Arthroplasty Rates Are Increased Among US Patients with Systemic Lupus Erythematosus: 1991–2005

Christina Mertelsmann-Voss, Stephen Lyman, Ting Jung Pan, Susan Goodman, Mark P. Figgie, and Lisa A. Mandl

ABSTRACT. ***Objective.*** To evaluate population-based systemic lupus erythematosus (SLE) arthroplasty rates and compare them with rates in patients with no inflammatory or autoimmune conditions.

Methods. Administrative hospital discharge databases from 10 American states were used to compare knee, hip, and shoulder arthroplasty rates from 1991 to 2005 in patients with SLE and in patients with no inflammatory or autoimmune conditions.

Results. Arthroplasties were performed on patients with SLE (n = 4253) and patients with non-inflammatory conditions (n = 2,762,660). Arthroplasty rates for patients with noninflammatory conditions almost doubled from 1991 to 2005 (124.5 cases/100,000 persons vs 247.5/100,000; $p < 0.001$). A similar trend was observed for SLE (0.17/100,000 vs 0.38/100,000; $p < 0.001$). The mean age at arthroplasty in patients with noninflammatory conditions decreased (71.5 ± 11.8 vs 69.0 ± 12.0; $p < 0.001$), whereas the mean age in patients with SLE increased (47.3 ± 17.0 vs 56.8 ± 16.0; $p < 0.001$). When stratified by age and sex, arthroplasty in cases of SLE increased in all groups except for women < 44 years old. In 1991, osteonecrosis accounted for 53% and osteoarthritis (OA) 23% of cases of SLE; by 2005 this relationship had reversed, with osteonecrosis accounting for 24% and OA 61% of cases of SLE.

Conclusion. From 1991 to 2005, arthroplasty rates increased in patients with SLE in similar proportions to overall joint replacement rates. The age of patients with SLE arthroplasty increased and fewer cases were due to osteonecrosis. These data suggest significant changes are occurring — patients with SLE are now living long enough to develop OA and are healthy enough to undergo elective surgery. (First Release April 1 2014; J Rheumatol 2014;41:867–74; doi:10.3899/jrheum.130617)

Key Indexing Terms:
ARTHRITIS ARTHROPLASTY SYSTEMIC LUPUS ERYTHEMATOSUS
OSTEONECROSIS EPIDEMIOLOGY

In recent decades, there has been a striking increase in the rates of joint replacements in the general population[1], and this trend is projected to continue[2]. In contrast, joint replacement rates have decreased or remained stable in patients with rheumatoid arthritis (RA)[3,4].

In patients with systemic lupus erythematosus (SLE), the musculoskeletal system is a main target of the disease and patients are at increased risk of multiple conditions that can lead to arthroplasty surgery. Arthritis and arthralgia occur in up to 95% of patients[5]. Between 4% and 30% of patients with SLE are reported to develop osteonecrosis[6] and it most frequently develops in the femoral head. The definitive treatment for osteonecrosis is total joint replacement[7,8,9,10]. Patients with SLE who take corticosteroids are at the greatest risk of osteonecrosis, although it can occur in the absence of glucocorticoid therapy[11]. Patients with SLE are also at an increased risk of fracture[12], which may necessitate joint replacement. Despite the prevalence of joint involvement in SLE, there is little evidence regarding patterns of arthroplasty use in this patient population. To our knowledge, there is only one retrospective cohort study of 500 patients with SLE, in which 4% of patients had one or more joints replaced[13].

There have been tremendous improvements in SLE treatment over the past 50 years, with 5-year survival rates increasing from 50% in the 1950s to 95% in 2000[14,15]. How better treatments and increased longevity might affect arthroplasty rates is unknown. The aim of our study was to evaluate trends in rates of knee, hip, and shoulder arthroplasty due to SLE from 1991 to 2005, and to compare those rates with those among patients with no inflammatory or autoimmune conditions.

