years after having undergone bariatric surgery) had only 1 complication (4%), a postoperative manipulation. Group 3 (61 TKAs) had 10 complications (16%) and included deep infection in the 3 knees and 1 patient each with delayed wound healing, intraoperative lateral femoral condyle fracture, postoperative acute renal failure, pulmonary embolism, acute cholecystitis, postoperative myocardial infarction, and postoperative respiratory failure.

For the historic controls, the authors compared the 3 groups to 17 784 primary TKAs previously reported [14]. In the control group, 59 knees were identified as having early wound complications within 30 days of index primary TKA, necessitating surgical treatment, for a rate of return to surgery of 0.33%. This group had a 2-year cumulative probability of deep infection rate of 6% and of major subsequent surgery of 5.3%. In contrast, for knees without early surgical intervention in the control group for the treatment of wound complications, the 2-year cumulative probabilities of deep infection and major subsequent surgery were 0.6% and 0.8%, respectively [14]. The rate of 90-day wound complications seen in groups 1 and 3 at 5% (2/39) and 7% (4/61) are markedly higher than in the historic control group. This difference may be explained by the fact that the current study includes all infections including some that may not require operative intervention, whereas the group used for historical control only includes wound complications within 30 day that required return to surgery.

No patients in group 1 required transfusion of blood products, 3 patients in group 2 required transfusion (12%), and 6 patients required transfusion in group 3 (10%). Differences in transfusion rates approached statistical significance between groups 1 and 3 (P = .06) and between groups 1 and 3 (P = .08) (Table 3). There were no significant differences between groups 2 and 3 (P = .72) (Table 3).

There were a total of 7 revisions among all 3 groups, with a mean time to revision of 35 months (range, 4-131 months). Group 1 (n = 39) had 2 revisions (5%), and group 3 (n = 61) had 5 revisions (8%). There were no revisions required in group 2. Reasons for revision included the following: stiffness (4 months after index TKA); osteolysis/polywear (131 months after index TKA); osteolysis (44 months after index TKA); acute periprosthetic fracture of the tibia (4 months after index TKA); acute hematogenous infection requiring polyethylene liner exchange (21 months after index TKA); deep infection requiring full, staged revision (13 months after index TKA); and another deep infection requiring full, staged revision (30 months after index TKA).

Discussion

This study analyzed if weight loss surgery with bariatric surgery before TKA would mitigate risk to the patient. Our findings suggest that regardless of the temporal relationship between TKA and bariatric surgery, the complication rate is high. We chose to distinguish groups 2 and 3 from each other, with the idea that patients who undergo gastric bypass surgery are relatively catabolic and have a metabolic imbalance

Table 3. Ninety-Day Complications and Postoperative Transfusion Rate in the 3 Groups

	Group 1*	Group 2*	Group 3*	Group 1 vs Group 2	Group 1 vs Group 3	Group 2 vs Group 3
90-d complications	8/39 (21%)	1/25 (4%)	10/61 (16%)	P = .08	P = .60	P = .16
Postoperative transfusions	0/39	3/25 (12%)	6/61 (10%)	P = .06	P = .08	P = .72

* Group 1 underwent TKA before bariatric surgery for weight loss; group 2 underwent TKA less than or equal to 2 years after bariatric surgery; group 3 underwent TKA greater than 2 years after bariatric surgery.

in the first 2 years after the weight loss surgery [16-19]. Dalcanale et al [18] showed that most laboratory tests do become stable by about 2 years after gastric bypass surgery and recommended 2-year laboratory testing to assess equilibration and nutritional status because this has a long-term predictive value. This study is limited by its lack of power, and the underpowered nature of the study may explain the disparate results. Although it is possible that the metabolic process has changed by 2 years leading to increased complications, this should not be seen as the sole reason for the differences seen among transfusions, thromboembolic events, and perioperative medical complications. Another weakness in this study was that the surgical procedures in each cohort were not equally distributed over the course of the study period, and thus, surgeon experience may have played a role in complication rates. There was no standardized technique shared among all surgeons, which may also lend to differences in outcome. The patients in this study did not undergo a detailed preoperative nutritional screening, which represents a potential weakness in the study. Total operative time, anesthesia time, and tourniquet time were lowest in group 3 and significantly different from those in groups 1 and 2, indicating that patients with bariatric surgery more than 2 years before TKA had shortest operative times.

