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Rheumatoid Arthritis Does Not Increase Risk of Short Term Adverse Events After Total Knee Arthroplasty: A Retrospective Case Control Study

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Abstract

Objective—RA patients report more adverse events (AEs) after Total Knee Arthroplasty (TKA) than patients with osteoarthritis (OA). This study evaluates 6-month post-operative AEs in a high volume center in a contemporary RA cohort compared to OA.

Methods—Patients with RA in an institutional registry (2007–2010) were matched 2:1 to OA by age, gender, and procedure. AEs were identified by self-report and chart review. RA specific surgical volume was determined. Baseline characteristics and adverse events were compared.

Results—There were 159 RA TKA and 318 OA. 20% of RA were on corticosteroids, 41.5% on biologics, and 67% on non-biologic DMARDs. There was no difference in comorbidities. RA specific surgical volume was high; 64% of cases were performed by surgeons with ≥ 20 RA cases during the study period. RA had worse baseline pain and function and health status (EQ-5D 0.59

vs. 0.65; $p < 0.01$). There were no deep infections in either group and no difference in superficial infection (9.4% RA vs. 10.1%; $p = 0.82$), myocardial infarction (0.7% RA vs. 0%; $p = 0.33$), or thromboembolism (1.3% RA vs. 0.6%; $p = 0.60$). Return to the operating room was more common in OA due to manipulations. OA were more likely to have adverse events at 6 months (OR 3.34, 95% CI 1.24–9.01; $p = 0.02$).

Conclusion—In a high volume center, with high RA specific experience, RA does not increase post-operative adverse events, despite worse pre-operative function and high steroid and DMARD use. Further study to determine generalizability is needed.

Key Indexing Terms

Osteoarthritis; Disease modifying antirheumatic drugs; knee; rheumatoid arthritis; surgery

Introduction

The role of orthopedic surgery in the management of patients with rheumatoid arthritis (RA) is well established.; 30–58% of RA patients undergo orthopedic procedures during the course of their illness (1, 2), and the most common joint replaced is the knee (57%) (3). Moreover, despite the widespread use of potent disease modifying anti-rheumatic drugs (DMARDs) and biologic DMARDs such as tumor necrosis α inhibitors (TNFi), as well as improved health status in RA patients (4, 5), rates of total knee arthroplasty (TKA) in patients with RA are increasing (6, 7). While improved overall health status might improve the outcomes of TKA, the impact of potent DMARDs and biologics on the complication rates of patients with RA undergoing TKA remains unclear (8–12),

RA patients have been reported to have a higher risk of post-operative adverse events after TJA (13). An increased risk of infection has been consistently described for RA patients undergoing both hip and knee arthroplasty (14–16) and confirmed in a recent meta-analysis utilizing a large administrative database (17). Increased thromboembolic events have also been described within the general RA population, although the literature is inconsistent with specific regard to post-operative risk (18–22). Although recent studies utilizing large data bases demonstrate that risk of re-admission for infection for RA patients after arthroplasty continues to increase, high volume centers have fewer adverse events, and surgical experience specifically with RA decreases the risk of post-operative complications (23–25).

The purpose of this study was to evaluate short term adverse events after TKA in patients with RA compared to those with osteoarthritis (OA) to assess if RA remains a risk factor for increased adverse events in a contemporary RA cohort, in a high volume orthopedic hospital with high RA specific volume.

Materials and Methods

This is a retrospective case control study of patients enrolled in a single high volume institutional TKA registry between May 1, 2007 and December 31, 2010. Patients provide demographic self-reported data including the Western Ontario and MacMaster University Osteoarthritis index (WOMAC) (26), SF-36 (27), and EQ-5D (28). The Charlson-Deyo

comorbidity index was calculated excluding diagnosis of RA. RA was identified by self-report and ICD-9 code 714.0, and the diagnosis was confirmed by chart review. Rheumatoid arthritis was confirmed if it was diagnosed by a rheumatologist, or if it was diagnosed by an internist and the patient was on a DMARD or biologic. Osteoarthritis (OA) controls were taken from the same registry after excluding those without six month self-reported data and those with another ICD-9 coded autoimmune disease or fracture. Two controls were matched to each RA case based on age $\pm$ five years, gender, as well as type of TKA procedure (primary versus revision surgery). Simultaneous bilateral TKAs were included and counted as a single procedure. In the event that a patient had a staged bilateral TKA (contralateral TKA within six months) and both surgeries were recorded in the registry, only the first procedure was included in the analysis. Only subjects who had hospital charts, office charts, and 6 month self-reported event data were eligible for this analysis. Any patient with an ICD-9 code for fracture was excluded. RA specific surgical volume was ascertained for the surgeons contributing cases to the study, and the association of complications with RA specific volume was analyzed.