MATERIALS AND METHODS

Source of data. Administrative discharge records were identified using 3

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different sources for 1991 to 2005. The State Inpatient Databases (SID) of the Healthcare Cost and Utilization Project (HCUP) were used for Arizona, Colorado, Florida, Massachusetts, New Jersey, Washington, Iowa, and Wisconsin. Data from New York were obtained from the New York Department of Health Statewide Planning and Research Cooperative System, and California data were obtained from the California Statewide Health Planning and Development. These databases encompass about 90% of all community hospital admissions within these states, and include discharge diagnoses. HCUP-SID rather than HCUP-National Inpatient Sample (NIS) was chosen because the NIS relies on sampling, which can be unreliable in rare events. Primary total knee arthroplasty, primary partial and total hip arthroplasty, and primary total and partial shoulder arthroplasty cases were identified using International Classification of Diseases-9-Clinical Modification (ICD-9-CM) procedure codes (81.54, 81.52, 81.51, 81.81, and 81.80, respectively). Non-state residents were excluded from the analysis. Indications for surgery were derived from ICD-9-CM discharge diagnosis codes. Patients with a discharge diagnosis of malignant neoplasms (ICD-9-CM 140.0–209.9, or V-code V10.0–10.9, V71.1), except for non-melanomatous skin cancer (ICD-9-CM 173), were also excluded. SLE arthroplasties were identified using ICD-9-CM code 710.0. Procedures that carried concurrent diagnosis codes for RA (ICD-9-CM 714) or juvenile idiopathic arthritis (ICD-9-CM 714.3) and SLE were excluded, to ensure a homogenous group of SLE cases. The comparator group of noninflammatory arthroplasties included arthroplasty cases without ICD-9-CM codes for any inflammatory or autoimmune condition (Appendix 1: available from the author on request). This research was approved by the Institutional Review Board of Hospital for Special Surgery.

Statistical analysis. This was a procedure-based analysis because no unique patient identifiers were consistently available for all states and years. Annual population data for each state were obtained from the US Census Bureau[16]. The annual arthroplasty rate per 100,000 persons was calculated by dividing the number of cases per period by the number of persons living in each state during the same period. Poisson regression analysis was performed to investigate trends over time. Analyses were performed stratified by sex and age categories. Linear regression models were also performed to compare trends over time between different groups. A 2-tailed critical p-value of 0.05 was considered statistically significant for all analyses. All statistical analyses were performed using SAS 9.3 software (SAS Institute Inc.).

RESULTS

Patient cases. There were a total of 2,905,937 primary hip, knee, and shoulder arthroplasties performed in these 10 states from 1991 to 2005. After excluding 52,064 subjects with malignancies, 86,322 subjects with inflammatory or autoimmune disease, 96,916 nonstate residents, and 638 subjects with a dual diagnosis of SLE and RA or juvenile rheumatoid arthritis, 2,766,913 primary joint replacements were identified for analysis. There were 4253 (0.2%) SLE arthroplasties. In comparison to cases of noninflammatory arthroplasty, the patients with SLE cases were younger (54.0 ± 16.0 yrs vs 70.5 ± 12.1 yrs; $p < 0.001$), more likely to be female (90.2% vs 63.5%; $p < 0.001$), and more likely to be black or Hispanic (16.9% vs 3.6%; $p < 0.001$ and 8.3% vs 4.2%; $p < 0.001$, respectively; Table 1). Hip arthroplasty was the most frequent procedure in patients with SLE (50.1% vs 31.1% for the noninflammatory group, $p < 0.001$), whereas knee arthroplasty was most common in the noninflammatory group (47.4% vs 33.7%; $p < 0.001$; Table 2). The majority of arthroplasty cases were performed at urban nonteaching institutions (52.3% for SLE and 70.5% for noninflammatory cases). However, SLE cases were comparatively more likely to have been performed at urban teaching hospitals (29.4% vs 13.5% noninflammatory; $p < 0.001$).

Table 1. Characteristics of cases of systemic lupus erythematosus (SLE) arthroplasty and cases of arthroplasty with no inflammatory or autoimmune conditions**.** Chi-square analyses and p values were adjusted using the false discovery rate method.

