CE

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Bilateral Total Knee Arthroplasty

Predictors of Discharge Disposition

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BACKGROUND: Total knee arthroplasty is on the rise. Some patients choose to undergo simultaneous bilateral total knee arthroplasty (simultaneous BTKA). No studies were found that examined which patients may be better candidates to successfully undergo this procedure.

PURPOSE: The purpose of this study was to determine personal and comorbid characteristics of patients undergoing simultaneous BTKA that are predictive of length of stay (LOS) and discharge to a skilled nursing facility (SNF).

METHODS: A retrospective database study of 125 patients post-simultaneous BTKA was conducted. Binary and multiple linear regression models identified personal and clinical predictors of LOS and SNF discharge.

RESULTS: Body mass index (BMI) ($p < .001$) and SNF discharge ($p = .025$) were significant predictors of increased LOS and explained 18% of the variance. Older age, female sex, and presence of cardiopulmonary disease predicted SNF admission; 21% of the variance for SNF discharge was explained by the model.

CONCLUSION: Patients with a high BMI should be carefully screened before undergoing simultaneous BTKA; older patients, women, and those with cardiopulmonary disease may benefit from early discharge planning for SNF transfer, thereby decreasing LOS and hospital utilization.

Total knee arthroplasty (TKA) is commonly employed for patients with osteoarthritis of one or both knees. The total number of TKAs is predicted to rise from 450,000 procedures in 2005 to nearly 3.48 million procedures in 2030, a 673% increase (Kurtz, Ong, Lau, Mowat, & Halpern, 2007; Losina, Thornhill, Rome, Wright, & Katz, 2012). Primary reasons for this are the aging population, increased obesity, increased knee injuries among younger patients, and expanding surgical indications for TKAs (Losina et al., 2012). Most commonly, each knee is operated on via a separate procedure, either unilateral total knee arthroplasty (UTKA) or staged bilateral total knee arthroplasty (staged BTKA), performed on two separate occasions within 1 year. Some patients choose to undergo simultaneous bilateral total knee arthroplasty (simultaneous BTKA) during one hospital stay. The number of simultaneous BTKAs is also expected to rise as they have nearly doubled since the 1990s and involve 6% of all TKAs (Meehan, Blumenfeld, White, Kim, & Sucher, 2015; Memtsoudis, Hargett, et al., 2013; Memtsoudis, Mantilla, Parvizi, Stundner, & Mazumdar, 2013).

Although patient outcomes of UTKA are well known, the outcomes of staged BTKA and simultaneous BTKA are less clear (Meehan et al., 2015; Odum & Springer, 2014). The few studies that exist are flawed with lack of clarity between those who underwent staged BTKA and those who underwent simultaneous BTKA, small sample sizes, lack of inclusion of patients who did not successfully complete the staged BTKA, and variability in healthcare systems and surgical techniques (Meehan et al., 2015). Because simultaneous BTKAs are on the rise, it will be important to understand the outcomes associated with this procedure such as complication rates, length of stay (LOS), and disposition. It is likely that some patients may be better candidates to undergo simultaneous BTKA than the other two more conservative surgeries. Examining predictors of LOS and disposition associated with successful simultaneous BTKA could shed light on the different outcomes between the three surgeries and suggest which patients mkay do better with simultaneous BTKA. The purpose of this study was to determine the personal and comorbid characteristics of patients undergoing simultaneous BTKA that predict an increased LOS and discharge to a skilled nursing facility (SNF) for rehabilitation, suggestive of poorer overall outcomes for simultaneous BTKA.

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Review of Literature

Individual characteristics and comorbidities influence the risk, outcome, and disposition of any type of surgery and would certainly include patients undergoing both types of BTKA. One study found that patients undergoing simultaneous BTKA had fewer comorbidities than those in the UTKA group but had a 1.6 times higher rate of procedure-related complications and mortality (Memtsoudis, Gonzalez Della Valle, Besculides, Gaber, & Sculco, 2008). The 2013 Consensus Conference on Bilateral Total Knee Arthroplasty (Memtsoudis, Hargett, et al., 2013) and a study by Bohm et al. (2016) affirmed a lower prevalence of most comorbidities (hypertension, diabetes, hypercholesteremia, and pulmonary and coronary disease), except obesity (Bohm et al., 2016; Memtsoudis, Hargett, et al., 2013). Comorbidities such as diabetes, dementia, heart disease, and chronic obstructive pulmonary disease (COPD) are common in older adults and the TKA population, so there is potential for selection bias to occur where healthier individuals are more likely to undergo simultaneous BTKA. More studies that critically examine the influence of comorbidities on TKA outcomes would be important in deciding which patients would be best candidates for BTKA and for providing postoperative care for these populations.

