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ORTHOPAEDIC SURGERY

Bilateral staged total knee arthroplasty in obese patients

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Abstract
Introduction The purpose of this study was to compare the clinical and functional results and complications associated with staged bilateral total knee arthroplasty (TKA) performed 4–11 days apart during a single hospitalization in patients who were obese and patients who were not obese.
Methods We retrospectively evaluated 48 (96 knees) patients who were obese and divided into two groups based on their body mass indices (BMI). Morbidly obese patients (group A1, BMI $\geq$ 40 kg/m^2) consisted of 21 patients (42 knees), and obese patients (group A2, BMI $\geq$ 30 kg/m^2) consisted of 27 patients (54 knees). The control group (group B, BMI < 30 kg/m^2) consisted of 20 non-obese patients (40 knees), who were undergoing staged bilateral procedure within the same time frame. All patients had cemented TKAs with use of posterior cruciate sparing prosthesis without patellar resurfacing. If medically stable after the first arthroplasty the patients then underwent the second arthroplasty 4–11 days later. The data on major complications and minor complications were evaluated.
Results Although, there was no statistically significant difference in overall complication rates in any of the groups, the non-obese group had fewer wound complications than the other groups ($P > 0.05$). No significant differences in preoperative or postoperative Knee Society score, and functional score could be demonstrated between the three groups ($P > 0.05$). Both obese and nonobese patients showed improvements in pain and function from pre-surgery to a minimum 2 years follow-up.
Conclusion Results of bilateral staged TKAs in obese patients have low complication and high success rates and increased BMI has no negative effect on the early outcome. Bilateral staged TKA might be a good treatment alternative for the improvement of the patient's quality of life and functional and clinical outcomes.

Keywords Osteoarthritis · Total knee arthroplasty · Obesity · Complications · Body mass index

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Introduction

Total knee arthroplasty (TKA) is one of the most predictable and successful reconstructive procedures performed on adults [20]. The prevalence of knee osteoarthritis in the 45- to 74-year age group is 2% and the prevalence of bilateral osteoarthritis of the knee in the same age group is 5% [5]. Obesity has been found to be a strong predictor of bilateral osteoarthritis of the knee [5].

Orthopaedic surgeons suspect that obese patients are at greater risk of having complications, component failure, and worse outcomes after TKA than other candidates [22]. The effect of obesity on the outcome of TKA has been reported to be variable. Although a few studies reported that excellent patient satisfaction and a few complications [11, 19, 25], other reports cite increased rates of wound complications, and perioperative and postoperative morbidity [18, 25]. Foran et al. [10] reported that lower Knee Society score (KSS) (of $\geq$80 points) as well as higher revision

rates, and other perioperative complications in obese patients at approximately 7 years after the operation. In contrast, Stickles et al. [23] found no difference between obese and non-obese patients regarding satisfaction, and revision rates. Benjamin et al. [2] compared the local wound and systemic complications after unilateral and simultaneous TKAs in obese and non-obese patients. Knee scores, local wound complication and systemic complication rates were not found to be significantly different between any patient groups.

The purpose of this study was to compare the clinical and functional results and complications associated with staged bilateral TKAs in patients who were obese and patients who were not obese.

Materials and methods

Using computerized patient database and medical records, we retrospectively reviewed a consecutive series of 68 patients (136 knees) who underwent staged bilateral TKA between May 2003 and September 2004. The patients who were obese divided into two groups based on their body mass indices (BMI). The BMI equals a person's weight in kilograms divided by his or her height in meters squared and correlates with total body fat [3]. Obesity is defined as a BMI of $\geq$30 kg/m^2, and morbid obesity is defined as a BMI $\geq$ 40 kg/m^2. The scores less than 30 kg/m^2 are classed as non-obese. Morbidly obese patients' group (group A1) consisted of 21 patients (42 knees), and obese patients' group (group A2) consisted of 27 patients (54 knees). Both group A1 and group A2 had had a bilateral staged TKA, with the intervals ranging from 4 to 11 days during a single hospitalization. The control group (group B) consisted of 20 non-obese patients (40 knees), who underwent a staged bilateral procedure within the same time frame.