Major medical adverse events included pulmonary embolus (PE), deep vein thrombosis (DVT; defined by positive ultrasound if in the hospital chart, phone call validation if self-reported, or physician reported if in the office chart), deep surgical site infection, a major bleeding event (requiring blood transfusion), pneumonia, stroke, myocardial infarction, fracture, dislocation, reoperation, and death. Major surgical adverse events included surgical manipulation, revision, or re-operation. Minor adverse events included minor bleeding, superficial infection, ecchymosis, transient neuropathy, incision site drainage, poor wound healing, erythema, and atelectasis.

Data Collection

Adverse events were identified by review of office and hospital charts and by self-reported answers to a questionnaire six months after surgery. The in-patient hospital chart was reviewed for events occurring prior to discharge. The outpatient orthopedic surgeon chart was reviewed for additional adverse events recorded within six months. Of the self-reported adverse events from the six month questionnaire, only those that were validated by chart review or phone call were included. Baseline characteristics of RA and OA patients were collected pre-operatively, including WOMAC Pain and Function scores, SF-36 Physical (PCS) and Mental (MCS) components, Euroqol (EQ-5D), Lower Extremity Activity Scale (LEAS), American Society of Anesthesiologists (ASA) class (29), and Charlson-Deyo Index comorbidities. The WOMAC is a validated knee-specific patient reported outcome (PRO) measure used to assess pain, stiffness, and function, with higher scores indicating better outcomes (26). The SF-36 is a validated instrument used to assess perceived health related mental and physical limits (27). The EQ-5D scale is a patient reported outcome measure used to assess the value patients place on their health status on a 1–100 scale with higher numbers indicating better health. The EQ-5D score indicates a state of perfect health (1), or death (0) (28). The LEAS is a validated scale comprised of 12 questions and correlates well with measures such as WOMAC pain and function scores. Scores ranged from 1 (bedbound) to 18 (up and about at will and participating in vigorous sports) (30). Osteoporosis was

identified by ICD-9 coding. Medications were recorded in RA cases by chart review and self-report.

This study was approved by the hospital's Institutional Review Board.

Statistical Analysis

Descriptive statistics were performed on matching variables, patient baseline characteristics, baseline function outcomes, and surgery related outcomes. Means and standard deviations were calculated for continuous variables and frequency distributions for categorical variables. Continuous variables were compared between RA cases and OA controls using Student t-test, whereas categorical variables were compared using Pearson's Chi-square or Fisher's exact test as appropriate. The results of short term adverse events from hospital charts, office charts and patient self-reports were summarized using frequencies. Pearson's Chi-square or Fisher's exact test was used to assess the differences between RA cases and OA controls. Multiple logistic regressions were performed to assess the differences between RA cases and OA controls and to identify variables independently associated with short term adverse events. The multiple logistic regression included variables found to be significant in the univariate analysis (p -value < 0.05). All tests were two-sided with significance level of 0.05, and all analyses were conducted using SAS for Windows 9.2 (SAS Institute Inc., Cary, NC, USA).

