OPEN Research Article

Short-Term Outcomes of Noncemented Total Knee Arthroplasty in Patients With Morbid Obesity

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ABSTRACT

Introduction: Noncemented primary total knee arthroplasty (TKA) compromises over 14% of all primary TKA procedures reported in the American Joint Replacement Registry. While studies have indicated similar outcomes for cemented and noncemented TKA in obese individuals, the efficacy and safety of noncemented TKA in morbidly obese patients (body mass index [BMI] $\geq$ 40 kg/m^2) remain unexplored. This study compares short-term postoperative outcomes and complications between noncemented and cemented TKA in morbidly obese patients.

Methods: A retrospective review of 605 cases of patients with a BMI of at least 40 kg/m^2 (22.5% of 2,691 total cases at a single tertiary center) who underwent TKA was conducted. All patients had a minimum follow-up of 1 year. Data collected included age, BMI, sex, race, ethnicity, American Society of Anesthesiologists status, and the Charlson Comorbidity Index. Postoperative complications were tracked, including 90-day readmission, 1-year mortality, 1-year revision surgery, wound complications, fractures, and infections. Categorical variables were analyzed with chi-square tests and continuous variables with *t*-tests.

Results: Of the included patients with a BMI $\geq$ 40 kg/m^2, 40 (6.6%) received noncemented TKA. The noncemented TKA group had a lower mean BMI (43.3 $\pm$ 3.1 vs. 45.0 $\pm$ 4.4; P = 0.012) and a higher proportion of male patients compared with the cemented group (n = 17 [42.5%] vs. n = 143 [25.3%]; P = 0.028). Surgical time was shorter for noncemented TKA (97 $\pm$ 27 minutes) than for cemented TKA (118.0 $\pm$ 39.4 minutes; P = 0.001). No significant differences were found in length of stay and postoperative complications, including 90-day readmission, 1-year mortality, revision surgery rates, wound complications, fractures, and infections.

Conclusion: The findings of the study suggest that noncemented TKA may be a feasible, safe alternative and not inferior to the standard cemented TKA in patients with morbid obesity with the benefit of decreasing surgical time.

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While cemented primary total knee arthroplasty (TKA) remains the benchmark in the United States, the utilization rate of noncemented primary TKA is emerging, accounting for over 14% of all primary TKA procedures reported in the 2021 American Joint Replacement Registry.[1] Noncemented TKA procedures have undergone considerable improvements in implant design over the past few years, and because of this, their indications are expanding. The use of highly porous fixation surfaces, additive manufacturing, improved keel and peg design, accurate instrumentation, and understanding of previous failure mechanisms have contributed to improved osseointegration, stability, and mitigation of stress shielding, all of which ultimately enhance survivorship.[2-4] The design evolution of noncemented TKA offers several theoretical advantages over the standard benchmark of cemented TKA, including long-term survivorship of implants secondary to durable and stable biological ingrowth and enhanced surgical efficiency with potentially associated cost reduction, while simultaneously reducing complications associated with cement utilization and wear from cement debris.[3,5,6] Previous studies have reported similar or improved clinical outcomes and survivorship in patients who have undergone noncemented TKA compared with cemented TKA.[2,4,7-9] These design improvements and promising clinical outcomes have made noncemented TKA an increasingly popular option for surgeons and different patient populations.

Noncemented TKA may be a safe and effective option for obese patients, defined as a body mass index (BMI) $\geq$ 30 kg/m^2. There is a high prevalence of obesity in the United States, with the most recent data reporting 42.4% of the adult population in the United States.[10] Given the large proportion of obese patients who elect to undergo TKA, a notable proportion of TKA procedures are expected to be performed in this patient population. Cemented TKA in obese patients is associated with various complications, including at least three times higher rate of revision compared with nonobese patients.[11-14] Previous studies have demonstrated comparable outcomes between cemented and noncemented TKA in obese patients, including survivorship, revision rates, and patient-reported outcome measures.[2-4]

Despite some studies showing comparable results in patients with a BMI $\geq$ 30 kg/m^2, the utility and safety of noncemented TKA in morbidly obese (BMI $\geq$ 40 kg/m^2) patients is not yet well understood. According to the American Association of Hip and Knee Evidence–Based Committee, patients with a BMI $>$ 40 kg/m^2 meet the threshold for which there is an observed increase in perioperative complications.[15] These patients are also over 30 times more likely to require a TKA.[16] Therefore, it is crucial to determine whether noncemented TKA can be used in this patient population. Given the limited recent literature on this topic,[8,9] this study aimed to compare the short-term postoperative outcomes and complications between noncemented and cemented TKA procedures in patients with a BMI of at least 40 kg/m^2.

