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Bariatric Surgery Prior to Total Joint Arthroplasty May Not Provide Dramatic Improvements In Post Arthroplasty Surgical Outcomes

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Abstract

This study compared the total joint arthroplasty (TJA) surgical outcomes of patients who had bariatric surgery prior to TJA to TJA patients who were candidates but did not have bariatric surgery. Patients were retrospectively grouped into: Group 1 (n=69), those with bariatric surgery >2 years prior to TJA, Group 2 (n=102), those with surgery within 2 years of TJA, and Group 3 (n=11,032), those without bariatric surgery. In Group 1, 2.9% (95%CI 0.0–6.9%) had complications within 1 year compared to 5.9% (95%CI 1.3–10.4%) in Group 2, and 4.1% (95%CI 3.8–4.5%) in Group 3. 90-day readmission (7.2%, 95%CI 1.1–13.4%) and revision density (3.4/100 years of observation) was highest in Group 1. Bariatric surgery prior to TJA may not provide dramatic improvements in post-operative TJA surgical outcomes.

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Keywords

bariatric surgery; joint arthroplasty; obesity; revision; surgical site infection; complications

Introduction

Obesity (body mass index (BMI)≥30 kg/m^2) occurs in 34%[1] of the general population. Obesity is the second leading cause of death in this country,[2] the leading cause of overall health burden,[3] and also a risk factor and moderator in the development of other health conditions. An estimated 55% of patients undergoing total knee arthroplasty (TKA)[4] and 39% of patients undergoing total hip arthroplasty (THA)[5] in the United States are obese. Obesity is associated with higher complication rates (e.g. surgical site infection, dislocations, and readmissions)[6,7] in patients undergoing total joint arthroplasty (TJA).

Bariatric surgical procedures are an option for weight reduction in patients with BMI≥40 kg/m^2 or BMI≥35 kg/m^2 and certain co-morbidities.[8–10] Compared to standard weight loss approaches, bariatric procedures lead to significantly higher mean amounts of weight loss.[11] Due to the high prevalence of morbid obesity in TJA patients and recommendations by orthopedic providers for patients to lose weight prior to TJA, bariatric surgery has been considered an option for morbidly obese TJA candidates. However, the relationship between bariatric procedures and TJA has not been thoroughly examined. Three small descriptive studies have evaluated surgically induced weight loss in TJA patients. All studies reported higher incidence of TJA peri-operative complications despite patients' weight loss.[12–14] No studies, to our knowledge, have evaluated whether bariatric surgery prior to TJA is associated with a different incidence of post-operative complications in comparison to a similar group of patients - those who are morbidly obese TJA patients but have not had bariatric surgery.

The purpose of this study was to compare TJA outcomes (surgical site infections (SSI), thromboembolic events, readmissions, early TJA revision, and mortality) of patients who had bariatric surgery prior to TJA patients to those of patients who were candidates for bariatric surgery at the time of their TJA but did not have bariatric surgery.

Methods

Study Design and Sample

A retrospective cohort study was conducted. Inclusion criteria consisted of patients who underwent a primary unilateral TJA for osteoarthritis between 01/01/2005 and 12/31/2011, were 18 years old or over, and had their TJA procedure(s) in 36 hospitals in the two largest geographical regions (Southern and Northern California) of an United States integrated healthcare system.[15] Patients who had multiple procedures within one year of each other were excluded. Only the first operation of patients with multiple procedures (outside the one year window) was included in the sample (N=64,854). After these initial selection criteria, the bariatric surgery history of patients was obtained. A patient was included in the study if she/he: (1) had a bariatric surgery procedure prior to TJA (N=171) or (2) would be

considered a candidate for bariatric surgery, using as criteria a BMI≥40 kg/m^2 or a BMI≥35 kg/m^2 and one other co-morbidity (i.e. diabetes, hypertension, liver disease, and chronic lung disease) in addition to osteoarthritis (N=11,032).[8]