Results

Of 728 potential RA cases identified by ICD-9 or self-report, 252 cases were validated as RA (34.6%). Of these eligible cases, 181 (70.2%) had self-reported data at six months. 159 of these also had available hospital charts and office charts (63.1%) and were included in this study. There were no significant differences in age (61.1 $\pm$ 11.6 vs. 63.5 $\pm$ 11.7; p -value = 0.11), gender (86% female vs. 88% female; p -value = 0.64), or pre-operative pain or function (WOMAC Pain 43.9 $\pm$ 17.5 vs. 47.2 $\pm$ 18.9; p -value = 0.26; WOMAC Function 42.5 $\pm$ 19.7 vs. 43.8 $\pm$ 19.6; p -value = 0.68) between the 93 validated RA cases excluded from the study due to missing data and RA cases included. However, excluded cases reported worse pre-operative stiffness (WOMAC stiffness 33.12 $\pm$ 22.4 vs. 41.0 $\pm$ 23.7; p -value = 0.03), had worse ASA status (43% class 3 vs. 27.9%; p -value = 0.01), and were less likely to be Caucasian (66% vs. 83.7%; p -value = 0.003). Because of these differences, adverse events during the hospital admission and medication use were determined for the excluded patients. There was no significant difference in the number of adverse events between groups. Of the apparent 93 excluded cases, 7 were duplicates, leaving 86 cases. Hospital charts were available for review for 62 of the excluded cases and there was no difference in the in-hospital adverse events compared to those in the included cases. For serious adverse events, there was one case of pneumonia and one case of atrial fibrillation in the excluded cases. For minor adverse events, there was one urinary tract infection, one superficial surgical site infection, and one corneal abrasion, differences which were not significant between groups. We additionally determined the medications used by the excluded cases. Fewer excluded cases were on TNFis: 19 (30%) of the excluded were on TNFis vs. 66 (41%) of the included cases, but this was not statistically significant (p -value=

0.17). Methotrexate use was equivalent between groups: 73 (45.9%) of included vs. 27 (45%) of excluded. The difference in nonbiologic DMARD use was not statistically significant: 107(67.3%) of included cases vs. 33 (53%), p-value =0.06. Corticosteroid use in combination was significantly different between groups; more excluded cases were receiving therapy with corticosteroids: excluded 31(50%) vs. included 39 (24.5%), p-value=0.0004.

One RA patient had a TKA within six months after the first, and only the first surgery was included. RA specific surgical volume was determined for the 34 individual surgeons contributing cases to the study. 22/159 (14%) of cases were performed by surgeons who operated on 50 RA cases during the course of the study. 30% (48/159) of cases were performed by surgeons with 40 RA cases, and 64% (102/159) cases were performed by surgeons who had operated on 20 RA cases during the study period. Adverse events were equally distributed.

Of potential OA controls, 89.0 % had self-reported data at six months and accessible office and hospital charts. There were no statistically significant differences between the included OA and the excluded OA cohort in all demographics, including age, gender, pre-operative pain, function and stiffness, type of surgery, ASA status, or race. None of the OA controls had a contralateral TKA within six months.

Mean age of the RA cases was 63 years (range 22–93), 88% were female, and 83% were primary TKAs, (See Table 1). RA patients had significantly lower body mass index (BMI 28.2 vs. 30.2; p-value < 0.001) and were less likely to be Caucasian (83.7% vs. 88.4%; p-value = 0.042). RA patients had no more Charlson-Deyo comorbidities than OA patients (p-value < 0.64) and ASA class was no different between RA and OA (p-value = 0.28). RA patients were significantly more likely to have osteoporosis (29.6% vs. 12.0%; p-value < 0.001).

41.5% of RA patients were on TNFi, of which 60.6% were on etanercept, 19.7% were on adalimumab, 18.2% were on infliximab, and 1.5% were on golimumab. 45.9% of RA patients were on methotrexate, 67.3% were on one or more non-biologic DMARD, and 4.4% were on a non-TNFi biologic (either alone or in combination with other medications). 24.5% were on corticosteroids, and 20.1% received supraphysiologic “stress dose” steroids after surgery, which in our institution is given as 100 mg of hydrocortisone intravenously in the operating room with the dose repeated 8 hours later and tapered to the baseline dose within 36 hours. There was no consistency in the interval between stopping TNFi and surgery. 14.5% of RA patients were not on any TNFi, DMARD, biologic, or steroid medication (see Table 2).

Pre-operative WOMAC pain and function were statistically significantly worse for RA than OA patients (47.1 vs. 53.7; p-value < 0.001 and 43.8 vs. 54.2; p-value < 0.001). However, the difference was not clinically meaningful for pain (31, 32). RA patients had worse health status on the EQ-5D (0.59 vs. 0.65; p-value = 0.006), and also lower SF-36 PCS (29.3 vs. 33.3; p-value < 0.001). Similarly, RA patients had significantly lower median scores on the LEAS (8 vs. 9; p-value < 0.001). Operative time (144 minutes RA vs. 146 minutes OA; p-

value = 0.66) and post-operative stay (5 days with interquartile range 5–6 RA vs. 5 days with interquartile range 4–6 OA; p-value = 0.09) were not different between both groups, (see Table 1).