Characteristic	SLE	Noninflammatory	p
Arthroplasty, n (%)	4253 (0.2%)	2,762,660 (99.8%)	< 0.001
Mean age, yrs ± SD	54.0 ± 16.5	70.5 ± 12.1	< 0.001
Female	90.2%	63.5%	< 0.001
Race			
White	54.1%	72.5%	Reference
Black	16.9%	3.6%	< 0.001
Hispanic	8.3%	4.2%	< 0.001
Other	8.9%	3.6%	< 0.001
Missing	11.7%	16.1%	< 0.001
Median length of hospital stay, days	5	4	< 0.001
Arthroplasty type, n (%)			
Total hip	2132 (50.1)	859,562 (31.1)	Reference
Partial hip	507 (11.9)	510,786 (18.5)	< 0.001
Total knee	1432 (33.7)	1,309,655 (47.4)	< 0.001
Total shoulder	60 (1.4)	36,125 (1.3)	0.002
Partial shoulder	122 (2.9)	46,532 (1.7)	0.552
Hospital type, n (%)			
Rural	140 (3.3)	222,752 (8.1)	Reference
Urban nonteaching	2224 (52.3)	1,946,601 (70.5)	< 0.001
Urban teaching	1249 (29.4)	373,189 (13.5)	< 0.001
Missing	640 (15)	220,118 (8.0)	< 0.001

Table 2. Comparison of patient characteristics for arthroplasties due to osteoarthritis (OA), avascular necrosis (AVN), and fracture in cases of systemic lupus erythematosus (SLE) and nonautoimmune/noninflammatory conditions. P values were obtained from t tests or chi-square tests, adjusted for Bonferroni correction when multiple comparisons were performed.

	SLE	Noninflammatory	p
AVN			
Arthroplasty, n	1566	142,911	
Mean age, yrs ± SD	42.4 ± 14.1	62.3 ± 15.4	< 0.001
Age group, n (%)			< 0.001
≤ 44 yrs	914 (58.4%)	22,240 (2.5%)	
45–65 yrs	531 (33.9%)	51,661 (32.4%)	
> 65 yrs	121 (7.7%)	69,010 (65.2%)	
Female, n (%)	1380 (88.1%)	76,391 (60.7%)	< 0.001
Arthroplasty type, n (%)			< 0.001
Total hip	1219 (77.8%)	78,075 (54.6%)	
Partial hip	109 (7.0%)	6854 (4.8%)	
Total knee	110 (7.0%)	7239 (5.1%)	
Total shoulder	46 (2.9%)	31,370 (22.0%)	
Partial shoulder	82 (5.2%)	19,373 (13.6%)	
Charlson Comorbidity Index, n (%)			< 0.001
0	510 (32.6%)	115,924 (81.1%)	
1–2	879 (56.1%)	24,913 (17.4%)	
3+	177 (11.3%)	2074 (1.5%)	
OA			
Arthroplasty, n	1939	1,981,919	
Mean age, yrs ± SD	60.0 ± 12.5	68.4 ± 10.6	< 0.001
Age group, n (%)			< 0.001
≤ 44 yrs	220 (11.4%)	48,785 (2.5%)	
45–65 yrs	1024 (52.8%)	641,662 (32.4%)	
> 65 yrs	695 (35.8%)	1,291,472 (65.2%)	
Female, n (%)	1772 (91.4%)	1,202,162 (60.7%)	
Arthroplasty type, n (%)			0.3
Total hip	710 (36.6%)	690,119 (34.8%)	
Partial hip	9 (0.5%)	7542 (0.4%)	
Total knee	1219 (62.9%)	1,283,973 (64.8%)	
Total shoulder	0 (0%)	122 (< 0.01%)	
Partial shoulder	1 (0.1%)	163 (< 0.01%)	
Charlson Comorbidity Index, n (%)			< 0.001
0	632 (32.6%)	1,646,518 (83.1%)	
1–2	1201 (61.9%)	323,044 (16.3%)	
3+	106 (5.5%)	12,357 (0.6%)	
Fracture			
Arthroplasty, n	453	567,952	
Mean age, yrs ± SD	69.7 ± 13.1	80.1 ± 9.9	< 0.001
Age group, n (%)			< 0.001
≤ 44 yrs	21 (4.6%)	3402 (0.6%)	
45–65 yrs	122 (26.9%)	40,845 (7.2%)	
> 65 yrs	310 (68.4%)	523,705 (92.2%)	
Female, n (%)	419 (92.5%)	429,308 (75.6%)	
Arthroplasty type, n (%)			< 0.001
Total hip	58 (12.8%)	62,535 (11.0%)	
Partial hip	348 (76.8%)	476,072 (83.8%)	
Total knee	22 (4.9%)	7187 (1.3%)	
Total shoulder	4 (0.9%)	2476 (0.4%)	
Partial shoulder	21 (4.6%)	19,682 (3.5%)	
Charlson Comorbidity Index, n (%)			< 0.001
0	93 (20.5%)	379,534 (66.8%)	
1–2	299 (66.0%)	172,241 (30.3%)	
3+	61 (13.5%)	16,177 (2.9%)	