All patients had cemented TKAs with use of posterior cruciate sparing prosthesis without patellar resurfacing. All patients had a preoperative diagnosis of either primary osteoarthritis or post-traumatic arthritis. Bilateral staged TKAs were generally performed on healthier patients. If medically stable after the first arthroplasty, they then underwent the second arthroplasty 4–11 days later and all of the patients received a controlled rehabilitation program in the postoperative period. Two patients were not medically stable after the first arthroplasty. One patient had fever due to an upper respiratory tract infection on the second postoperative day which was controlled by oral antibiotics and the other one had abdominal pain due to cholelithiasis after 5 days postoperatively. Their second arthroplasties were postponed for 2 and 3 months, respectively. For this reason, they were not included in this study.

Preoperative comorbid conditions such as hypertension, diabetes, and coronary heart disease were recorded on a preoperative registry form. Any complications, whether intraoperative or postoperative, were noted. Complications were defined as minor or major. Minor complications included urinary retention, urinary tract infection, deep-vein thrombosis diagnosed by venous Doppler ultrosonogarphy performed only for the patients with clinical signs and symptoms of thrombosis, pneumonia, and superficial infection defined as any erythma, drainage, or both for which the patient required removal of any absorbable subcutaneous stitch or brief course of oral antibiotics. Major complications were defined as deep infections, pulmonary embolism, cerebrovascular accident, myocardial infarction, death, or a return to the operating room for any reason. Outcome for group A was assessed at the average follow-up of 34 months (range 24–40 months) and 32 months (range 24–39 months) for group B.

All patients were evaluated preoperatively and postoperatively with the Knee Society objective rating scale. Postoperative score was assigned based on each patient's clinical status at the time of latest follow-up. A rating of 90–100 points was considered excellent; 80–89 points, good; 70–79 points, fair; and <70 points, poor. Excellent and good ratings were considered "successes", whereas fair and poor ratings were considered "failures".

To evaluate the position of prosthetic components and radiolucency at the bone-prosthesis interface, pre- and postoperative anteroposterior (AP) and lateral X-rays were used.

A standardized postoperative TKA clinical pathway was utilized for all patients. This consisted of immediate postoperative continuous passive motion; use of patient controlled anesthesia pump, and removal of drains on the first postoperative day. Antibiotic therapy started 30 min prior to incision and continuing for 48 h postoperatively. All patients received postoperative low-molecular-weight heparin for 4 weeks. Patients were mobilized on the first postoperative day.

A Fisher exact two-tailed test was performed to analyze the significance of any difference between probabilities. Student *t* test, analyses of variance (ANOVA), and Tukey's test were used to examine the difference between groups. All confidence intervals were calculated at the level of 95% and significance was determined as $P < 0.05$.

Results

A significant difference was found in the gender distribution among the three groups, with the obese and morbidly obese groups having more female patients and non-obese group having more male patients ($P < 0.001$). There were 9

Table 1 Demographic details of the groups

	Group A1 ($N = 21$)	Group A2 ($N = 27$)	Group B ($N = 20$)	P value
Age	59.9 ± 5.2	65.1 ± 7.1	67.2 ± 8.9	0.032
Sex (M/F)(%)	0/21 (0)	9/27 (33.3)	14/20 (70)	<0.001
BMI	41.6 ± 1.4 (40.0–44.8)	33.5 ± 2.1 (30.0–39.2)	27.3 ± 3.7 (23.7–29.8)	<0.001
Follow-up (months)	32 (24–40)	35 (24–40)	32 (24–39)	NS
Hospital stay (days)	19.9 ± 5.0 (10–29)	18.7 ± 6.9 (10–38)	14.5 ± 5.3 (9–27)	0.03

BMI body mass index

Values are mean (SD)

Table 2 Preoperative comorbidities of the groups

	Group A1 ($N = 21$)	Group A2 ($N = 7$)	Group B ($N = 20$)
Hypertension	12	16	9
Diabetes mellitus	5	4	2
COLD	1	–	–
CAD	1	3	2
GIS disease	–	1	1
Urinary tract infections	2	5	2
Total	21	29	16

COLD chronic obstructive lung disease, *CAD* coronary artery disease, *GIS* gastrointestinal system

men (17.7%) and 39 women (82.7%) in the group A, 14 men (70%) and 6 women (30%) in the group B (Table 1).

The group A1 had the lowest age at the surgery within all groups ($P = 0.032$). The average BMI were 36.2 ± 4.3 (range 30.2–44.9) in the group A, and 27.3 ± 3.7 (range 23.6–29.8) in the group B ($P < 0.001$) (Table 1). The mean length of hospitalization was 19.9 ± 5.0 days (range 10–29) in the group A1, 18.7 ± 6.9 days (range 10–38) in the group A2, and 14.5 ± 5.3 days (range 9–27) in the group B. This difference was statistically significant ($P = 0.03$) (Table 1).