Interestingly, the group we postulated to be at increased risk for a metabolic state, group 2, actually had the fewest complications (4%) and required no revisions. In the group with TKA before bariatric surgery, another group at higher risk because of their morbid obesity, the rate of complications was highest (21%) and revision rate was 5%. Group 3 actually had the highest revision rate of 8%. Our study is underpowered and, thus, unable to show a statistically significant difference in revision rates. Certainly, the small patient population in this study is a limitation despite that this represents one of the largest such study we are aware of in the English literature. Another study similar to ours was performed in the United Kingdom that included 143 patients, among whom bariatric surgery was performed first in 53 and arthroplasty first in 90 patients, and compared them to nonobese patients undergoing arthroplasty [20]. Within the 2 obese groups, wound infection rate was 3.5 times lower and 30-day hospital readmission rate was 7 times lower in patients who had bariatric surgery before joint arthroplasty ($P = .06$) [20]. Our study differed in the setting and categorization of patients into 3 groups, instead of 2 groups in the previous study, which may explain some of the differences noted between these 2 studies.

The findings presented in this study are relevant, given the well-documented trends in the United States [2-4]. In accordance, obesity predisposes individuals to needing TKA more frequently [2,7]. Bourne et al [7] showed nearly a 19-fold increase in the need for TKA in patients with a BMI of 35 to 39.9 kg/m^2 and a 32-fold increase in TKA in patients with a BMI of more than 40 kg/m^2. Understanding the negative impact of morbid obesity on the outcomes of TKA [21-26] has prompted the potentially attractive option of referring patients to a bariatric surgeon before undergoing TKA.

When examining prior literature relevant to our study, one study is available for review [27]. Parvizi et al [27], from our institution, evaluated 20 total hip arthroplasties and 14 TKAs, and all patients had undergone bariatric surgery before their joint arthroplasty. The average time from bariatric surgery to arthroplasty was 23 months (range, 7-65 months). Twelve of the 20 joints reported were TKAs. No knee revisions were required, and only 2 patients developed deep venous thrombosis. It should be noted that Parvizi et al used the same institutional registry to report their data as the current study. The 12 TKAs in the study of Parvizi et al are included in the current study. Nearly a decade has gone by since the initiation of our current study and the publication of the prior study. Pavizi et al stated that consideration should be given for referral of morbidly obese patients to a bariatric surgeon, considering the good outcomes they showed as well as the plethora of other benefits that accompany the marked weight reduction afforded by bariatric surgery.

Separate from the other benefits of weight loss, this study points to a high complication rate across all groups, regardless of the temporal relationship between the 2 operations (bariatric surgery and TKA). This study shows that total operative time and tourniquet time is significantly less in the group that had weight loss surgery at least 2 years before TKA, suggesting that it may be technically easier to perform TKA; however, that alone should not be a reason to recommend weight loss surgery. The high complication rate seen in group 3 was not predicted by the authors and challenges one of the study hypotheses. The high wound complication rates between groups 1 and 3, although both similarly high, may be from different underlying mechanisms, however.

Light et al [28] investigated the metabolic changes seen in the skin and its collagen by obtaining skin tissue from 10 patients who had undergone bariatric surgery. The skin samples were taken while in the operating room performing circumferential lipectomy after weight loss. The histologic evaluation of the postbariatric skin samples showed a poorly organized collagen structure, elastin degradation, and regions of scar formation within macroscopically normal areas. In addition, they were able to show tissue matrix degradation in striae [28].

The findings in this study suggest that although operative time is less in group 3 and transfusion rates are lower in group 1, the patients experience similar increased rates of perioperative complications regardless of the temporal relationship between bariatric surgery and TKA. These results compare adversely to prior published outcomes in nonbariatric patients using the same institutional registry. The authors conclude that patients who undergo bariatric surgery and TKA experience increased rates of perioperative complications regardless of the temporal relationship between bariatric surgery and TKA. It should be communicated to patients who fit the profile of the subjects in this study that they are an "at risk" group for the development of complications. Based on our findings in this study, even patients who have undergone bariatric surgery may have an increase in the early complication risk when undergoing TKA.

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