The data collected from the hospital charts (Supplemental Table 1) revealed no significant differences in major adverse events prior to discharge. Differences in pneumonia (0.6% vs. 0.3%; p-value = 0.56), DVT (0.6% vs. 0.9%; p-value = 0.80), and PE (0.0% vs. 0.3%; p-value = 0.99) were all non-significant. Neither group had any fractures, deep surgical site infections, or deaths prior to discharge. For minor adverse events, ecchymoses were encountered more frequently in RA patients (4.4% vs. 1.3%; p-value = 0.036)..

Data collected from outpatient charts show that OA patients had significantly higher rates of major surgical adverse events, (1.9% vs. 8.8%; p-value = 0.02), due mostly to manipulations (1.3% vs. 7.2%; p-value = 0.006). There were no significant differences in major medical adverse events or minor adverse events. Using data derived from the self-reported six month questionnaire, there was no significant difference between RA and OA patients in either major or minor adverse events, fracture (0.6% vs. 0.6%; p-value = 0.70), pneumonia (1.3% vs. 0.3%; p-value = 0.26), DVT (0.0% vs. 2.2%; p-value = 0.99), PE (0.6% vs. 0.3%; p-value = 0.56), stroke (0.0% vs. 0.3%; p-value = 0.99), MI (0.6% vs. 0%; p-value = 0.33), surgical site infections (0.6% vs. 1.9%; p-value = 0.94), or minor bleeding episodes (1.3% vs. 1.6%; p-value = 0.74). No deep surgical site infections were reported in either group.

When cumulative major adverse events (Table 3) from all three sources were compared (counting each unique adverse event only once), OA patients had significantly more major AE (RA 6.9% vs. OA 14.5%; p-value = 0.02), driven by major surgical events (RA 2.5% vs. OA 8.2%, p-value = 0.02). There was no significant difference in 6-month post-operative mortality (1.3% vs. 0.6%; p-value = 0.41), major medical adverse events (4.4% vs. 6.3%; p-value = 0.41), or cumulative minor events (56.7% vs. 55.3%; p-value = 0.79). No significant difference in adverse events was observed in RA patients when stratified by type of immunosuppressive medication, (see Table 4).

Multivariate regression was performed evaluating risk of major adverse events and death, controlling for basic demographic and pre-operative health status variables that were found to be significant on univariate analysis, including diagnosis (OA vs. RA), race, BMI, SF-36 PCS, pre-operative WOMAC Pain, and pre-operative WOMAC Function. OA increased the risk of major complication and death with an adjusted odds ratio (OR) of 3.34 (95% CI 1.24– 9.01). Being Caucasian decreased the risk of complications and death with an adjusted OR of 0.34 (95% CI 0.12– 0.96). Worse pre-operative WOMAC Pain slightly increased the risk of major complication with an adjusted OR of 1.03 (95% CI 1.001– 1.07), (see Table 5).

Discussion

For patients with RA undergoing TKA in a high volume tertiary care center, with surgeons who have high RA specific surgical volume RA does not increase the incidence of post-operative adverse events.. In fact, OA increased the risk of adverse events compared to RA, primarily due to increased rates of post-TKA manipulation. In spite of worse pre-operative

function, worse health status, higher co-morbidity scores, and higher steroid and DMARD use, infection and wound healing complications were not increased in RA patients.

An increase in RA prosthetic joint infection is described in multiple prior series, but the highest risks of infection are seen when older studies are included (16, 33, 34). A 2012 meta-analysis, which included both THA and TKA, reported an increased incidence in joint infection. However, the most recent of the five studies that contributed data on infections included cases from 1998 to 2005 (15, 35). Moreover, only 3 of the 40 studies included in the meta-analysis discuss the establishment of the diagnosis of RA based on ACR (American College of Rheumatology) criteria or diagnosed by referring rheumatologist or internist. Our study only included patients operated on between 2007 and 2010, therefore better reflecting the impact of current surgical, anesthetic, and medical treatment. Additionally, RA specific surgical volume was assessed, which decreases the risk of complications for RA patients (25). RA was also carefully validated, as self-reported RA has notoriously poor accuracy (36, 37). Using more recent data, Ravi et al. evaluated infection rates within two years after first primary TKA in a large cohort from 2002–2009 (38). This study defined RA using an established algorithm based on ICD-10 coding without chart review. While they did report an increase in infection rate in RA after two years, they found no significant difference in infection rates between RA and OA within ninety days of the operation, consistent with our findings. This shorter interval may better reflect the risk related to surgery. The type of infections and rates of occurrence in that study are not specified. Given that deep implant infections are rare, and wound complications are strongly associated with deep implant infection (39), we included superficial wound complications, to increase the sensitivity of our analysis. We found no difference in rates of superficial or deep infections or wound complications between groups. There was also no increase in thromboembolic complications, cardiac complications, or post-operative mortality.