Preoperative medical comorbidities such as hypertension was the most common medical comorbidity in all three groups and was present in 54.4% (37/68) of all patients. Other common comorbidities included diabetes (11/68), urinary tract infections, and (9/68) coronary artery diseases (6/68) (Table 2).

Eighty-six (89.5%) of the 96 knees in the group A, and 35 (87.5%) of the 40 knees in the group B were considered to have overall successful outcome at the final follow-up (Table 3). Five knees in morbidly obese group (11.9%), seven knees (12.9%) in obese group, and five knees (12.5%) in non-obese group were fair results (KSS between 70 and 79), but none required revision (Table 3). There was no significant difference in the success rates between obese and non-obese groups at minimum two years follow-up ($P > 0.05$).

There were four superficial infections in the group A1, four in the group A2, and one in the group B. Overall minor complications occurred in 30% (7/21) in the group A1, 25.9% (7/27) of those in the group A2, and 25% (5/20) of those in the group B. There was no statistically significant difference between groups for the overall minor complication rates ($P > 0.05$). There were no deep infections or major complications in any of the groups. There were no perioperative deaths or fatal pulmonary emboli during minimum 2 years follow-up in any of the patients. Minor complications consisted mainly of wound complications and clinically detectable deep vein thrombosis in the group A1 and A2, while gastrointestinal disorders were more frequent in the group B. Although, there was no significant difference in overall minor and major complication rates in any of the groups ($P > 0.05$), the non-obese group had fewer wound complications than the other groups.

The mean preoperative range of motion (ROM) was revealed similar in all groups ($P > 0.05$). At the final follow-up, the morbidly obese group had lowest overall postoperative ROM compared with the other groups but no

Table 3 Clinical results in all groups

	Group A1 ($N = 42$)	Group A2 ($N = 54$)	Group B ($N = 40$)	P value
Excellent (%)	17 (40.5%)	22 (40.7%)	18 (45%)	NS
Good (%)	20 (47.6%)	27 (50%)	17 (42.5%)	NS
Fair (%)	5 (11.9%)	7 (12.9%)	5 (12.5%)	NS
Poor (%)	–	–	–	–

statistically significant difference could be detected ($P > 0.05$) (Table 4).

The three groups had comparable pre-operative KSS. Similarly, no statistically significant difference between the final follow-up KSS and functional scores could be detected among the three groups ($P > 0.05$). The cumulative KSS had improved significantly from a mean of 64.4 ± 10.6 (range 42–89) before surgery to a mean of 90.6 ± 12.0 (57–100) at the final follow-up ($P < 0.001$). The overall functional score also had increased significantly from a preoperative mean of 51.6 ± 9.4 (range 38–72) to 84.1 ± 11.0 (range 55–100) at the final follow-up ($P < 0.001$) (Table 5).

Non-progressive radiolucencies below the tibial component were observed in three knees (3/42) in the group A1, four knees (4/54) in the group A2, and two knees (2/40) in the group B at the final follow-up. The difference was not statistically significant ($P > 0.05$). None of the radiolucencies were >1 mm in width, and none were complete. All components were well fixed at the latest follow-up, and none required revision.

Discussion

Obesity has been associated with degenerative joint disease [4, 7, 15]. More than 70% of women and 35% of men with degenerative joint disease of the knee are overweight [4]. The prevalence of obesity (BMI > 30) in the United States is estimated to be 30% in the general population [9]. Two major concerns with regard to morbidly obese patients who undergo a TKA are mechanical loosening and perioperative morbidity [25].

The TKA patients with BMI 35 or higher were reported to be significantly younger, further supporting the strong association of obesity and knee osteoarthritis [16]. This was also the case in our series, where morbidly obese patients were younger than obese and non-obese patients. In the current study, a higher rate of female patients was observed in the obese patients with BMI greater than 30, consistent with observations of osteoarthritis of the knee in obese women [16].

Systemic complications after TKA have been reported in some studies to occur with increased frequency in patients with obesity [18]. Some authors have claimed that deep vein thrombosis occurs with greater frequency in patients with obesity [14]. Others contend that bilateral TKAs are associated with increased pulmonary complications, increased incidence of deep vein thrombosis and pulmonary embolism [6, 13]. However, Benjamin et al. [2] have reported that obesity is not a contraindication to bilateral TKA under one anesthetic. Soudry et al. [21] have reported a 59% risk of deep vein thrombosis and an 11% risk of asymptomatic pulmonary emboli in 234 patients undergoing one-stage bilateral TKAs. In the present study, no major complications were seen in obese patients undergoing staged bilateral TKAs. Except the wound complications, the occurrence of total minor complications was not increased in obese patients in our study. This is in contrast to some reports where increased complications were observed [14, 18], but in agreement with other studies [2].

