Orthopedic Surgery Among Patients with Rheumatoid Arthritis 1980-2007: A Population-based Study Focused on Surgery Rates, Sex, and Mortality

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ABSTRACT. ***Objective.*** To describe current trends in arthritis-related joint surgery among a population-based cohort of patients with rheumatoid arthritis (RA) and to examine the influence of joint surgery on mortality.

Methods. A retrospective medical record review was performed of all orthopedic surgeries following diagnosis in cases of adult-onset RA in Olmsted County, Minnesota, USA, in 1980-2007. Surgeries included primary total joint arthroplasty, joint reconstructive procedures (JRP), soft tissue procedures (STP), and revision arthroplasty. Cumulative incidence of surgery was estimated using Kaplan-Meier methods. Time trends, sex differences, and mortality were examined using Cox models with time-dependent covariates for surgery.

Results. A total of 189 of 813 patients underwent at least 1 surgical procedure involving joints during followup. The cumulative incidence of any joint surgery at 10 years after RA incidence for the 1980-94 cohort was 27.3% compared to 19.5% for the 1995-2007 cohort ($p = 0.08$). The greatest reduction was in STP, which decreased from 12.1% in 1980-94 to 6.0% in 1995-2007 at 10 years after RA incidence ($p = 0.012$). Women had more surgery (cumulative incidence 26.6% at 10 years for women; 20.4% for men; $p = 0.049$), as did obese patients. JRP were significantly associated with mortality (hazard ratio 2.6; 95% CI 1.8, 3.9; $p < 0.001$) compared to patients not requiring JRP.

Conclusion. The rates of joint surgery continue to decrease for patients more recently diagnosed with RA. JRP is associated with increased mortality. These findings may reflect improved treatments for RA as well as continued higher disease burden among some patients. (J Rheumatol First Release Jan 15 2012; doi:10.3899/jrheum.111056)

Key Indexing Terms:
ORTHOPEDIC SURGERY RHEUMATOID ARTHRITIS SEX
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Rheumatoid arthritis (RA) is an immune-mediated disease characterized by synovial inflammation, leading to pain, joint damage, and loss of joint function. The need for surgical intervention in RA-related joint disease has been regarded as a failure of medical treatment to control RA adequately[1].

In recent years, the rates of RA-related joint surgery have declined, with patients diagnosed after 1985 through 1995 having less RA-related orthopedic surgery than those diagnosed earlier[2]. Reasons for this decline likely relate to more aggressive use of effective disease-modifying antirheumatic drugs (DMARD) with reduction in the progression of radiographic joint damage[3]. As well, it has been suggested that the extent of joint involvement may be less in more recently diagnosed patients[4]. Women are more likely to undergo joint surgery than men, so sex may play a role in the need for joint surgery for RA, related to disease severity or other factors[5].

While significant morbidity is associated with surgeries related to RA, no difference has been reported in survival between patients who undergo RA-related joint surgery and patients with RA at large[1,5]. Factors that influence survival in RA include age, education, extraarticular disease, inflammatory burden, use of glucocorticosteroids and nonsteroidal antiinflammatory drugs, and comorbidities[6,7,8,9,10,11]. The possible contribution of RA-related joint surgery to excess mortality in patients with RA is largely unexplored.

The aim of our study was to evaluate the use of joint surgery among patients with RA in the modern era of DMARD therapy. Using the resources of a population-based incidence cohort of patients with RA in Rochester, Minnesota, USA, we examined whether the prior sex differences and use trends in reduced surgical intervention for RA persist in

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patients diagnosed after 1995, and evaluated the effect of RA surgery on survival in these patients. This information is important for understanding the current use of RA-related surgery and its effect on overall prognosis for patients with RA.

MATERIALS AND METHODS

Study population and data collection. A population-based cohort of 813 Olmsted County, Minnesota, residents aged 18 years and older with RA incident between January 1, 1980, and December 31, 2007, was assembled using the facilities of the Rochester Epidemiology Project as described[12,13]. All patients met 1987 American College of Rheumatology classification criteria for RA[14]. All cases were followed longitudinally until December 31, 2008; death; or migration out of the county.