It is intriguing that RA cases had lower reported manipulation rates. A speculative explanation is the ligamentous laxity in RA patients. Additionally, osteoporosis, which is a clinical concern for the surgeon prior to manipulation, was significantly higher in RA and may have influenced the lower rate. The increased rate of manipulations in OA influenced the multivariate analysis in which a diagnosis of OA increased the risk of a major adverse event.

Strengths of this study include a large cohort of validated RA patients at a major referral center, all with standardized prospective collection of self-report health status measures, with detailed information on co-morbidities and medications. Ascertainment of RA specific surgical volume adds validity to our findings. All surgery was performed within a relatively short time period, and our study was limited to TKA, increasing the specificity of our findings. Our data reflect results in non-urgent cases, and arthroplasties are almost always planned elective surgeries.

This study is limited by the lack of the ACR (American College of Rheumatology) definition of RA (40), as this is a tertiary referral hospital often without access to the primary chart. However, data support the accuracy of ICD-9 codes and RA medication as an algorithm to validate a diagnosis of RA (41–44). Additionally, we do not have information

regarding RA specific disease activity scores, and active RA increases the risk for infection (45). Although rheumatologists at the hospital advise discontinuing TNFi prior to orthopedic surgery, there was no consistency in the withhold interval, and was not be analyzed. Our sample size only provided a 28% power to detect a difference between the groups for a combined superficial surgical site and other infection rate of 4.4%. (with the significance level set at 0.05). We have estimated that 55,890 cases would be needed to demonstrate an increase in deep surgical site infections (46), and given our hospital's extremely low standardized infection ratio for THA (0.46), it is not feasible (47). Results from our high volume specialized center should not be generalized to smaller centers where most TKAs are currently performed, as increased surgeon experience both overall as well as specifically with RA surgery has been linked to reduced risk of complications (25), and the majority of our cases were performed by surgeons with high RA specific experience. However, although this study lacks power to identify differences between rates of severe AE in RA and OA TKA, these data provide reassurance to RA patients that under optimal conditions, post-operative AE rates do not appear to be as high as previously reported.

RA cases excluded from the analysis due to lack of follow-up data had worse ASA status and were less likely to be Caucasian and may have been more likely to develop adverse events. To optimize identification of AEs, 100% of OA controls included in this study had 6 month self-report data. For RA, only 70.2% of cases had 6 month self-report data, and those without data were excluded. However, 100% of RA cases had hospital and office records accessible for review. This may have led to an over reporting of AE among OA controls. However, when considering only the self-reported data, there were no significant differences in any AEs. The only significant differences observed between groups were seen in the differences in hospital and office chart data. Moreover, adverse events during the hospitalization were ascertained for the excluded cases to further evaluate differences between the cases included vs. the excluded group, as patients with poorer outcomes are less likely to follow-up, which may lead to bias. No difference in adverse events was seen. Additionally, while excluded cases were less likely to be treated with TNFis, this was not statistically significant. More excluded cases were receiving therapy with corticosteroids than were included cases, but this would be expected to raise infection risk.

In summary this paper found that short term complication rates for RA patients undergoing TKA are low, similar to OA, when performed under optimal conditions in a high volume tertiary referral center with high RA specific surgical experience. DMARDs and biologic use was not a risk factor for complications. This is important information as the rate of TKA among RA appears to be increasing. These data will be useful to orthopedic surgeons and RA patients contemplating TKA.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Patient characteristics. Not all patients contributed to every variable because of missing data. Values are n (%) or mean $\pm$ SD unless otherwise specified.

