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Utilization of Orthopedic Surgery Among Patients with Rheumatoid Arthritis 1980–2007: A Population Based Study Focused on Rates of Surgery, Patient Gender and Mortality

Courtney A. Shourt, MD¹, Cynthia S. Crowson, MS^{2,3}, Sherine E. Gabriel, MD, MSc^{2,3}, and Eric L. Matteson, MD, MPH^{2,3}

¹Department of Medicine, Mayo Clinic College of Medicine

²Division of Rheumatology

³Department of Health Sciences Research

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 incident in 1980–2007. Surgeries included primary total joint arthroplasty, joint reconstructive procedures (JRP), soft tissue procedures (STP) and revision arthroplasty. Cumulative incidence (CI) 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 1 surgical procedures involving joints during follow-up. The cumulative incidence of any joint surgery at 10 years after RA incidence for the 1980–1994 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 1980–1994 to 6.0% in 1995–2007 at 10 years after RA incidence ($p=0.012$). Obese patients, and women (cumulative incidence 26.6% at 10 years for women; 20.4% for men; $p=0.049$) had more surgery. JRP was significantly associated with mortality (hazard ratio [HR]: 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 both improved treatments for RA as well as continued higher disease burden among some patients.

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

Corresponding author: Eric L. Matteson, MD, MPH Mayo Clinic 200 1st St SW Rochester, MN 55905, USA.

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Author's contributions

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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 in earlier years (2). Reasons for this decline likely relate to more aggressive use of effective disease-modifying antirheumatic drugs (DMARDs) 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). Gender may play a role in need for joint surgery for RA, related to disease severity or other factors, as women are more likely to undergo joint surgery than men (5).

While significant morbidity is associated with surgeries related to RA, no difference in survivorship between patients who undergo RA related joint surgery and RA patients at large has been reported (1,5). Factors which influence survivorship in RA include age, education, extraarticular disease, inflammatory burden and use of glucocorticosteroids and nonsteroidal inflammatory drugs and medical 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 this 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, we examined whether the prior gender differences and utilization trends in reduced surgical intervention for RA persist in patients diagnosed after 1995, and evaluated the impact of RA surgery on survivorship in these patients. This information is important for understanding the current utilization of RA related surgery and its impact on overall prognosis for patients with RA.

PATIENTS 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 previously 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 was 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; 2) joint reconstructive procedures including non-implant arthroplasty such as Keller bunionectomy, fusion, osteotomy, osteotomy or wire arthrodesis; 3) soft tissue procedures (STPs): 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 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/m². Data on severe extra-articular manifestations (including pericarditis, pleuritis, Felty's syndrome, glomerulonephritis, vasculitis, peripheral neuropathy, scleritis and episcleritis), medical 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 Kaplan-Meier method with censoring of patients who are still alive at last follow-up. 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 gender 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 follow-up. 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: body mass index, history of smoking, rheumatoid factor positivity, severe extra-articular 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 adjusters was obtained from a previously published 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 female and the mean age at incidence of RA was 55.9 (SD 15.7) years. Rheumatoid factor was present in 66% (537). The mean follow up 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 1980–1994 ($p < 0.001$ 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 DMARDs compared to patients with incident RA in 1980–1994.

A total of 189 patients underwent ≥ 1 surgical procedures involving joints during the follow-up period. The cumulative incidence of any joint procedure at 10 years after RA incidence for patients with incident RA in 1980–1994 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 1980–1994 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

1980–1994 to 6.0% in 1995–2007 at 10 years after RA incidence ($p=0.012$). The cumulative incidence of primary joint arthroplasty declined from 15.2% in 1980–1994 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 1.

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 1980–1994. The cumulative incidence of knee surgeries at 10 years after RA incidence was 11.0% for patients with incident RA in 1980–1994 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 1980–1994 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 two time periods ($p=0.72$).