Obesity is on the rise across the United States, and body mass index (BMI) is one comorbidity that should be examined as a possible predictor of poorer perioperative outcomes (Ogden, Carroll, Fryar, & Flegal, 2015). Most studies define obesity as a BMI of 30 kg/m^2 or greater. A critical analysis of the literature found that patients undergoing staged BTKA had the highest prevalence of obesity: 31.4% in patients undergoing staged BTKAs as compared with 15.3% in UTKA and 16.8% in simultaneous BTKA (Meehan et al., 2015; Memtsoudis, Hargett, et al., 2013). Although one study found no differences in pain scores, outcomes, and complications between obese and nonobese patients undergoing UTKA, patients with a higher BMI had more functional difficulty postoperatively (Ayyar, Burnett, Coutts, van der Linden, & Mercer, 2012). Another study that examined patients undergoing UTKA found that knee function was poorer for those with a BMI greater than 30 kg/m^2, but no significant differences in function existed 6 months to a year postoperatively (Suleiman et al., 2015).

Length of stay is another variable to consider for surgical comparison. Increased LOS has been associated with personal characteristics (i.e., older age, female sex, greater number of comorbidities, living in a deprived area, absence of a caregiver at home), postoperative function, and surgical characteristics (i.e., simultaneous BTKA, low-volume surgeon) (Bohm et al., 2016; Halawi et al., 2015; Jonas, Smith, Blair, Dacombe, & Weale, 2013; Memtsoudis et al., 2008; Ong & Pua, 2013). While women had a longer LOS, men had more cardiac complications, higher pulmonary emboli rates, and received more blood transfusions (Bohm et al., 2016). It is possible that women stayed longer in the hospital due to lack of a caregiver at home.

Length of stay can also vary according to the type of TKA employed. A handful of studies compared LOS in patients undergoing simultaneous BTKA (4–5.8 days) versus UTKA (3.4–5.3 days) (Memtsoudis et al., 2008; Shetty, Mullaji, Bhayde, Chandra Vadapalli, & Desai, 2010; Suleiman et al., 2015). These studies indicated that LOS was longer for patients undergoing simultaneous BTKA, but consideration was not given to personal and comorbid characteristics. Conversely, decreased hospital LOS has been associated with improved perioperative pain control (Danninger, Opperer, & Memtsoudis, 2014) and in patients transferred to a transitional care setting (Memtsoudis et al., 2008).

Regarding disposition, two U.S. studies and one Canadian study noted that a larger proportion of patients undergoing simultaneous BTKA were transferred to transitional care than those undergoing UTKA (Bohm et al., 2016; Memtsoudis et al., 2008; Suleiman et al., 2015). This was not seen in India, where all patients, undergoing BTKA and UTKA, were discharged home (Shetty et al., 2010). Comparing studies internationally is especially challenging due to differences in healthcare reimbursement, postoperative guidelines, availability of caregiver support at home, and availability of long-term and rehabilitative care.

Significant gaps in the literature continue to exist regarding which patients are best candidates for simultaneous BTKA. Although it appears that patients undergoing any type of BTKA procedure may have more complications, longer LOS, and higher likelihood of discharge to long-term care, no studies were found that examined which patients undergoing simultaneous BTKA may have poorer outcomes.

Methods

Sample and Setting

This retrospective database study examined hospitalized patients who underwent a simultaneous BTKA at a fully integrated, Magnet-designated healthcare facility in the northwest United States. Surgeries occurred between 2011 and 2014. All patients undergoing a simultaneous BTKA during the time frame were enrolled in the study.

Procedures

Following institutional review board approval, a retrospective sample was identified through *Current Procedural Terminology* (*CPT*) billing codes. Pertinent research variables and demographics used to describe the sample were then downloaded from the electronic health record into Excel and imported into SPSS 22.0 and SAS 9.4 for analysis. Data were stored on the principal investigator's locked computer. Both LOS and discharge disposition were the outcome variables. Length of stay was calculated in days; discharge disposition was a secondary outcome dichotomized as discharged to home or an SNF.

Statistical Analysis

Descriptive statistics were used to describe the characteristics of the sample. Pearson's chi-square and Fisher's exact tests were used to evaluate differences among categorical variables. Independent-samples *t* tests and analysis of variance were used to evaluate differences among quantitative variables. Multiple linear and

logistic regressions were used to determine predictors of LOS and discharge disposition, respectively. Nine variables were evaluated in these models including three continuous (age, BMI, and total number of comorbidities) and seven categorical (gender, marital status, cardiopulmonary disease, diabetes, obesity, dementia, and operating room time) variables. Cardiac disease and COPD were combined to cardiopulmonary disease because only four patients had COPD. Sample size was set a priori according to Tabachinek and Fidell's protocol for regression analysis: 50 + 8 (number of covariates) = 50 + 8 (10) = 130 (Tabachnick & Fidell, 2013).