Characteristics	RA Cases n = 159	OA Cases n = 318	p-value
Matching criteria			
Age, yrs, mean $\pm$ SD (range)	63.6 $\pm$ 11.7 (22–92)	63.8 $\pm$ 11.2 (22–93)	0.87
Female	139 (88.0)	278 (87.7)	0.93
Surgical procedure			0.96
Primary	131 (82.9)	263 (82.7)	
Revision	27 (17.1)	55 (17.3)	
Baseline characteristics			
BMI	28.2 $\pm$ 6.6	30.8 $\pm$ 7.1	< 0.001
White, %	83.7	88.4	0.04
Education			0.54
High school or less	36 (24.7)	64 (20.1)	
Some college or college degree	67 (45.9)	153 (48.1)	
Advanced degree	43 (29.5)	101 (31.8)	
Charlson/Deyo Comorbidity Index *, %			0.64
0	74.2	74.2	
1–2	23.3	24.5	
3+	1.9	0.9	
ASA class, %			0.28
I or II	72.2	76.7	
III	27.9	23.3	
Osteoporosis, %	29.6	12.0	< 0.001
Previous THA or TKA	59 (37.1)	125 (39.3)	0.64
Baseline function			
WOMAC			
Pain	47.1 $\pm$ 19.0	53.7 $\pm$ 19.1	< 0.001
Stiffness	41.0 $\pm$ 23.7	44.8 $\pm$ 22.7	0.10
Function	43.8 $\pm$ 19.6	54.2 $\pm$ 17.8	< 0.001
LEAS, median (IQR)	8 (6–10)	9 (7–11)	< 0.001
EQ-5D score	0.59 $\pm$ 0.20	0.65 $\pm$ 0.18	0.006
SF-36			
PCS	29.3 $\pm$ 7.7	33.3 $\pm$ 8.5	< 0.001
MCS	47.3 $\pm$ 13.7	50.4 $\pm$ 12.2	0.02
Surgical characteristics			
Operation time, min	144.3 $\pm$ 41.1	146.0 $\pm$ 38.2	0.66
Procedure time, min	93.9 $\pm$ 34.1	94.5 $\pm$ 32.9	0.87

Characteristics	RA Cases n = 159	OA Cases n = 318	p-value
Length of hospital stay, days, median (IQR)	5 (5–6)	5 (4–6)	0.09
Anesthesia type			
Neuraxial	151 (95.0)	311 (97.8)	0.10
General	4 (2.5)	9 (2.8)	0.84
Regional	1 (0.6)	0 (0.0)	0.33
Regional + block	120 (75.5)	271 (85.2)	0.01

Significant data are in bold face.

* Comorbidity Index excluding RA.

RA: rheumatoid arthritis; OA: osteoarthritis; BMI: body mass index; ASA: American Society of Anesthesiologists; THA: total hip arthroplasty; TKA: total knee arthroplasty; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; LEAS: Lower Extremity Activity Scale; IQR: interquartile range; SF-36: Medical Outcomes Study Short Form-36; PCS: physical component summary; MCS: mental component summary; IQR: interquartile range.

Table 2

Medications in RA Cases

Medication	Percent of RA Cases (n)
No TNFi, DMARD, biologic, or steroid	14.5 (23)
TNFi	41.5 (66)
Etanercept	60.6 (40)
Adalimumab	19.7 (13)
Infliximab	18.2 (12)
Golimumab	1.5 (1)
Methotrexate	45.9 (73)
Nonbiologic DMARD	67.3 (107)
1 nonbiologic DMARD	78.5 (84)
2 nonbiologic DMARD	19.6 (21)
3 nonbiologic DMARD	1.9 (2)
Non-TNFi biologics	4.4 (7)
Corticosteroids in combination	24.5 (39)
Corticosteroids alone	4.4 (7)
Supraphysiologic perioperative steroid	20.1 (32)

RA: rheumatoid arthritis; TNFi: tumor necrosis factor inhibitors; DMARD: disease-modifying antirheumatic drugs.

Table 3

Adverse events. Values are n (%) unless otherwise specified.