Data Sources

An integrated healthcare system's Total Joint Replacement Registry (TJRR) was used to identify the study cohort of patients with total knee or hip arthroplasty.[16,17] The institutional electronic medical record (EMR) was used to identify the history of bariatric surgery. Detailed information on TJRR coverage, data collection procedures, and quality assurance has been previously published.[15–18] The EMR is composed of several modules and surgical procedures are typically extracted from its operative and inpatient modules. Using International Classifications of Disease, 9th revision, (ICD9) procedure codes for bariatric surgery (44.31, 44.38, 44.39, 44.68, 44.95, 44.96, 44.97, 44.98, 44.5, 44.99,44.69, 43.89, 45.50, 45.51, 45.90, 45.91, 43.7, 43.5, 43.6, 44.93, 44.99) in conjunction with ICD9 diagnoses codes for obesity (278.0, 278.00, 278.01, 278.02, V85.35, V85.37, V85.38,V85.39, V85.4, V77.8) we identified patients who underwent surgery for obesity. Patients who had an ICD9 diagnostic code for cancer (150.0–159.9, 230.1–230.9) were excluded.[19,20]

Exposure of Interest

Bariatric surgery was the exposure of interest. Patients were grouped into (1) those that had the surgery >2 years prior to their TJA, (2) those who had the surgery within 2 years prior to TJA, and (3) those who did not have bariatric surgery but could be considered candidates. Two years was used as the cut off to stratify the patients who underwent bariatric surgery because maximum weight loss and stabilization is typically achieved two years after surgery.[21]

Outcomes of Interest

Outcomes evaluated included: SSI (deep (1 year) and superficial (30 days))[22], deep vein thrombosis (90 days),[23] pulmonary embolism (90 days),[23] revision (all cause, septic (ever)), revision density (all cause (ever)), and mortality (30 days, 90 days) after TJA surgery. Composite complication indexes (inclusive of SSI, thromboembolic events, revision, and mortality) of surgical outcomes (occurring within 30 days, 90 days, and 1 year) were also evaluated. Inpatient readmissions (30 days and 90 days) were evaluated for a subset of the sample (years 2009–2011).

Covariates

Patient characteristics (gender, age, race), procedure type (hip or knee arthroplasty), general health status as defined by the American Society of Anesthesiologist (ASA) score,[24] BMI at TJA, and co-morbidity profile at TJA as defined by the Elixhauser co-morbidity algorithm,[25] were obtained from the TJRR.

Statistical Analysis

Given the small sample size of Group 1 and 2, we only report descriptive statistics. Means and standard deviations were calculated for continuous variables and frequencies and proportions were used to describe categorical variables. The cumulative incidence of outcomes evaluated was calculated as the number of events over the number of cases, confidence intervals were calculated. Revision /100 person years of observation (revision density) was calculated as the number of revision procedures divided by the entire follow up time for the group. Revision/100 person years was also calculated by bariatric surgery group and then stratified by age group. Between 3% (patients who did not have bariatric surgery and those with bariatric surgery >2 years prior to TJA) and 7% (bariatric surgery within 2 years) of patients did not have complete one year follow up. These patients contributed information for the time they had complete information (mean 122 days).

Results

11,032 TJA patients fit the criteria for bariatric surgery but had not undergone the procedure, 69 patients that had bariatric surgery >2 years prior to TJA and 102 had it within 2 years of TJA. There was a higher proportion of females and younger patients who had bariatric surgery (in both groups) compared to those without surgery. There was a higher proportion of TKA as opposed to THA patients in the group who had their bariatric surgery >2 years before TJA (89.9%) than in groups with TJA within 2 years (70.6%) of bariatric or those who were candidates for bariatric surgery (76.3%). Both groups of patients with bariatric surgery (33.3% bariatric within 2 years and 37.3% bariatric >2 years) had a lower prevalence of ever having had diabetes compared to patients who did not have bariatric surgery (47.2%) (Table 1). At the time of TJA, patients with bariatric surgery had a better general health status (ASA 1 and 2, 55.1% in bariatric within 2 years vs. 68.6% in bariatric >2 years) than in those with no bariatric surgery (39.1%). Length of stay of stay was similar between groups, ranging from 2.7 days (SD=0.8) in patients with bariatric surgery >2 years prior to TJA to 3.0 days (SD=1.5) in patients without bariatric surgery. The distributions of co-morbidities prevalence in the study groups at the time of TJA can be seen in Table 2.