Results

Sample

The sample included 125 patients. Half were female; mean age was 64.8 years, and mean BMI was 32.9 m^2. Most patients were Caucasian (96%), and 74% were partnered or married. The mean total number of comorbidities was 1.4, with heart disease being the most common. The mean pain score postoperatively was 4.4 ± 1.5 on a 0–10 scale, with 0 being no pain and 10 being worst possible pain. A description of the sample is included in Table 1.

Hospital Utilization Descriptive Results

The average LOS was 4.2 days. One patient had a lengthy hospital stay of 30.2 days and was eliminated from the analysis; inclusion of this patient significantly influenced results. Important to note is that this patient was older, overweight, and had cardiopulmonary disease, dementia, and diabetes. This resulted in a sample size of 124 for this predictive model. Length of stay without the outlier was 4.02. Most patients (63%) returned home following surgery; the remaining went to an SNF for rehabilitation. Of the patients who went to an SNF, the majority were women (65%).

Regression Results

The multiple linear regression model indicated BMI ($p < .001$) and discharge to an SNF ($p = .025$) as the only significant predictors of increased LOS. Approximately 18% of variance in the model was attributed to these two factors (see Table 2). Patients going home had a mean LOS of 4.1 ($SD = 3.07$) days compared with those going to an SNF with a mean LOS of 4.4 ($SD = 2.23$) days ($p = .025$). Age, sex, race, marital status, total number of comorbidities, dementia, diabetes, heart disease or COPD, and time in the operating room were not significant.

Three variables predicted SNF disposition in the binary logistic regression model: age, sex, and cardiopulmonary disease. With each 1-year increase in age, patients were 8% (odds ratio [OR] = 1.08; $p = .012$) more likely to go to an SNF. Although not significant, women were 94% more likely to be discharged to an SNF (OR = 1.94; $p = .114$), which contributed to the overall model. Those with cardiopulmonary disease were 12 times more likely ($p = .018$) to go to an SNF. Of the 46 patients (36.8%) who went to an SNF, 45 (97.8%) had cardiopulmonary disease, which also explains the wide confidence interval. Approximately 21% of the variance for SNF disposition was explained by the three variables (see Table 3).

Table 1. Characteristics of Patients

Variable	All Patients ($N = 125$)
Demographics	
Age, mean ± *SD*, years	64.8 ± 8.5
Female, *n* (%)	63 (50.4)
Race, *n* (%)	
Caucasian	120 (96.0)
Native American/Alaskan Native	1 (0.8)
Asian	1 (0.8)
Mixed	2 (1.6)
Other	1 (0.8)
Marital status, *n* (%)	
Married	93 (74.4)
Divorced	6 (4.8)
Single	26 (20.8)
Clinical characteristics	
BMI, mean ± *SD*, kg/m^2	32.9 ± 6.6
Dementia, *n* (%)	12 (9.6)
Diabetes, *n* (%)	28 (22.4)
Heart disease or COPD, *n* (%)	100 (80.0)
Obesity, *n* (%)	76 (60.8)
Total comorbidities, mean ± *SD*, *n*	1.8 ± 0.8
Pain block, *n* (%)	113 (90.4)
Pain score, mean ± *SD*	4.4 (1.5)
Discharge location, *n* (%)	
Home	79 (63.2)
Skilled nursing facility	46 (36.8)
Time in the operating room, mean ± *SD*, hours	1.8 ± 0.3

Note. BMI = body mass index; COPD = chronic obstructive pulmonary disease.

Discussion

This study was the first to examine predictors of LOS and SNF discharge in patients undergoing simultaneous BTKA. Although a plethora of studies compare

Table 2. Predictors of Length of Stay

Effect	Estimated Parameter	Standard Error	*p*
Intercept	1.573	0.66	.018
BMI	0.085	0.02	<.001
Home vs. SNF	−0.582	0.26	.025

Note. BMI = body mass index; SNF = skilled nursing facility.

Table 3. Predictors of Skilled Nursing Facility

Effect	OR	95% CI	*p*
Age	1.08	[1.02, 1.14]	.012
Female sex	1.94	[0.85, 4.46]	.114
Heart disease or COPD	0.08	[0.01, 0.66]	.018

Note. CI = confidence interval; COPD = chronic obstructive pulmonary disease; OR = odds ratio.