Obesity has been implicated in increased perioperative morbidity, including wound infections and prolonged hospital stay [8, 25]. There may be a strong association between obesity and wound complications. Although many authors revealed that not correlation between obesity and

Table 4 Correlation between preoperative and postoperative ROM in the groups

	Group A1 ($N = 42$)	Group A2 ($N = 56$)	Group B ($N = 40$)	P value
Preoperative ROM	86.0 ± 15.7 (50–110)	87.8 ± 13.5 (55–115)	84.9 ± 12.8 (50–120)	*NS*
Postoperative ROM	92.4 ± 13.2 (80–135)	97.8 ± 11.6 (80–140)	101.2 ± 10.7 (90–135)	*NS*

ROM range of motion
Values are mean (SD)

Table 5 The pre and postoperative KSS (objective and functional scores) of the groups

	Group A1 ($N = 21$)	Group A2 ($N = 27$)	Group B ($N = 20$)	P value
Total of knees	42	54	40	
Preoperative				
KSS	60.7 ± 9.6 (42–76)	63.0 ± 10.4 (49–89)	69.5 ± 12.0 (61–83)	NS
Functional score	46.3 ± 8.6 (39–74)	52.8 ± 11.8 (38–73)	55.6 ± 7.7 (40–78)	NS
Postoperative				
KSS	88.6 ± 12.2 (57–94)	92.4 ± 13.4 (63–100)	90.8 ± 10.5 (64–97)	NS
Functional score	79.8 ± 10.9 (55–83)	84.1 ± 11.5 (62–98)	88.5 ± 10.6 (60–100)	NS

KSS knee society score
Values are mean (SD)

wound complications [11, 18], other studies show a higher rate of wound complications with TKA procedures in morbidly obese patients with BMI greater than 40 as in our study [14, 25]. Weakened immune response and poorly vascularized fatty tissue in obese patients are generally accepted as the cause of increased wound complications. Wilson et al. [24] reviewed 67 deep infections in a series of 4,171 knees and concluded that infection was associated with obesity. Winiarsky et al. [25] reported a higher infection rate in 40 patients with obesity (BMI > 40) when compared with a cohort of patients who were not obese. The non-obese group had fewer wound complications and a shorter hospital stay than other two obese groups in our study.

A higher rate of comorbidities, specifically hypertension and diabetes mellitus, was observed in morbidly obese and obese patients [18]. A statistically higher rate (23.8%) of diabetic patients was found in morbidly obese patients, but in our study, interestingly only one out of five patients with superficial wound infections were diabetic.

The current study did not reveal a difference in patello-femoral symptoms and KSS between the three groups at minimum 2-year follow-up period. Stern and Insall [22] found a higher incidence of patello-femoral symptoms (30 vs. 14%) in their patients who were obese. Griffin et al. [11] have reported lower KSSs, and poorer patellar scores in 56 obese patients at 10-year follow-up. Mont et al. [19] compared 50 TKAs in obese patients (BMI > 30) with a 50 TKAs in a directly matched nonobese group and found no significant difference in KSSs or progressive radiolucencies at a mean follow-up of 65 months. In another study, Marcacci et al. [17] reported that overweight was not correlated with outcome, radiolucency or patellar pain.

There was no evidence of radiographic loosening or wear at the latest follow-up in our study. All components were well fixed and none were revised. A few reports have blamed obesity in late loosening of TKA, leading to an increased risk of reoperation [4, 17]. Other reports have shown that obesity does not preclude benefit from TKA and that even morbidly obese patients do benefit to an extent [1, 17]. A major limitation of our study is the relative short period of follow-up. This limitation is particularly important relative to the development of aseptic loosening and subsequent need for revision. The good clinical outcome in obese patients has been maintained in several studies with longer follow-up. Griffin et al. [11] have found similar revision rates between obese and non-obese patients 10 years after TKA.

In this study, we postulate that results of bilateral staged TKAs in obese patients have low complication and high success rates and conclude that increased BMI has no negative effect on the early outcome of bilateral staged TKA. Bilateral staged TKA might be a good treatment alternative for the improvement of the patient's quality of life and functional and clinical outcomes regardless of age, sex and BMI.

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