In patients who had bariatric surgery >2 years since TJA, 2.9% had complications within 1 year post-operative compared to 5.9% in patients with bariatric surgery within 2 years of TJA and 4.1% in the patients who did not have bariatric surgery. Readmissions within 90 days was highest in patients with bariatric surgery >2 years since surgery (7.2%), followed by patients with no bariatric surgery (5.9%), and then patients who had bariatric surgery within 2 years of TJA (2.5%). No deep vein thrombosis, pulmonary embolisms, or deaths within 90 days post-operative occurred in patients with bariatric surgery. In patients with bariatric surgery (>2 years 1.5% vs. within 2 years 1.0%) the incidence of deep infection was similar to the cases with no bariatric surgery (1.2%) (Table 3).

Patients who had bariatric surgery >2 years before TJA had a revision density of 3.4/100 years of observation, which was higher than in patients with bariatric surgery within 2 years of TJA (2.7/100 years of observation) and those without bariatric surgery (1.0/100 years of observation). When evaluating revision density by age (Table 4), both groups of patients with bariatric surgery had higher revision densities in the 50–59 year old groups than

patients without bariatric surgery. In the 40–49 and 60–69 years old groups those with bariatric surgery within 2 years of TJA (5.4/100 years of observation and 1.4/100 years of observation, respectively) also had a higher revision density than those without surgery (2.0/100 years of observation and 0.9/100 years of observation, respectively).

Discussion

In a cohort of patients with bariatric surgery prior to TJA we found a low incidence of post-operative TJA complications. The incidence of complications was comparable between patients with bariatric surgery prior to TJA and those who were candidate for bariatric surgery but did not undergo the procedure. A higher readmission rate was observed in patients who had bariatric surgery >2 years prior to TJA surgery than in the other groups and higher revision density was observed in patients with bariatric surgery (both groups) than in patients without bariatric surgery.

Three previous studies evaluated patients who underwent bariatric surgery prior to TJA. The first study evaluated a series of 14 American patients with 20 TJAs.[13] While patients were reported to gain pain relief and had functional improvement they also reported a number of peri-operative complications (two DVTs, two superficial SSIs, and one renal failure episode) and one revision (at five years). This study had a small number of cases but the proportion of events in these patients was higher than those we observed in our study, with the exception of revisions. These differences could be due to the small sample size, resulting in complications due to chance error and other possible differences between the sample characteristics. The second study evaluated a cohort of 90 English patients who underwent bariatric surgery at least six months prior to TJA.[12] Kulkarni et al. reported one death, one DVT, one medical complication, one infection, one 30-day readmission and one revision in their cohort of patients. These are similar to rates in our cohort, except for the revision rate, which again was higher in our patients. This could be due to their shorter follow up time (one year), although most of our revisions occurred within one year. Finally, in the latest study by Severson et al., of 86 American patients with bariatric procedure prior to TKA (knees only), the reported incidence of 90-day complications was found to be different from those with bariatric surgery within 2 years of their TKA (4%) or those with surgery >2 years since the procedure (16%).[14] This study included more complications in their composite index than in ours, which could explain the higher rates. Severson et al., like us, reported a higher incidence of revision (8%) in patients who had bariatric surgery more than 2 years prior to TJA.

A higher revision density was observed in patients with bariatric surgery (both groups) than in the bariatric surgery candidate group. Because patients undergoing bariatric surgery are younger than the general TJA population, and younger age is a major risk factor for revision after TJA surgery,[26,27] we stratified the groups by ten years age categories and found this higher revision density continued to be observed even in younger groups. This could be due to several factors. These patients could be more willing to undergo revision procedures, or if mobility improved joints could be suffering a higher risk of wear and subsequently revision TJA, or these patients may suffer from metabolic bone disease (possible after bariatric surgery).[8] An unintended consequence of some bariatric procedures is the possible

malabsorption of Calcium and changes to patients' endocrine system during the weight loss period, which could impact the bone mineral density.[28–30] While we could not determine the reasons for this, we hope to revisit this when more cases and longer follow up are available.