Methods

After obtaining Institutional Review Board approval, a retrospective review of all patients who underwent TKA between January 1, 2009, and December 31, 2021, was conducted. The total number of primary TKA procedures conducted during this period was 2,691. Exclusion criteria included patients with a BMI $<$ 40 kg/m^2, who have undergone revision surgery, who had a unicompartmental TKA, and with missing information. All patients included in this study had a minimum follow-up period of 1 year. Patient demographics such as age, BMI, sex, race, ethnicity, and comorbidities included in the Charlson Comorbidity Index were recorded.[17] The American Society of Anesthesiologists status was also included in this study's initial review. Patients were divided into cemented or noncemented TKA cohorts based on the materials listed in the surgical report at the time of their surgery. Decision to opt for noncemented TKA was at the discretion of the attending surgeon based on a subjective analysis of bone quality. Postoperative complications were categorized into 90-day readmission, 1-year mortality, 1-year revision surgery, wound complication, fracture, and infection of the knee. Other perioperative hospital variables included length of stay (LOS), discharge disposition, blood loss, and surgical time. Categorical variables were analyzed using chi-square analysis while *t*-test analysis was conducted to analyze continuous variables. Statistical analysis was conducted using Python. Statistical significance was denoted using a P value of 0.05 or less.

Results

Of the 605 patients with a BMI $\geq$ 40 kg/m^2 in this study, 40 (6.6%) received noncemented TKA. The average follow-up period for noncemented and cemented TKA was 1.47 and 1.44 years, respectively. Patients who underwent a noncemented TKA (43.27 $\pm$ 3.08) had a lower mean BMI than those who underwent a cemented

TKA (45.08 ± 4.44; P = 0.012). Male patients comprised a greater proportion of those who underwent noncemented TKA (n = 17; 42.5%) than the cemented TKA cohort (n = 143; 25.3%; P = 0.028). While comorbidities between the two groups were comparable, those who underwent cemented TKA had a higher rate of chronic obstructive pulmonary disease (COPD) (n = 132; 23.4%) and liver disease (n = 93; 16.5%; Table 1).

Patients who underwent noncemented TKA (97.1 minutes ± 27.3) had significantly shorter mean surgical time than those with cemented TKA (118.0 minutes ± 39.4; P = 0.001). No difference was noted in postoperative complications between cemented and noncemented TKA procedures, including readmission rates within 90 days (6.9% vs. 5%), blood loss (245.24 ± 180.80 vs. 232.5 ± 108.34), periprosthetic infection (1.6% vs. 2.5%), fracture (0.5% vs. 0%), aseptic loosening (0.2% vs. 0%), 1-year mortality (0.2% vs. 0%), and 1-year revision surgery (2.7% vs. 0%) within a year. The patient with aseptic loosening of the TKA also had a retained tibial nail from an old stress fracture. The patient's one-year radiographs demonstrated lucency in the lateral and posterior aspect of the tibial tray with medial migration. They underwent surgical intervention to revise the loose tibial implant and remove the tibial nail at 1 year and 5 months after the primary cemented TKA. The mean LOS postoperatively was similar in both cemented (3.20 ± 1.88) and noncemented (2.85 ± 3.72) TKA procedures (P = 0.297). While more patients in the cemented TKA cohort were discharged to nonhome facilities such as skilled nursing facility (n = 183, 32.7%, vs. n = 7, 17.5% of the noncemented cohort), this difference was not statistically significant (P = 0.074; Table 2).

Discussion

A notable proportion of TKA procedures is expected to be performed on obese patients, given the high prevalence of obesity in the United States and their increased likelihood of requiring a TKA. While there is a broad consensus that obesity is associated with an increased risk of postoperative complications, noncemented TKA has some advantages over the standard cemented TKA that may be useful in this patient population, such as decreased surgical and anesthesia time in patients who may have more medical comorbidities. Previous studies investigate the performance of noncemented TKA in obese patients, but few describe its performance in morbidly obese (BMI ≥ 40 kg/m^2) patients. In addition, although many of these studies review survivorship and long-term performance of noncemented TKA, they have failed to address more immediate complications or outcomes associated with the procedure. This study is one of the first to assess the short-term postoperative outcomes and complications after noncemented TKA in morbidly obese patients.