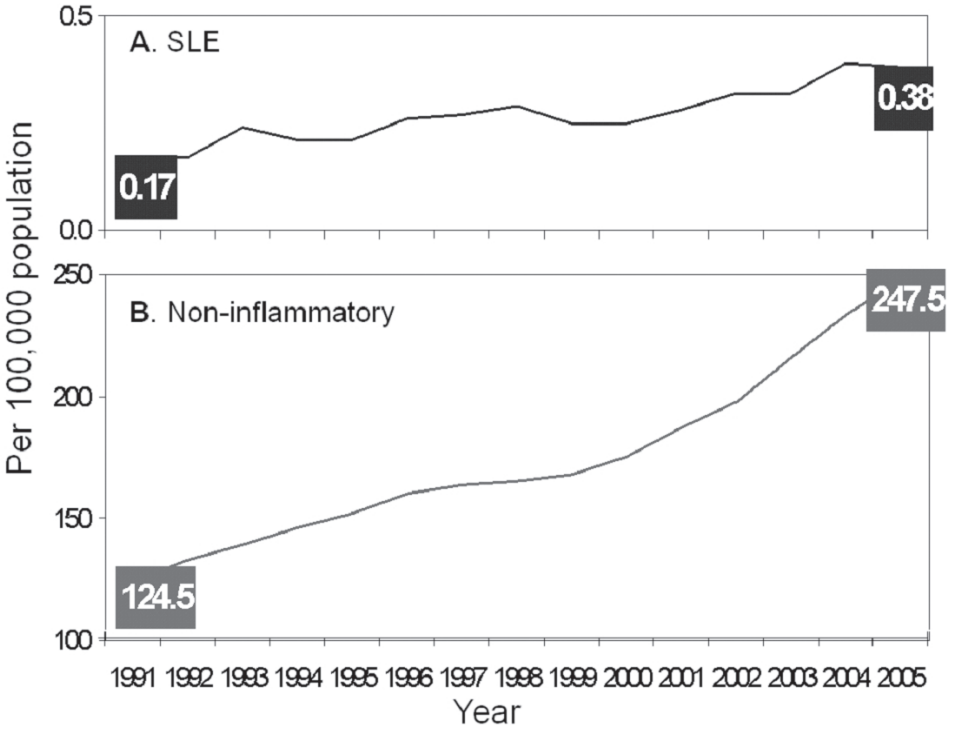

Figure 1. Population-based rates of total and partial shoulder, total and partial hip and knee arthroplasties for (A) cases of systemic lupus erythematosus (SLE) and (B) cases of nonautoimmune/noninflammatory conditions. In both noninflammatory and SLE arthroplasties there was a statistically significant increase in rate between 1991 and 2005 (both $p < 0.001$). SLE joint replacements, on average, had a significantly higher increase in mean rate compared to noninflammatory joint replacements ($p < 0.001$).