For each patient, the entire inpatient and outpatient medical records from all providers in Olmsted County were reviewed to obtain data on orthopedic procedures. The date and type of each procedure after the RA incidence date were recorded along with the involved joints. Surgeries involving the following joints were included: temporomandibular joints, shoulders, elbows, wrists, thumbs [base, metacarpophalangeal joint (MCP), interphalangeal joint (IP)], other fingers [MCP, proximal interphalangeal joint (PIP), distal interphalangeal joint (DIP)], hips, knees, ankles, first toes [metatarsophalangeal joint (MTP) and IP], MTP 2-5, toes 2-5 (PIP, DIP), and cervical spine fusion for RA indication. Procedures were recorded as (1) primary total joint arthroplasty (TJA); (2) joint reconstructive procedures including nonimplant arthroplasty such as Keller bunionectomy, fusion, ostectomy, osteotomy or wire arthrodesis; (3) soft tissue procedures (STP): synovectomies, ligament releases (such as carpal tunnel release), tendon repairs, tendon transfers, tendon releases, meniscus repair, or cartilage repair; and (4) revision arthroplasty.

Data on smoking status at RA incidence (never, current, former), height, weight, and results of rheumatoid factor (RF) tests were also collected by medical record review. Body mass index (BMI) at RA incidence was calculated and obesity was defined as BMI ≥ 30 kg/m^2. Data on severe extraarticular manifestations (including pericarditis, pleuritis, Felty's syndrome, glomerulonephritis, vasculitis, peripheral neuropathy, scleritis, and episcleritis), comorbidities (including cardiovascular disease, renal disease, liver disease, dementia, cancer, alcohol abuse), and use of glucocorticoids were also collected. The Deyo adaptation of the Charlson comorbidity index was defined[15,16].

Statistical methods. Descriptive statistics were used to summarize the demographic characteristics of the cohort. The cumulative incidence of surgery adjusted for the competing risk of death was estimated[17]. These methods are similar to the Kaplan-Meier method, with censoring of patients who are still alive at last followup. However, patients who die before experiencing surgery are appropriately accounted for to avoid the overestimation of the rate of occurrence of surgery, which can occur if such subjects are simply censored. Cumulative incidence rates were compared using methods by Gray[18]. Time trends and sex differences were examined using Cox models to allow adjustment for age and Charlson comorbidity index.

The influence of surgery on mortality was examined using Cox models with time-dependent covariates for surgery occurring during followup. First, each type of surgery was assessed in a model adjusted for age, sex, calendar year of RA incidence, and surgery of the same type prior to RA incidence. Then the influence of each type of surgery was assessed in a model that was additionally adjusted for factors known to be related to mortality: BMI, history of smoking, RF positivity, severe extraarticular manifestations, comorbidities (cardiovascular disease, renal disease, liver disease, dementia, cancer, and metastatic cancer as defined using the Deyo adaptation of the Charlson comorbidity index), history of alcohol abuse, and glucocorticoid use[10,11,15,16]. This additional list of adjustors was obtained from a previous study[11], in an attempt to provide a comprehensive adjustment while avoiding issues of bias related to variable selection.

RESULTS

Between 1980 and 2007 there were 813 Rochester residents aged > 18 years who fulfilled the 1987 ACR criteria for RA. Of these, 68% (556) were women and the mean age at incidence of RA was 55.9 years (SD 15.7). RF was present in 66% (537). The mean followup for this cohort was 9.6 years, during which 229 patients died. Characteristics of patients with RA according to time period of RA incidence are displayed in Table 1. Patients with incident RA in 1995-2007 were less likely to be current smokers and were more likely to be obese at incidence of RA compared to patients with incident RA in 1980-94 ($p < 0.001$ for each). By 5 years after RA incidence, patients with incident RA in 1995-2007 were more likely to have used methotrexate, hydroxychloroquine, biologics, and corticosteroids, and they were less likely to use other DMARD compared to patients with incident RA in 1980-94.

