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Original Research

Arthroplasty Rates Not Increasing in Young Patients With Rheumatoid Arthritis: A National Database Review, 2005 Versus 2014

John F. Nettrour, MD [a, b, *], Bradley S. Bailey, MD, MBA [c], Major B. Burch, MD, MS [b], Devin D. Clair St., MD [b], Rayford R. June, MD [c, d], Nancy J. Olsen, MD [c], Djibril M. Ba, MPH [e, f], Guodong Liu, PhD [e, f], Douglas L. Leslie, PhD [e, f]

[a] Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, PA, USA
[b] Department of Orthopaedic Surgery, University of Missouri, Columbia, MO, USA
[c] Division of Rheumatology, Department of Medicine, Penn State College of Medicine, Hershey, PA, USA
[d] Lebanon Veteran's Administration Medical Center, Lebanon, PA, USA
[e] Department of Public Health Sciences, Pennsylvania State University College of Medicine, Hershey, PA, USA
[f] Center for Applied Studies in Health Economics (CASHE), Penn State College of Medicine, Hershey, PA, USA

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ABSTRACT

Background: For 20 years, authors have predicted an expansion in total knee arthroplasty (TKA) and total hip arthroplasty (THA) utilization. Over this same period, the introduction of biological disease-modifying antirheumatic drugs has dramatically altered the treatment of rheumatoid arthritis (RA) with hopes of preventing articular damage and obviating the need for prosthetic replacement. The goal of our investigation was to evaluate TKA and THA utilization in young patients with RA (<65 years) in 2005 vs 2014 compared to patients with osteoarthritis (OA).

Methods: Using relevant International Classification of Disease Ninth Revision (ICD-9) and Current Procedural Terminology codes, the Truven MarketScan Database (over 46 million enrollees) was queried to determine THA and TKA incidence rates for RA and OA patients aged <65 years during the final decade of ICD-9 use. Patients with potentially confounding ICD-9 codes were excluded to limit coding variation. Statistical analysis consisted of student *t*-tests, Pearson's chi-square tests, and Breslow-Day tests.

Results: For patients with OA, TKAs increased substantially from 0.07% in 2005 to 0.1% in 2014 (+42.9% change, $P < .001$). Similarly for patients with OA, THAs increased from 0.04% to 0.06% over the same time period (+66.0% change, $P < .001$). For young patients with RA, the rate of TKA remained relatively stable—1.06% in 2005 to 1.04% in 2014 (−1.7% change, $P = .65$)—as did THA—0.44% to 0.48% (+9.0% change, $P = .14$).

Conclusions: Dramatic increases in THA and TKA rates for OA patients aged <65 years were indeed observed from 2005 to 2014. This trend, however, was not seen in the RA population where TKA and THA rates remained unchanged.

Introduction

Affecting between 0.5% and 1% of the population, rheumatoid arthritis (RA) is a common autoimmune disease capable of producing long-term musculoskeletal sequelae for those who suffer from the condition [1,2]. One of the many devastating effects of RA is the articular manifestations where small and large joints are damaged from a prolonged inflammatory process. When medical measures fail to preserve a joint, arthroplasty procedures may become necessary for patients with RA. As such, the rate of these procedures can be used as a relative measure of the effectiveness of nonsurgical management of RA over time [3]. Arthroplasty procedures have transformed orthopedic management of end-stage arthritis with more than one million hip and knee replacement procedures performed annually in the United States alone [4]. For most patients, the procedures are not performed for RA, but rather,

* Corresponding author. 2002 W. Grove Circle, Gibsonia, PA, 15044, USA. Tel.: +1-813-447-9820.
E-mail address: nettrour@gmail.com

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osteoarthritis (OA), a common noninflammatory condition affecting 46.4 million Americans and 240 million people globally [5–8]. For the past 3 decades, investigators have reported a consistent trend of accelerating total joint arthroplasty growth with many predicting continued growth for the foreseeable future [5,9–13].

Recent advances in diagnostics, medications, and treatment approaches have improved the care of patients with RA over the past 20 years in ways not seen in their OA counterparts. New insights into RA disease pathophysiology have shown that irreversible structural damage occurs within the first 2 to 3 years of disease, implying that there may exist a window of opportunity in which early treatment can prevent permanent structural damage [14,15]. Furthermore, the development of anticyclic citrullinated peptide assays provides caregivers with greater testing specificity which can lead to earlier diagnosis [16]. Paralleling the rise of early RA testing, new treatments with biologic disease-modifying antirheumatic drugs (DMARDs) have become available [17]. Since their introduction in the United States in 1998, the biologic DMARDs have become a staple of RA treatment as their efficacy and patient tolerance have been confirmed [14]. The dramatic expansion of use of biologic DMARDs was reported by Donges et al. in a review of the prescribing and dispensing data from the Medicare Australian Registry from 2004 through 2014 [18]. In this work, the authors reported an increase of 2089% in biologic DMARD use over their 10-year study period.

For this study, the overall aim was to assess whether the forecasted large-scale rise in hip and knee arthroplasty utilization did in fact occur and if it affected different patient populations equally. We hypothesized that recent diagnostic and therapeutic advances for patients with RA would serve to temper the expansion of arthroplasty procedures in the RA population relative to patients with OA. Our specific goals for the study were to (1) assess the national trends within the United States in THA and TKA utilization in young patients (<65 years) and then (2) to evaluate trend differences between patients with RA and OA in the year 2014 vs 2005. The particular time points for the study were chosen because (1) they represent the final consistent decade of International Classification of Disease Ninth Revision (ICD-9) code use and (2) they coincide with the emergence and incorporation of biologic DMARDs into contemporary RA management [18].