Female patients had somewhat higher rates of experiencing any joint surgery than males. The cumulative incidence of surgery for females was 26.6% at 10 years of RA disease compared to 20.4% for males during the entire study period 1980–2007 ($p=0.049$). Similarly, females were somewhat more likely to have a primary total joint arthroplasty (cumulative incidence at 10 years after RA incidence of 14.8% among females and 11.2% among males), but this difference did not reach statistical significance ($p=0.06$). There were no significant differences between females and males 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; age, sex and calendar year adjusted $p=0.015$). 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 total joint arthroplasty (cumulative incidence at 10 years after RA incidence of 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 non-obese patients in types or sites of surgery were found.

The occurrence of any joint surgery was marginally significantly associated with mortality (hazard ratio [HR]: 1.3; 95 % confidence interval [CI]: 0.96, 1.8; $p = 0.09$ adjusted for age, sex and calendar year) compared to patients not requiring joint surgery. 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 (body mass index, smoking, rheumatoid factor positivity, severe extra-articular manifestations, medical 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 seen in prior studies of patients with RA in Olmsted County of reductions in the use of RA related surgery in patients diagnosed with RA between 1985 and 1995 (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 (19–24).

In the current study, we clarified actual rates of RA related surgery in the first ten years following RA diagnosis. This approach more accurately reflects the course of patients with recently diagnosed RA, and the impact 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 most frequently operated joint 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 to have declined in recent decades (21–24). A new finding in our cohort is that in the recent decade, surgery is now being done more often on the knee than the hip. Obese patients were more likely to have joint surgery, and knee surgery accounted for virtually all of 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 ten years following RA diagnosis. In our prior study of this population, we reported surgical data from a cumulative incidence of thirty 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 the 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 females (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 non-smokers, and reduced rates of total joint replacement amongst long-term 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 not addressed in our study.

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

The decreased survivorship among patients undergoing orthopedic surgeries had not been noted in a previous study from Olmsted County that reported finding on patients with RA in 1955 to 1985 (5). This may be due to temporal changes in any one of a number of things including selection of surgical candidates, RA treatment, lifestyle factors, 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 post operative complications and their possible impact on mortality. Further studies investigating these factors may help in clarifying the mortality associated joint surgery, and joint reconstructive procedures in particular.

Potential limitations of our study include the fact that the Olmsted population is 90% Caucasian 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 impact of differing patterns of DMARD use might be on 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 long term 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 as compared with patients not needing joint surgery reflects the still significant disease burden of RA, and the need for ongoing efforts to improve the lives of the patients who suffer from it.

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Table 1

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

Variable	1980–1994 (n=349)	1995–2007 (n=464)	p-value
Age, years, mean $\pm$ SD	56.3 $\pm$ 15.9	55.6 $\pm$ 15.5	0.44
Female	236 (68)	320 (69)	0.68
Length of follow-up, years, mean $\pm$ SD	14.6 $\pm$ 7.2	5.9 $\pm$ 3.5	
Smoking			<0.001
current	98 (28)	80 (17)	
former	116 (33)	155 (33)	
Rheumatoid factor positive	231 (66)	306 (66)	0.94
Obesity (BMI $\geq$ 30 kg/m ²)	111 (32)	210 (45)	<0.001
Medication use by 5 years after RA incidence date *			
Methotrexate	98 (30)	284 (64)	<0.001
Hydroxychloroquine	141 (42)	290 (64)	<0.001
Other DMARDs	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 logrank test.

Table 2

Orthopedic surgery rates (at 10 years after RA incidence) for 813 patients with incident rheumatoid arthritis (RA) in Olmsted County, Minnesota 1980–2007 by time period of RA incidence

Type / site of surgery	Number of patients with surgery	Complete cohort 1980–2007	1980–1994	1995–2007	p-value comparing 1980–1994 to 1995–2007
Total: Any surgeries	189	24.6 ± 1.8	27.3 ± 2.4	19.5 ± 2.6	0.08
Types					
Primary total joint arthroplasty	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 procedures	82	9.3 ± 1.2	10.1 ± 1.6	8.1 ± 1.9	0.52
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

* values are cumulative incidence (%) ± standard error at 10 years after RA incidence