A total of 189 patients underwent at least 1 surgical procedure involving joints during the followup period. The cumulative incidence of any joint procedure at 10 years after RA incidence for patients with incident RA in 1980-94 was 27.3% compared to 19.5% for patients with incident RA in 1995-2007; however, this apparent decline in surgery rates did not reach statistical significance ($p = 0.08$). The cumulative incidence of each category of joint surgeries was lower in the 1995-2007 cohort compared to the 1980-94 cohort, with the greatest reduction in soft tissue procedures (synovectomies, tendon repairs, tendon transfers, meniscus repair, ligament release, cartilage repair). The latter decreased from 12.1% in 1980-94 to 6.0% in 1995-2007 at 10 years after RA incidence ($p = 0.012$). The cumulative

Table 1. Characteristics of 813 patients with incident rheumatoid arthritis (RA) in Olmsted County, Minnesota, USA, 1980–2007, by time period of RA incidence.

Variable	1980–1994, n = 349	1995–2007, n = 464	p
Age, yrs, mean ± SD	56.3 ± 15.9	55.6 ± 15.5	0.44
Women, n (%)	236 (68)	320 (69)	0.68
Length of followup, yrs, mean ± SD	14.6 ± 7.2	5.9 ± 3.5	
Smokers, n (%)			< 0.001
Current	98 (28)	80 (17)	
Former	116 (33)	155 (33)	
Rheumatoid factor-positive, n (%)	231 (66)	306 (66)	0.94
Obesity (BMI ≥ 30 kg/m^2)	111 (32)	210 (45)	< 0.001
Medication use by 5 yrs after RA incidence date, n (%)*			
Methotrexate	98 (30)	284 (64)	< 0.001
Hydroxychloroquine	141 (42)	290 (64)	< 0.001
Other DMARD	125 (37)	92 (23)	< 0.001
Biologic response modifiers	0 (0)	80 (20)	< 0.001
Corticosteroids	173 (51)	361 (81)	< 0.001

* Percentages estimated using Kaplan-Meier methods. Comparison performed using log-rank test. BMI: body mass index; DMARD: disease-modifying antirheumatic drugs.

incidence of primary joint arthroplasty declined from 15.2% in 1980-94 to 10.3% in 1995-2007, but this difference did not reach statistical significance (p = 0.36). No differences between time periods were found in the cumulative incidence of total hip arthroplasty (p = 0.77) or total knee arthroplasty (p = 0.18). The cumulative incidence for each type of surgery by time period of RA incidence is displayed in Table 2.

Of the joints for which orthopedic surgery was undertaken, knee surgeries were less common in patients diagnosed in the period 1995-2007 compared to those diagnosed 1980-94. The cumulative incidence of knee surgeries at 10 years after RA incidence was 11.0% for patients with incident RA in 1980-94 compared to 6.0% for patients with incident RA in 1995-2007 (p = 0.047). Hand surgeries were also less common in those more recently diagnosed (cumulative incidence at 10 years after RA incidence was 6.3% in the 1980-94 cohort compared to 2.5% in the 1995-2007 cohort; p = 0.059). There was no difference in the rates of hip surgeries between these 2 time periods (p = 0.72).

Women had somewhat higher rates of any joint surgery than men. The cumulative incidence of surgery for women was 26.6% at 10 years of RA disease compared to 20.4% for men during the entire study period of 1980-2007 (p = 0.049). Similarly, women were somewhat more likely to have a primary TJA (cumulative incidence at 10 years after RA incidence of 14.8% among women and 11.2% among men), but this difference did not reach statistical significance (p = 0.06). There were no significant differences between women and men in other types of surgery or in surgery sites.

Both current and former smokers were more likely to have soft tissue procedures than patients who never smoked (cumulative incidence at 10 years after RA incidence 12.2% among current smokers, 11.1% among former smokers, and 6.7% among patients who never smoked; adjusted for age, sex, and calendar year, p = 0.015). There were no other significant associations between tobacco use and rate of RA-related surgery according to types or sites of surgery.