Arthroplasty trends. Rates of noninflammatory arthroplasty, as well as SLE arthroplasty, showed a steep increase, both almost doubling during the study period (124.5/100,000 persons in 1991 vs 247.5/100,000 persons in 2005, $p < 0.001$ and 0.17/100,000 persons vs 0.38/100,000 persons; $p < 0.001$, respectively; Figure 1). In the SLE group, the annual number of total hip, partial hip (PHA), and total knee arthroplasty (TKA) cases showed a statistically significant increase over time ($p < 0.001$), whereas there was no significant change for total shoulder arthroplasties. Strikingly, the rate of SLE knee arthroplasties increased 6-fold (0.03 to 0.18 per 100,000 subjects; $p < 0.001$). The proportion of total knee replacements in the SLE cases increased from 16% in 1991 to 48% in 2005, whereas the proportion of total hip replacements decreased from 66% to 40% (Figure 2). Patients with SLE-related TKA were significantly older than those with SLE-related total hip arthroplasty (THA; mean age at TKA 58.6 yrs ± 13.1, mean age at THA 49.1 yrs ± 16.1, $p < 0.001$).

In the noninflammatory arthroplasty group, all arthroplasty types showed a significant increase in rates. The most profound increases in rates were seen for TKA (49.1/100,000 persons in 1991 vs 133.4/100,000 in 2005; $p < 0.001$). These trends were all significantly different from SLE arthroplasty ($p < 0.001$), except PHA. The proportion of noninflammatory TKA increased from 39% to 54%, while proportion of noninflammatory THA decreased 34% to 30%.

Indications for arthroplasty. Among SLE arthroplasties, the number performed for osteonecrosis decreased from 53% in 1991 to 24% in 2005, while the proportion involving osteoarthritis (OA) increased from 23% to 61% (Figure 3). The proportion of fractures fluctuated over the years, but overall did not show a significant trend (Figure 3). In the noninflammatory group, the proportion of OA increased from 64% in 1991 to 79% in 2005 (Figure 3).

When comparing SLE and noninflammatory arthroplasties by indication, cases of SLE arthroplasty with osteonecrosis as indication were much younger (mean age of 42 yrs) compared to cases of noninflammatory osteonecrosis (mean age 62 yrs; Table 2). SLE cases in the OA and fracture group were also younger than the comparator group; however, the difference was less pronounced (mean age of 60 yrs vs 68 yrs for OA and 70 yrs vs 80 yrs for fractures; Table 2). Within cases of OA arthroplasty there was no significant difference in regards to arthroplasty distribution between the 2 groups.

Demographic trends. Annual joint replacement rates stratified by age and sex are shown in Figure 4. Annual noninflammatory joint replacement rates stratified by age and