Unlike the three previous studies on this topic, which compared the outcomes of patients with bariatric surgery prior to TJA to those who either (1) had their bariatric surgery after TJA or (2) were from a general TJA sample, we chose a group of patients who according to general criteria[8] were considered candidates for bariatric surgery at the time of TJA. We thereby attempted to evaluate whether bariatric surgery had improved the patients' well being enough that better results were observed than if they had continued with the same weight and co-morbidity profile they had at the time of bariatric surgery. At the time of TJA, those who underwent bariatric surgery had better general health status, lower BMI, and had lower prevalence of certain co-morbidities (i.e. diabetes[31–33], hypertension,[34,35] and renal failure[36,37]), all factors that influence the outcomes of post-operative TJA complications. However, because of the low number of events observed, we did not find differences between bariatric patients and who were candidates but did not have bariatric surgery. If selection bias existed when determining who had bariatric surgery, one would expect that "healthier" patients were selected for bariatric surgery and then allowed to undergo TJA within a period of time thereafter. If this was true, the joint arthroplasty outcomes of these patients would also be expected to be better than the control group, but as shown they were not. Conversely, one could argue that the compound effect of the surgeries and higher prevalence of certain co-morbidities that likely resulted from the bariatric procedure (e.g. deficiency anemia,[28] psychoses, and depression[38]) would actually cause more post-operative complications. If this was the case, one would expect a higher number of complications in the patients with multiple procedures, but we did not see this in our study sample.

Our study is a retrospective and suffers from the limitations of observational studies. One study limitation is possible selection bias in the control group. In order to identify a comparable group, we included only patients with a BMI over 40 kg/m2 or with both a BMI ≥35 kg/m2 and more than one co-morbidity (typically severe OA would make them already a candidate for bariatric surgery), which fits the criteria for bariatric surgery but does not capture other decisions that are involved in whether a patient is a true candidate (which are ultimately the patient and surgeon's decision). However, we believe that our control group was generally in worse overall health condition than our bariatric surgery group at the time of TJA and was therefore expected to have higher complications than our bariatric surgery groups, which is not what we observed. Because our sample size is small, we did not conduct any hypothesis testing and instead focused on describing the clinical differences between the groups. Our inability to evaluate confounders and effect modifiers in this complex sample led us to focus on a descriptive analysis of what we deemed to be clinically important differences in the groups evaluated. Our analyses are not adjusted for any of the covariates collated. It is possible our study suffered from healthcare access bias. The sample is part of a captured population that has access to comprehensive services provided by the institution. The patients included in this study had several co-morbidities and are likely regularly monitored by their providers and therefore were more likely to have their conditions controlled than patients without this access. Well controlled co-morbidities could explain the few post-operative complications observed when compared to other studies. The

extent of our lost to follow up is also a limitation of this study. However, the lost to follow up was similar between the groups and of all cases without complete one year follow up; on average at least 122 days of follow up was captured (assuring that most would have their 30 and 90 days complications reported). We were also not able to evaluate patients that underwent TKA and THA procedures separately due to our sample size. We recognize these patients are generally different groups, with different co-morbidity profiles and risk factors associated with the procedures outcomes. Again, we hope to address this in future analysis when a larger sample sizes are available. Finally, we cannot comment on the surgical outcomes of the bariatric procedures as these data were not available for our study.

Our study's strengths include the high sensitivity of our outcomes searches and high internal validity of our measurements. All encounters (e.g. outpatient, urgent care, emergency care) a patient had in the integrated healthcare system, used as the sampling frame for this study, were accessible for investigation of complications. Typically only inpatient encounters are evaluated and reported in studies. Additionally, after initial screening of encounters for complications, SSI, revision, and thromboembolic events were adjudicated via chart review, using predetermined criteria, reducing the chances of misclassification. Another strength of our study was the captive nature of the integrated healthcare system used for data collection. All care provided to the patients included in this study was obtained at facilities within the institution, which reduced the possibility of anyone obtaining services outside the system and not being captured as well as the likelihood of misclassifying someone as having these procedures.

In a cohort of 171 patients with bariatric surgery prior to TJA we found the rate of post-operative complications was similar to those in patients who were candidates for bariatric surgery at the time of TJA but did not have the surgery but the revision density of patients after surgery was higher in the patients with bariatric surgery, even after stratification for age. This suggests that bariatric surgery prior to TJA may not provide a dramatic improvement in post-operative TJA surgical outcomes as may be expected.