Patients with RA who were obese at RA incidence were more likely to undergo primary TJA (cumulative incidence at 10 years after RA incidence was 19.6% among obese patients compared to 11.4% among patients who were not obese; p < 0.001). Similarly, obese patients were more likely to experience any joint surgery (cumulative incidence at 10 years after RA incidence of 27.6% among obese patients compared to 23.3% among patients who were not obese; p = 0.022). Among surgery sites, obese patients with RA were particularly more likely to undergo knee surgeries (cumulative incidence at 10 years after RA incidence of 16.4% among obese patients compared to 6.5% among patients who were not obese; p < 0.001). No other significant differences between obese and nonobese patients in types or sites of surgery were found.

The occurrence of any joint surgery was marginally associated with mortality [hazard ratio (HR) 1.3; 95% CI 0.96,

Table 2. Orthopedic surgery rates (at 10 years after RA incidence) for 813 patients with incident rheumatoid arthritis (RA) in Olmsted County, Minnesota, USA, 1980–2007, by time period of RA incidence. Values are cumulative incidence (%) ± standard error at 10 years after RA incidence, except where indicated.

Type/Site of Surgery	No. Patients with Surgery	Complete Cohort, 1980–2007	1980–1994	1995–2007	p, Comparing 1980–94 to 1995–2007
Total: any surgery	189	24.6 ± 1.8	27.3 ± 2.4	19.5 ± 2.6	0.08
Types					
Primary TJA	109	13.6 ± 1.4	15.2 ± 2.0	10.3 ± 1.9	0.36
Total hip arthroplasty	30	3.4 ± 0.8	3.6 ± 1.0	2.3 ± 0.8	0.77
Total knee arthroplasty	62	7.4 ± 1.1	8.6 ± 1.5	5.3 ± 1.5	0.18
Joint reconstructive	82	9.3 ± 1.2	10.1 ± 1.6	8.1 ± 1.9	0.52
Procedures					
Soft tissue procedures	76	9.6 ± 1.2	12.1 ± 1.8	6.0 ± 1.4	0.012
Revision arthroplasty	14	1.2 ± 0.4	1.8 ± 0.7	0.8 ± 0.6	0.16
Sites					
Hip	38	4.4 ± 0.9	5.1 ± 1.2	2.8 ± 1.0	0.72
Knee	72	9.2 ± 1.2	11.0 ± 1.7	6.0 ± 1.5	0.047
Wrist	37	4.3 ± 0.8	5.3 ± 1.2	2.7 ± 0.8	0.14
Shoulder	15	1.9 ± 0.6	1.2 ± 0.6	2.9 ± 1.1	0.26
Elbow	13	1.4 ± 0.5	1.8 ± 0.7	0.3 ± 0.3	0.21
Hand	43	4.8 ± 0.9	6.3 ± 1.3	2.5 ± 1.2	0.059
Ankle	10	0.9 ± 0.4	0.9 ± 0.5	1.0 ± 0.6	0.98
Feet	50	5.4 ± 1.0	5.6 ± 1.3	5.3 ± 2.2	0.99
Cervical spine	8	0.5 ± 0.3	0.6 ± 0.4	0.4 ± 0.4	0.74

TJA: total joint arthroplasty.

1.8; p = 0.09, adjusted for age, sex, and calendar year] compared to patients not requiring joint surgery. However, this association was more pronounced among patients undergoing joint reconstructive surgery (HR 2.6; 95% CI 1.8, 3.9; p < 0.001, adjusted for age, sex, and calendar year). Following additional adjustment for risk factors known to be associated with mortality in patients with RA [BMI, smoking, RF positivity, severe extraarticular manifestations, comorbidities (cardiovascular disease, renal disease, liver disease, dementia, cancer, alcohol abuse), and use of glucocorticoids], the mortality risk associated with joint reconstructive procedures persisted (HR 2.8; 95% CI 1.9, 4.1; p < 0.001). This association was found in both time periods.

DISCUSSION

Rates of RA-related surgery have continued to decline in recently diagnosed patients, particularly those diagnosed after 1995. This furthers the trend of reductions in the use of RA-related surgery in patients diagnosed between 1985 and 1995 that was seen in prior studies of patients with RA in Olmsted County[2,5]. Studies from other populations have shown similar trends, as reflected in reduced hospitalizations for RA-related joint surgery of the upper and lower extremities since 1997[19,20,21,22,23,24].