Patients who underwent noncemented TKA had a markedly lower mean BMI and were more likely to be male. In addition, while comorbidity rates were comparable between the two cohorts, the cemented TKA group had a higher prevalence of COPD and liver disease. While previous studies have not reported differences in comorbidities between noncemented and cemented TKA procedures, patients with obesity, COPD, and liver disease have been previously shown to have an increased rate of postoperative complications, including readmission, infection, and morbidity after TKA.[18-20] The prevalence of osteoporosis in patients with COPD is up to fivefold higher than in age-matched healthy control subjects, with a predicted pooled global prevalence of 38%.[21] Similarly, approximately 30% of patients with chronic liver disease also have osteoporosis.[22] This high prevalence could be attributed to disease-specific risk factors such as systemic inflammation, vitamin D deficiency, and the use of glucocorticoids as treatment for patients with COPD. The observed relationship between poorer bone quality and COPD or liver disease, particularly in the context of obesity, could partially explain the preference for cemented TKA in these patients.

In our study, patients who underwent noncemented TKA had a markedly shorter mean surgical time (21 minutes) than those with cemented TKA. This is in concordance with previous findings, which recorded a mean difference of 11.6 minutes between the two procedures.[6] A shorter surgical time has several clinical and cost-related implications for TKA patients. Surgical periods are an important factor for thromboembolism and infection after primary TKA.[23-25] The higher thrombotic risk could be attributed to the longer period of knee flexion, which compromises venous outflow of the lower extremities. More prolonged exposure to the operating room also increases the opportunity for contaminants at the surgical site, leading to superficial or deep infection. Surgical time also directly correlates with blood loss and the need for transfusion in total joint arthroplasty, which is a factor in subsequent complications and healthcare utilization.[26] A study by Acuña et al[27] demonstrated markedly longer surgical periods in patients with American Society of Anesthesiologists class 3 and higher BMI. By using

Table 1. Demographic Factors of Cemented vs. Noncemented Total Knee Arthroplasty Patients

Factor or Variable	Cemented (n = 565)	Noncemented (n = 40)	*P*
Age	60.82 ± 8.21	60.83 ± 6.98	0.994
BMI	45.08 ± 4.44	43.27 ± 3.08	**0.012**
Sex (male)	143 (25.3%)	17 (42.5%)	**0.028**
Race			0.805
White	394 (69.7%)	26 (65.0%)	
Black	136 (24.1%)	11 (27.5%)	
Other	34 (6.0%)	3 (7.5%)	
Ethnicity			0.805
Hispanic	60 (10.6%)	4 (10%)	
Non-Hispanic	503 (89.0%)	36 (90%)	
Insurance			0.885
Medicare	211 (37.3%)	16 (40%)	
Medicaid	97 (17.1%)	7 (17.5)	
Private	239 (42.2%)	15 (37.5%)	
Other	18 (3.2%)	2 (5%)	
Laterality (right)	285 (50.4%)	23 (57.5%)	0.514
Smoking status	27 (4.8%)	5 (12.5%)	0.291
Alcohol use	167 (29.5%)	16 (40%)	0.529
Diabetes	190 (33.6%)	10 (25%)	0.344
Renal disease	44 (7.8%)	4 (10%)	0.843
ESRD	3 (0.5%)	0	0.998
IVDU	10 (1.8%)	2 (5%)	0.429
HIV/AIDS	2 (0.4%)	0	0.997
ASA status	3.14 ± 0.65	3.10 ± 0.64	0.707
Malignancy	68 (12.0%)	6 (15%)	0.762
CVD	56 (9.9%)	2 (5%)	0.458
COPD	132 (23.4%)	3 (7.5%)	**0.033**
CHF	62 (11.0%)	0	0.052
Dementia	1 (0.2%)	0	0.998
Hemiplegia	4 (0.7%)	0	0.997
Liver disease	93 (16.5%)	1 (2.5%)	**0.033**
MI	47 (8.3%)	1 (2.5%)	0.311
Peptic ulcer disease	23 (4.1%)	1 (2.5%)	0.942
PVD	59 (10.4%)	1 (2.5%)	0.061

Highlighted in bold are significant of *P*-values
ASA = American Society of Anesthesiologists; BMI = body mass index; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; CVD = cerebral vascular disease; ESRD = end-stage renal disease; IVDU = intravenous drug use; MI = myocardial infarction; PVD = peripheral vascular disease

noncemented TKA, postoperative complications that are historically higher in patients with morbid obesity could be somewhat mitigated by the shorter surgical time, as demonstrated by the nonsignificant differences in postoperative complications in our study. From the cost-analysis standpoint, the cost of 1 minute of surgical room time is estimated to range between 30 and 60 US dollars.[6] While the implants for a noncemented TKA

Table 2. Postoperative Outcomes in Cemented Versus Noncemented Total Knee Arthroplasty Patients