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Table 1

Study Sample Characteristics by Bariatric Surgery Status, 2005–2011

		Group 1 Bariatric Surgery >2 Yrs Prior to TJA (N=69)	Group 2 Bariatric Surgery w/in 2 Yrs of TJA (N=102)	Group 3 No Bariatric Surgery (BMI≥40 or BMI≥35 and Osteoarthritis +1 co-morbidity) (N=11032)
		N (%)	N (%)	N (%)
Procedure	THA	7 (10.1)	30 (29.4)	2616 (23.7)
	TKA	62 (89.9)	72 (70.6)	8416 (76.3)
Gender	Female	52 (75.4)	80 (78.4)	7496 (68.0)
	Male	17 (24.6)	22 (21.6)	3536 (32.1)
Age category, years	<65	49 (71.0)	93 (91.2)	5918 (53.6)
	≥65	20 (29.0)	9 (8.8)	5114 (46.4)
Race	Asian	3 (4.4)	4 (3.9)	238 (2.2)
	Black	7 (10.1)	13 (12.8)	1570 (14.2)
	Hispanic	14 (20.3)	12 (11.8)	1753 (15.9)
	Other/Multi	2 (2.9)	0 (0.0)	170 (1.5)
	Unknown	0 (0.0)	0 (0.0)	108 (1.0)
	White	43 (62.3)	73 (71.6)	7193 (65.2)
Diabetes (ever)		23 (33.3)	38 (37.3)	5231 (47.4)
ASA category at TJA	1&2	38 (55.1)	70 (68.6)	4315 (39.1)
	≥3	31 (44.9)	32 (31.4)	6598 (59.8)
	Unknown	0 (0.0)	0 (0.0)	119 (1.1)
Length of Stay, days (mean, SD)		2.7 (0.8)	2.9 (0.8)	3.0 (1.4)
Age, years (mean, SD)		59.9 (7.8)	57.0 (6.8)	63.8 (8.7)
BMI, kg/m^2 at TJA (mean, SD)		34.6 (6.2)	32.4 (4.7)	40.0 (4.4)
Follow up after TJA, days (mean, SD)		320 (259)	691 (457)	1076 (717)

BMI=Body mass index. TJA=Total joint arthroplasty. THA=Total hip arthroplasty. TKA=Total knee arthroplasty. SD=Standard deviation.

Table 2

Study Sample Co-morbidity Profile at Total Joint Arthroplasty by Bariatric Surgery Status, 2005–2011

	Group 1 Bariatric Surgery >2 Yrs Prior to TJA (N=69)	Group 2 Bariatric Surgery w/in 2 Yrs of TJA (N=102)	Group 3 No Bariatric Surgery (BMI≥40 or BMI≥35 and Osteoarthritis +1 Co-morbidity) (N=11032)
	N (%)	N (%)	N (%)
At least 1 Co-morbidity	64 (92.8)	94 (92.2)	8963 (81.3)
Missing Co-morbidity	3 (4.4)	2 (2.0)	1910 (17.3)
Co-morbidities			
Hypertension	45 (70.3)	63 (67.0)	7821 (87.7)
Chronic pulmonary disease	24 (37.5)	22 (23.4)	2201 (24.6)
Hypothyroidism	12 (18.8)	21 (22.3)	1371 (15.3)
Deficiency anemias	13 (20.3)	22 (23.4)	1088 (12.1)
Renal failure	3 (4.7)	2 (2.1)	860 (9.6)
Depression	10 (15.6)	15 (16.0)	857 (9.6)
Psychoses	14 (21.9)	7 (7.4)	582 (6.5)
Fluid and electrolyte disorders	2 (3.1)	3 (3.2)	520 (5.8)
Congestive heart failure	4 (6.3)	1 (1.1)	458 (5.1)
Peripheral vascular disease	0 (0.0)	3 (3.2)	360 (4.0)
Valvular disease	2 (3.1)	5 (5.3)	256 (2.9)
Liver disease	1 (1.6)	4 (4.3)	246 (2.7)
Other neurological disorders	1 (1.6)	0 (0.0)	243 (2.7)
Coagulopathy	3 (4.7)	2 (2.1)	145 (1.6)
Chronic blood loss anemia	4 (6.3)	2 (2.1)	122 (1.4)
Alcohol abuse	2 (3.1)	2 (2.1)	114 (1.3)
Pulmonary circulation disease	0 (0.0)	0 (0.0)	103 (1.1)
Drug abuse	1 (1.6)	2 (2.1)	75 (0.8)
Solid tumor w/out metastasis	0 (0.0)	0 (0.0)	67 (0.7)
Paralysis	0 (0.0)	0 (0.0)	46 (0.5)
Lymphoma	0 (0.0)	0 (0.0)	33 (0.4)
Weight loss	1 (1.6)	0 (0.0)	32 (0.4)
Metastatic cancer	0 (0.0)	0 (0.0)	18 (0.2)
Acquired immune deficiency syndrome	0 (0.0)	0 (0.0)	2 (0.0)
Peptic ulcer disease bleeding	0 (0.0)	0 (0.0)	1 (0.0)

BMI=Body mass index. TJA=Total joint arthroplasty.