UTKA with simultaneous BTKA (Bohm et al., 2016; Ekinci et al., 2014; Haddad, Khan, Mehta, Mbubaegbu, & Qamar, 2015; Halawi et al., 2015; Odum & Springer, 2014; Seol, Seon, & Song, 2016; Suleiman et al., 2015), no previous studies were found that focused on the simultaneous BTKA population alone. The mean LOS for simultaneous BTKA in this study of 4.01 days was essentially equal to Suleiman's et al. (2015) study (4.0 days) and lower than others of 5.1 (Shetty et al., 2010) and 5.8 days (Memtsoudis et al., 2008). The differences in LOS in more recent studies may be due to better anesthetic techniques, earlier mobilization, and better postoperative pain management over time. Two predictors were found to increase LOS in this study: BMI and discharge to an SNF. Although BMI was reported to be high in other studies examining BTKA (Ekinci et al., 2014; Halawi et al., 2015), no studies reported BMI as a predictor of LOS. Several studies in the literature found an increased LOS related to the number of comorbidities (Bohm et al., 2016; Ekinci et al., 2014; Halawi et al., 2015). Obesity was likely listed as one of the comorbidities in these studies but was not analyzed as an individual factor. It is helpful to identify which comorbidities pose the greatest risk, and this study sheds light on this issue.

Those who went to an SNF did have significantly longer hospital LOS than those who went home in this study ($p = .025$). It is possible that patients who went to an SNF needed more acute hospital care or lacked caregiver support at home. Lack of adequate assistance at home was found to increase LOS in one study (Halawi et al., 2015), and this may have been the reason for increased LOS with discharge to an SNF in this study as well. Unfortunately, with the retrospective design employed in this study, reason for SNF disposition was unknown.

This study was also the first to report predictors of discharge to an SNF. Understanding these factors may facilitate discharge planning and earlier discharge to the SNF, which could, in turn, decrease LOS and hospital costs. Older age, female sex, and cardiopulmonary disease predicted discharge to an SNF. It is not surprising that older age was a factor in that older patients reportedly have a higher complication rate with any type of TKA (Ekinci et al., 2014; Haddad et al., 2015) and may need more assistance with recovery. Although female sex predicted discharge to an SNF, this was not statistically significant ($p = .114$). This variable did contribute to the overall model, however, and the result that women are almost twice as likely to go to an SNF is worth discussion. This may be related to social factors in that men may not be as equipped in the caregiving role, so more women went to an SNF. Eighty percent of the entire sample had cardiopulmonary disease, and this was predictive of a discharge to an SNF. It is possible that these patients are not perfusing as well, lack stamina, and require longer rehabilitation.

Limitations

Several study limitations are noted. First, the sample size is small, and some cell sizes especially warrant caution with interpretation. For example, few patients had COPD or dementia and could not be tested in the predictive model. Chronic obstructive pulmonary disease was added to cardiac disease to adjust for this variable. Second, the study took place in a single setting, and surgeries were performed by two surgeons. Third, the sample was 96% Caucasian. These factors together may limit the generalizability of the findings.

Opportunities for Future Research

This study sheds light on studies for future research. First, interventions such as presurgical patient counseling and joint replacement classes could be measured for their impact on simultaneous BTKA outcomes. Discussion about need for an SNF could occur with the presurgical counseling, which could potentially affect decrease LOS.

Second, surgical and anesthetic techniques for TKA are dramatically changing. Multimodal preoperative medications, new placement of nerve blocks and intraoperative spinal blocks that limit anesthesia, and postoperative pain management protocols and early ambulation are some of the novel interventions being employed to improve patient outcomes. It will be important that future studies examine whether these novel techniques influence simultaneous BTKA outcomes.

Third, this body of research is challenged with a lack of long-term outcomes from simultaneous BTKA. Although we used LOS and SNF disposition in this study, long-term functional status and time to improved function would be better distal outcomes that could be compared with those undergoing UTKA and staged BTKA. Measuring distal outcomes between these surgeries can further guide recommendations regarding which surgery would be the most appropriate option for a particular patient.

Conclusions

Total knee arthroplasty is on the rise, and simultaneous BTKA is one surgical option when both knees require surgery. Knowing which patients may be at a greater risk for increased LOS could facilitate patient selection. This study suggests that patients with a high BMI should be carefully screened for simultaneous BTKA. It is possible that a staged BTKA may be more favorable for patients with a BMI over 30 kg/m^2. This study also suggests that older patients, women, and those with cardiopulmonary disease may benefit from early discharge planning and transition to an SNF. For any

patient considering simultaneous BTKA, orthopaedic nurses should educate patients about some of the rehabilitation challenges inherent with this surgery that include increased LOS and possible discharge to an SNF. Most important is that the patient makes an informed decision about which TKA elective surgical procedure to pursue.

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