Adverse Events	RA Cases n = 159	OA Controls n = 318	p-value
Major medical AE	7 (4.4)	20 (6.3)	0.40
Fracture	1 (0.62)	3 (0.94)	0.99
Pneumonia	3 (1.9)	2 (0.63)	0.34
DVT	1 (1.9)	11 (3.5)	0.07
PE	1 (1.9)	3 (0.94)	0.99
Stroke	0 (0.0)	1 (0.31)	0.99
MI	1 (1.9)	0 (0.0)	0.33
Deep surgical site infection	0 (0.0)	0 (0.0)	—
Major bleeding episode	0 (0.0)	0 (0.0)	—
Major surgical AE	4 (2.5)	26 (8.2)	0.02
Manipulation	2 (1.3)	23 (7.2)	0.01
Revision	1 (1.9)	3 (0.94)	0.99
Other operation	1 (1.9)	0 (0.0)	0.33
Major AE excluding death	11 (6.9)	46 (14.5)	0.02
Death	2 (1.3)	2 (0.6)	0.60
Minor AE	90 (56.7)	176 (55.3)	0.79
Minor infection	13 (8.2)	42 (13.2)	0.10
Superficial surgical site infection	8 (5.0)	30 (9.4)	0.09
Other minor infection	5 (3.1)	12 (3.8)	0.73
Transient neuropathy	3 (1.9)	6 (1.9)	0.99
Incision drainage	50 (31.4)	87 (27.4)	0.35
Erythema	8 (5.0)	17 (5.3)	0.88
Ecchymosis	7 (4.4)	7 (2.2)	0.25
Atelectasis	2 (1.3)	5 (1.6)	0.99
Hematoma	2 (1.3)	2 (0.63)	0.60
Minor bleeding episode	5 (3.1)	10 (3.1)	0.99

Significant data are in bold face.

AE: adverse events; DVT: deep vein thrombosis; PE: pulmonary embolus; MI: myocardial infarction; RA: rheumatoid arthritis; OA: osteoarthritis.

Table 4

AE in patients with RA according to medication. Values are n (%) unless otherwise specified.

Adverse Events	No Immunosuppressive Medications n = 23	TNFi, ± Other DMARD or Steroids n = 66	Non-TNFi Biologics, ± Other DMARD or Steroids n = 7	Nonbiologic DMARD, ± Steroids n = 56	Steroids Alone n = 7	p-value
Any major or minor AE	14 (60.9)	27 (40.9)	3 (42.9)	27 (48.2)	4 (57.1)	0.53
Any major AE	1 (4.4)	5 (7.6)	1 (14.3)	2 (3.6)	1 (14.3)	0.37
Major surgical AE	1 (4.4)	3 (4.6)	0 (0.0)	0 (0.0)	0 (0.0)	0.50
Major medical AE	0 (0.0)	3 (4.6)	1 (14.3)	2 (3.6)	1 (14.3)	0.21
Any minor AE	13 (56.5)	25 (37.9)	3 (42.9)	25 (44.6)	4 (57.1)	0.56

AE: adverse events; RA: rheumatoid arthritis; TNFi: tumor necrosis factor inhibitors; DMARD: disease-modifying antirheumatic drugs.

Table 5

Multiple logistic regression analysis of risk factors for major complications and death.

Putative Risk Factors	Adjusted OR (95% CI)	p-value
OA vs RA	3.39 (1.25–9.20)	0.02
White vs nonwhite	0.34 (0.12–0.95)	0.04
Preoperative BMI > 30 vs ≤ 30	0.89 (0.38–2.05)	0.78
Preoperative SF-36 PCS	0.99 (0.92–1.05)	0.68
Preoperative WOMAC pain	1.04 (1.00–1.08)	0.03
Preoperative WOMAC function	0.97 (0.93–1.01)	0.10
Preoperative LEAS	1.15 (0.99–1.34)	0.08
Preoperative SF-36 MCS	0.98 (0.95–1.02)	0.27
Preoperative EQ-5D index score	0.87 (0.05–16.24)	0.93

Multiple logistic regression controlling for diagnosis, race, BMI, SF-36 PCS, preoperative WOMAC Pain, preoperative WOMAC Function, preoperative LEAS, preoperative SF-36 MCS, and preoperative EQ-5D index score. Significant data are in bold face.

OA: osteoarthritis; RA: rheumatoid arthritis; BMI: body mass index; SF-36: Medical Outcomes Study Short Form-36; PCS: physical component summary; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; LEAS: Lower Extremity Activity Scale; MCS: mental component summary.