Table 3

Cumulative Incidence of Total Joint Arthroplasty Post-operative Outcomes by Bariatric Surgery Status, 2005–2011

	Group 1 Bariatric Surgery >2 Yrs Prior to TJA (N=69)	Group 2 Bariatric Surgery w/in 2 Yrs of TJA (N=102)	Group 3 No Bariatric Surgery (BMI≥40 or BMI≥35 and Osteoarthritis +1 co-morbidity) (N=11032)
	N, % (95%CI)	**N, % (95%CI)**	**N [% (95%CI)]**
Surgical Outcomes			
Surgical site infection (deep)	1 [1.5 (0.0–4.3)]	1 [1.0 (0.0–2.9)]	127 [1.2 (1.0–1.4)]
Surgical site infection (superficial)	0.0	2 [2.0 (0.0–4.7)]	42 [0.4 (0.3–0.5)]
Death within 30 days	0.0	0.0	19 [0.2 (0.1–0.2)]
Death within 90 days	0.0	0.0	34 [0.3 (0.2–0.4)]
Pulmonary embolism	0.0	0.0	65[0.6 (0.4–0.7)]
Deep vein thrombosis	0.0	0.0	61[0.6 (0.4–0.7)]
Revision (all-cause)	2 [2.9 (0.0–6.9)]	5[4.9 (0.7–9.1)]	313[2.8 (2.5–3.1)]
Revision (septic)	0.0	1[1.0 (0–2.9)]	138[1.3 (1.0–1.5)]
Composite Index of Surgical Outcomes			
Complication[1] (any) within 30 days	1 [1.5 (0.0–4.3)]	2 [2.0 (0.0–4.7)]	219[2.0 (1.7–2.2)]
Complication[1] (any) within 90 days	1 [1.5 (0.0–4.3)]	2 [2.0 (0.0–4.7)]	300[2.7 (2.4–3.0)]
Complication[1] (any) within 1 year	2 [2.9 (0.0–6.9)]	6 [5.9 (1.3–10.4)]	457[4.1 (3.8–4.5)]
Readmissions (Sample 2009–2011)			
Total limited N (%)	69 (100.0)	79 (100.0)	5537 (100.0)
Readmission within 30 days	2 [2.9 (0.0–6.9)]	0.0	208 [3.8 (3.3–4.3)]
Readmission within 90 days	5 [7.2 (1.1–13.4)]	2 [2.5 (0.0–6.0)]	325 [5.9 (5.3–6.5)]

BMI=Body mass index. TJA=Total joint arthroplasty.CI=Confidence Interval.

[1]Complication= death, surgical site infection (deep or superficial), pulmonary embolism, deep vein thrombosis or revision.

Table 4

Revision Density, Overall and by Age Group of Patients by Bariatric Surgery Status, 2005–2011

Age	Bariatric Surgery Group	Total N	Revised N	Total Years of Observation	Revision Density (revisions/100 observation years)
Total	None	11032	313	31109	1.0
	>2 years prior to TJA	69	2	59	3.4
	W/in 2 years of TJA	102	5	186	2.7
≤39	None	28	1	65	1.5
	>2 years prior to TJA	0	0	0	0.0
	W/in 2 years of TJA	1	0	0	0.0
40–49	None	511	28	1414	2.0
	>2 years prior to TJA	4	0	7	0.0
	W/in 2 years of TJA	17	2	37	5.4
50–59	None	2903	87	8159	1.1
	>2 years prior to TJA	33	2	23	8.6
	W/in 2 years of TJA	42	2	75	2.7
60–69	None	4713	124	13368	0.9
	>2 years prior to TJA	24	0	23	0.0
	W/in 2 years of TJA	40	1	72	1.4
70–79	None	2525	66	7109	0.9
	>2 years prior to TJA	7	0	5	0.0
	W/in 2 years of TJA	2	0	3	0.0
≥80	None	352	7	994	0.7
	>2 years prior to TJA	1	0	1	0.0
	W/in 2 years of TJA	0	0	0	0.0

TJA=Total joint arthroplasty.