In our current study, we clarified actual rates of RA-related surgery in the first 10 years following RA diagnosis. This approach more accurately reflects the course of patients with recently diagnosed RA, and the effect of disease management strategies. While the overall rates of RA-related surgery have declined, the rates of hip surgery, in particular, in our population have not changed in recent decades. Prior studies of this population revealed that until 1995, the hip was the joint most frequently operated on in this patient population[5]. Other studies investigating the rates of hip and knee surgery in patients with RA have reported varying results, with some suggesting stable rates of surgery, while others suggest these rates have declined in recent decades[21,22,23,24]. A new finding in our cohort is that in the more-recent decade, surgery is now being done more often on the knee than on the hip. Obese patients were more likely to have joint surgery, and knee surgery accounted for virtually all the excess joint surgery among the obese patients. Still, the rate of knee surgeries declined in this cohort, while the rate of hip surgeries remained stable.

While our study has the advantage of a more recent cohort, we can report here only on the cumulative incidence for 10 years following RA diagnosis. In our prior study of this population, we reported surgical data from a cumulative incidence of 30 years following RA diagnosis[5]. It is possible that our finding of more knee than hip surgeries might be related to the shorter disease duration and more immediate effects of obesity in our current study compared to the previous study. It is possible that hip surgeries occur more commonly in patients with longer RA disease duration.

As in previous decades, women had higher rates of RA-related surgeries than men, regardless of the type of surgery performed, consistent with other epidemiological evidence that disease severity is greater among women[4,25]. While a recent study has suggested no increase in rates of joint surgery for tobacco smokers of short duration (1–23 years, thus likely former smokers) compared to nonsmokers, and reduced rates of total joint replacement among longterm tobacco users (≥ 37 years, thus likely current smokers) in the general population, this association was not seen in our cohort[26]. The relationship of biological and social determinants of disease expression and management of RA, including need for surgery, is complex and is not addressed in our study.

Survival was reduced among patients with RA who underwent any type of RA-related surgery even after adjustment for risk factors known to be associated with mortality in RA. A new observation from our study was that among orthopedic surgeries we evaluated, survival was lowest for STP procedures.

The decreased survival among patients undergoing orthopedic surgeries had not been noted in a previous study from Olmsted County that reported on patients with RA from 1955 to 1985[5]. This may be due to temporal changes in any one of a number of factors including selection of surgical candidates, RA treatment, lifestyle, etc. We did not analyze the cause of death, nor did we assess morbidity associated with these procedures, such as surgical site infections or other postoperative complications and their possible effect on mortality. Further studies investigating these factors may help in clarifying the mortality associated with joint surgery, and joint reconstructive procedures in particular.

Potential limitations of our study include the fact that the Olmsted population is 90% white and has a higher educational achievement and mean household income compared to the national average for the United States. Also, the ready access to orthopedic procedures, given the proximity of the Mayo Clinic, may have influenced the rate of surgery in our patient population. In addition, it is unclear whether the rates and patterns of DMARD use in this population differ from those of other populations, or what the effect of differing patterns of DMARD use might be on the need for surgery. Further, practice patterns for surgical indication may differ from place to place in the United States and elsewhere, resulting in different rates of orthopedic surgery in different regions. Finally, statistical power for some comparisons was limited due to low rates for some types of surgeries.

This longterm study using complete medical information of a geographically well defined population of patients with RA provides evidence of continued improvement in joint outcomes, with a continued decline in the need for joint surgeries. Nonetheless, the associated increased mortality

among these patients compared with patients not needing joint surgery reflects the still significant disease burden of RA, and the need for continuing efforts to improve the lives of the patients who have it.

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Correction

Orthopedic Surgery Among Patients with Rheumatoid Arthritis 1980–2007: A Population-based Study Focused on Surgery Rates, Sex, and Mortality

Shourt CA, Crowson CS, Gabriel SE, Matteson EL. Orthopedic surgery among patients with rheumatoid arthritis 1980–2007: A population-based study focused on surgery rates, sex, and mortality. J Rheumatol 2012;39:481-5. In the Discussion, paragraph 5, the concluding sentence should read: "A new observation from our study was that among orthopedic surgeries we evaluated, survival was lowest for JRP procedures." We regret the error.

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