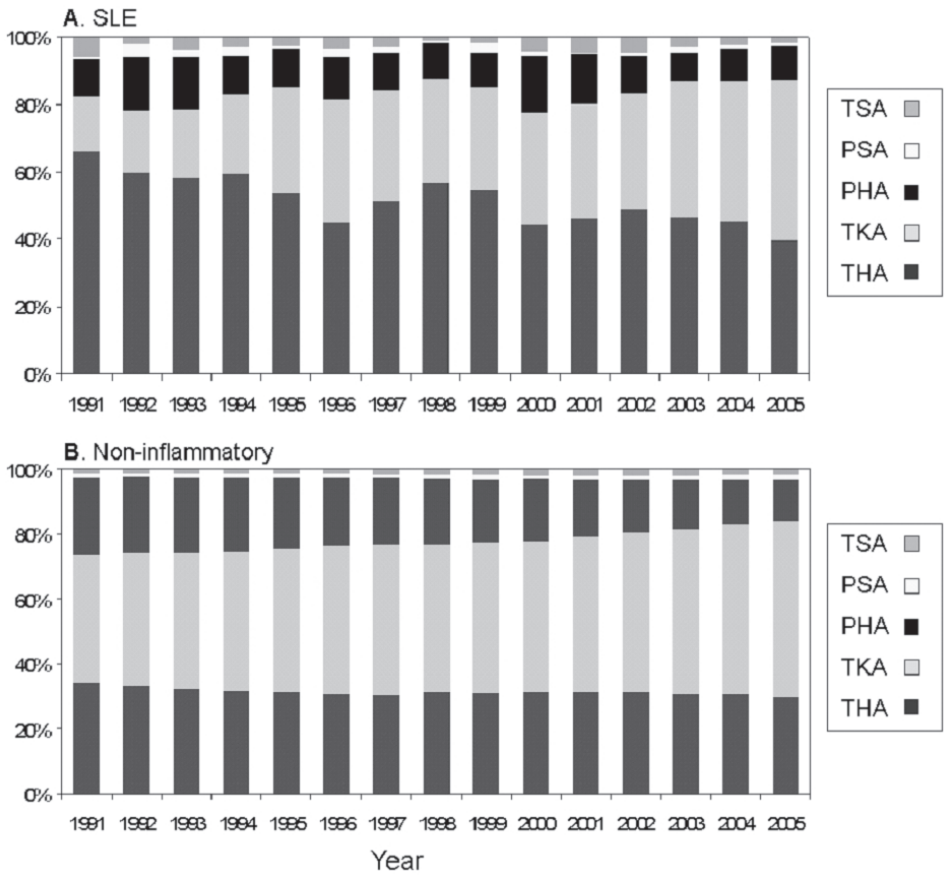

Figure 2. Annual proportion of total (TSA) and partial shoulder (PSA), total (THA) and partial hip (PHA) and knee arthroplasties (TKA) for cases of (A) systemic lupus erythematosus (SLE) and (B) nonautoimmune/noninflammatory conditions.

sex experienced an increase in rates over time (Figure 4). In the SLE group, however, young female patients (age < 44 yrs) demonstrated a statistically significant decrease in rates over time ($p = 0.009$), while all other age-stratified and sex-stratified groups showed an increase in rates over time. The mean age of patients undergoing arthroplasty with noninflammatory conditions decreased (71.5 ± 11.8 yrs in 1991, 69.0 ± 12.0 yrs in 2005; $p < 0.001$). In contrast, the mean age among cases of SLE increased significantly (47.3 ± 17.0 in 1991 vs 56.8 ± 16.0 in 2005; $p < 0.001$).

DISCUSSION

Despite dramatic improvements in SLE therapy over the past decades, orthopedic surgery and arthroplasty maintain a significant role in the management of endstage joint disease in patients with SLE. In fact, in the 15-year period between 1991 and 2005 the population-based rate of joint replacements due to SLE increased in a similar proportion to noninflammatory arthroplasties (Figure 1). This contrasts with RA, another inflammatory autoimmune disease, where rates of arthroplasty appear to be stabilizing or decreasing[3,4]. However, it is important to note that this increase was not seen in young women with SLE. This contrasts with noninflammatory cases, which were increasing in women of this age group.

These findings suggest that advances in SLE therapy may be preventing early joint destruction and the need for arthroplasties in young women, who are most commonly affected by SLE. This may also explain the increase in age at arthroplasty in SLE, going from 47.3 years to 56.8 years. In fact, over the study period the rates of SLE joint replacements tripled in patients older than 45 years. There was also a striking change in the indication for arthroplasty in the SLE group, with OA increasing from 23% to 61% and osteonecrosis decreasing from 53% to 24%. The distribution of SLE arthroplasties in the different joints changed impressively over the study period, with the rate of TKA rising more than 6-fold (0.03 per 100,000 subjects in 1991 to 0.18 per 100,000 subjects in 2005), whereas in the comparator group it slightly more than doubled. At the same time, the proportion of THA decreased 66% to 40%. The most common indication for THA was osteonecrosis. Less reliance on high therapeutic-dose corticosteroids may be leading to a decrease of osteonecrosis as the indication for SLE arthroplasty, and a corresponding decrease in the proportion of hip arthroplasties performed.