	Cemented (n = 565)	Noncemented (n = 40)	*P*
Length of stay	3.20 ± 1.88	2.85 ± 3.72	0.297
Nonhome discharge	183 (32.7%)	7 (17.5%)	0.074
Blood loss (mL)	245.24 ± 180.80	232.5 ± 108.34	0.66
OR time (min)	118.04 ± 39.37	97.05 ± 27.28	**0.001**
90-day readmission	39 (6.9%)	2 (5%)	0.997
1-year mortality	1 (0.2%)	0	0.998
1-year revision surgery	15 (2.7%)	0	0.605
Postoperative wound complication	23 (4.1%)	1 (2.5%)	0.942
Periprosthetic fracture	3 (0.5%)	0	0.998
Periprosthetic infection	9 (1.6%)	1 (2.5%)	0.997
Aseptic loosening	1 (0.2%)	0	0.998

Highlighted in bold are significant of *P*-values
OR = operating room

cost more than cemented TKA, this expense could be offset by reduced surgical time and no cement or cementing accessory use.[28]

Comparable rates of perioperative complications were noted between the two cohorts, with no significant differences in readmission, blood loss, periprosthetic infection, fracture, mortality, or revision surgery within the year. This is in contrast to previous studies, which suggested that revision rates were markedly higher in morbidly obese patients who underwent a cemented TKA.[8,9] Meanwhile, our study noted no revision surgeries within the noncemented cohort. These differences can be explained in part by the differences in follow-up periods. While the study by Bagsby et al had a longer mean follow-up (cemented 6.1 years; noncemented 3.6 years) and the study by Sinicrope et al had a minimum 5-year follow-up, our study reviewed complications within a year of surgery.[8,9] Our results more closely align with a recent study of noncemented TKA utilization in the general patient population, which demonstrated that noncemented TKA exhibited similar rates of all-cause 90-day readmissions, 1-year revision surgery, and mortality as cemented TKA.[29] While the findings of our study cannot be extrapolated to longer term outcomes after noncemented TKA in morbidly obese patients, once a noncemented implant develops ingrowth, it is unlikely to loosen until later in the implant life when there is clinically significant polyethylene wear. In addition, these findings offer several implications regarding the immediate advantages of noncemented TKA. Unplanned hospital readmissions after total joint arthroplasty account for 55% of unplanned orthopaedic readmissions, greatly influencing patient recovery and hospital expenditure.[30] Transfusion secondary to intraoperative blood loss is strongly associated with thromboembolic events, infection, and mortality. Given the substantial effect of some of the short-term events on patient recovery and hospital costs, the results of our study suggest the noninferiority of noncemented TKA to cemented TKA in morbidly obese patients with the advantage of shorter surgical time. In addition, this study demonstrated comparable LOS after surgery and a trend toward more nonhome discharges in the cemented TKA cohort; however, this was not statistically significant. A previous propensity score–matched cemented and noncemented TKA cohort study demonstrated similar median LOS and nonhome discharge dispositions.[29] Given the increased cost and suboptimal clinical recovery associated with longer LOS and discharge to nonhome facilities, the results are reassuring for patients and clinicians who may be worried about recovery pathways after noncemented TKA.

The results of this study should be reviewed in the context of its limitations. First is the inherent limitation of single-institution retrospective study, such as selection bias and reliance on previously existing medical records. Second, this study focused on short-term outcomes within a year of the TKA, which only partially captures long-term complications or survivorship trends. However, noncemented designs have been improving, and previous studies suggesting inferior outcomes in obese patients may not appropriately capture outcomes with newer designs and improved techniques. As noncemented TKA is being promoted to have longer

survivorship than cemented TKA, future studies must conduct a long-term analysis of this patient population. Third, while we manually reviewed surgical reports to confirm the presence or absence of cement use in TKA, a relatively smaller sample size of morbidly obese patients undergoing noncemented TKA was obtained. This is likely due to surgeon or hospital hesitancy to extend noncemented TKA to higher risk patient populations. Fourth, we could not compare patient-reported outcome measures of patients who have undergone surgery. This information could provide additional insight into the patient's perspective on pain and function after undergoing noncemented TKA. Additional research with larger cohorts and more extended follow-up periods is warranted to validate the findings of this study.

Conclusion

The findings of the study suggest that noncemented TKA may be a feasible, safe alternative and not inferior to the standard cemented TKA in patients with morbid obesity with the benefit of decreasing surgical time. It is important to emphasize that this study identified patients who generally had a higher BMI, COPD, and liver disease in the cemented TKA cohort. The short-term outcomes demonstrated in this study call for future studies to assess survivorship and long-term outcomes in a larger group of patients. Such studies will further strengthen the platform for optimizing TKA outcomes using this alternative approach in a challenging patient population.

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