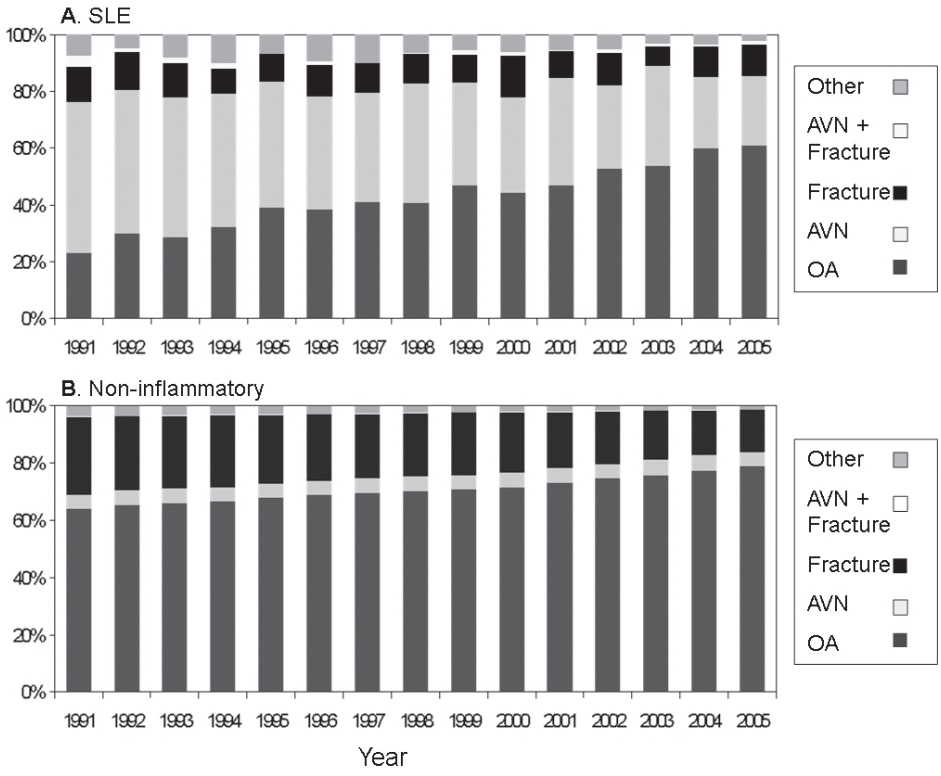

Figure 3. Annual proportion of indication for arthroplasty for cases of (A) systemic lupus erythematosus (SLE) and (B) nonautoimmune/noninflammatory conditions. AVN: avascular necrosis; OA: osteoarthritis.

There were similar increases in rates and similar patterns of arthroplasty use in both older patients with SLE and those with noninflammatory conditions. These convergent patterns suggest that older patients with SLE are approximating their noninflammatory peers in their use of arthroplasty, and that contemporary patients with SLE are living long enough to develop either primary or secondary OA and are healthy enough to have elective surgery.

Even though SLE accounted for only 0.2% of all cases, these data suggest there will be an ongoing need for both surgical and perioperative experts to care for patients with SLE arthroplasty. However, the small absolute numbers of SLE cases may make it difficult for trainees to obtain adequate exposure to these potentially difficult cases. This is important, because patients with SLE have an increased risk for postoperative mortality after joint arthroplasty in comparison to both the general population as well as patients with RA[11] (OR 4.0, 95% CI 1.9–8.0, and OR 1.2, 95% CI 0.2–7.5, respectively). Our data show that although most arthroplasties are performed at nonteaching hospitals, SLE arthroplasties were disproportionally performed at urban teaching hospitals. It is unclear whether this reflects referral patterns of patients perceived to be more challenging or an urban concentration of patients with SLE. Regardless, continuing or even increasing regionalization of patients with SLE arthroplasties may be necessary to ensure trainees receive adequate exposure in caring for these complex medical patients.

Strengths of our study include that it was a large, longitudinal population-based sample representing different geographic areas of the United States. Procedure and diagnosis codes are audited at state level prior to data release, and these data include all payers rather than Medicare (healthcare plan for the elderly) only, a limitation of many similar studies. In addition, the 3 most common arthroplasty sites (hip, knee, and shoulder) were evaluated. Limitations include those common to administrative database analyses. Diagnoses were not validated with chart review, and there is the possibility of miscoding and therefore misclassification bias. However, the coding of major surgical procedures has been demonstrated to be reliable in similar studies[17]. This was a procedure-based analysis, and we could not determine whether the same patient contributed multiple arthroplasties. In addition, annual rates were based on population census data, not the population at risk (i.e., patients with SLE), which would provide disease-based rates, because the state-by-state annual population rate of SLE was not available. Finally, we had no information on disease severity and medications, which might have provided insight into the changing incidence of osteonecrosis among patients with SLE undergoing joint replacement.

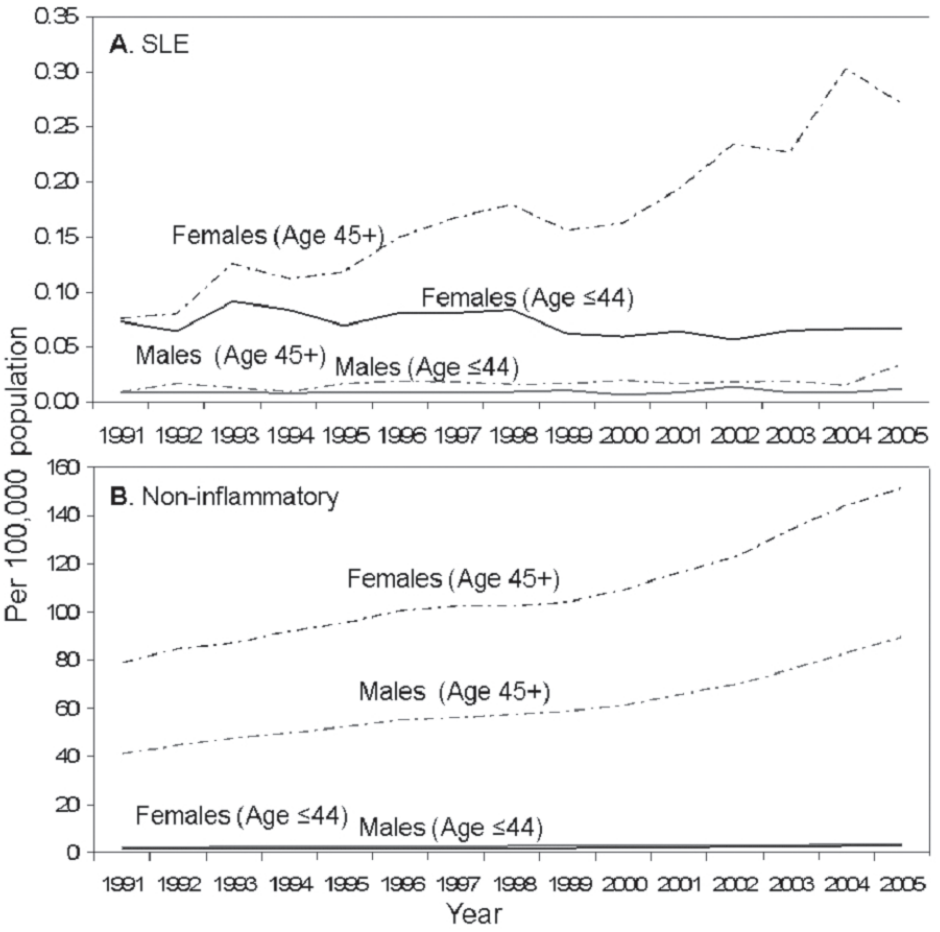

Figure 4. Arthroplasty rates stratified by age and sex for cases of (A) systemic lupus erythematosus (SLE) and (B) nonautoimmune/noninflammatory conditions. Cases of SLE showed statistically significant changes ($p < 0.01$) in rates over time in all groups except in men ≤ 44 years. There were statistically significant differences in trend between the sexes in both age groups ($p < 0.05$). For noninflammatory cases, in all groups there was a statistically significant increase in rates over time ($p < 0.001$). In men and women > 45 years, the increase was about double.

To our knowledge, this is the first evaluation of trends in SLE arthroplasty rates. From 1991 to 2005, patients with SLE continued to require joint replacements despite improvements in SLE morbidity and mortality. In fact, SLE arthroplasty rates increased dramatically, particularly for knees, showing similar relative overall increases compared to patients with no inflammatory or autoimmune disease. In addition, while the mean age of noninflammatory joint replacement fell, the age at the time of SLE joint replacements increased. Further study is needed to better characterize the disease activity in patients with SLE arthroplasty, and to see whether these trends continue with ongoing improvements in clinical care.

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