Material and methods

Study database

The Truven MarketScan Claims and Encounters Database was queried for this investigation. The database is an extensive compilation of medical and prescription insurance information including the inpatient and outpatient records from more than 100 large corporations and insurance carriers. The portion of the database queried for this study comprised patients aged <65 years and contained the health and drug information for more than 47 million enrolled United States participants. For this investigation, the years 2005 and 2014 were evaluated, representing the final decade of ICD-9 code designation use.

Study groups and exclusions

After obtaining institutional review board approval, the MarketScan database was queried for patients who underwent a THA or TKA in the years 2005 and 2014. Each procedure was searched by the designated Current Procedural Terminology codes: 27,130 for THA and 27,447 for TKA. From this group of patients who underwent the arthroplasty procedures, RA and OA cohorts were generated for the 2 years. To create the RA cohort, the ICD-9 code designations 714.0 (RA) and 714.1 (RA with Felty's syndrome) were searched in the database. To limit the potential for coding variation and errors for both the RA and OA cohorts and produce the most "true" study groups possible, a list of "potentially confounding" inflammatory codes were compiled for exclusion, and patients receiving the potential codes were removed from the study groups (Table 1). The remaining patients who did not carry a specific code for RA or a "potentially confounding" inflammatory arthropathy code were designated for the OA group. The total number of THA and TKA procedures performed for each of the 2 study groups was determined for the years 2005 and 2014. To evaluate the underlying demographic stability and consistency of the MarketScan database over the study time period, patient ages, genders, ICD-9 code designations, and frequencies were assessed for the years 2005 and 2014.

DMARD utilization

To evaluate changes in biologic DMARD prescribing patterns over the time period, the MarketScan database was queried for all RA enrollees (as defined previously) who were prescribed a DMARD medication in the years 2005 and 2014. All known biologic DMARD medications approved by the United States Food and Drug Administration for the treatment of RA before 2016 were searched within the database by generic name. All routes of administration, including oral, subcutaneous, and intravenous, were included for the pharmacology record searches (Table 2).

Statistical analysis

A univariate statistical analysis for the derived data was performed using (1) student *t*-tests to assess parametric patient demographic data, (2) Pearson's chi-square tests to analyze categorical frequency data, and (3) the Breslow-Day test to evaluate different rate changes between data sets at the different years of study. For all analyses, a *P* value of less than 0.05 was used to denote statistical significance.

Results

Patient demographics and database consistency

Comparing 2014 to 2005, the MarketScan database underwent an expansion in participant enrollment. The underlying demographic parameters, however, remained largely unchanged (Table 3). The number of enrolled participants increased 88.8% from 25,035,852 in 2005 to 47,258,528 in 2014. Most database participants in 2005 were female (12,964,920; 51.8%), and this slight female predominance was again observed in 2014 (24,226,585; 51.3%). As this study comprised only patients aged <65 years, the average patent age was young for both years. From 2005 to 2014, the mean enrollee age decreased slightly from 33.7 years (±18.4, range 0-64 years) to 33.3 years (±18.4, range 0-64 years). RA prevalence within the database remained consistent for both study points. In 2005 and 2014, 0.4% of database enrollees had been assigned an ICD-9 RA diagnosis code without receiving a "potentially confounding" code. However, approximately 25% of patients receiving RA codes in both 2005 and 2014 also received one or more "potentially confounding" inflammatory codes and were removed from the investigational groups (Table 1).

Within the RA population, gender distribution remained consistent at the 2 measured time points. In 2005, most patients carrying an RA diagnosis code were female (68,997 females, 74.9%). A similar gender distribution was observed in 2014 (144,437 females, 76.4%). The average age of the RA cohort remained constant with a 2005 mean age of 50.2 years (±10.8) and a 2014 mean age of 50.5 years (±10.8).

Table 1
Excluded diagnoses for study groups.

Condition	Associated ICD-9 Code(s)[a]	Occurrence count 2005[b]	Occurrence count 2014[b]
Total patients with rheumatoid arthritis	714.0, 714.1	91,106	186,961
Excluded diagnosis codes			
Unspecified inflammatory polyarthropathy	714.9, 714.89	7054	15,642
Ankylosing spondylitis	720.0, 720.2, 720.8, 720.9, 696.0	4296	10,073
Systemic lupus erythematosus	710.0	3146	6687
Other specified diffuse diseases of connective tissue	710.8-710.9	1771	4116
Systemic sclerosis, Sjogren's syndrome, dermatomyositis, polymyositis, sicca syndrome	710.1-710.4	1601	6722
Still's disease	714.30-714.33	1401	2422
Polymyalgia rheumatica	725	548	926
Regional enteritis-unspecified, ulcerative colitis	556	413	1162
Sarcoidosis	135	345	923
Autoimmune disease (not otherwise classifiable)	279.4-279.8	327	1588
Palindromic rheumatism	719.3	185	444
Granulomatosis with polyangiitis (Wegener's)	446-446.9	125	306
Vasculitis	447.6	80	374
Postrheumatic arthropathy	714.4	66	92
Hypersensitivity angiitis	446.2	59	146
Reactive arthritis	711.1	48	55
Polyarteritis nodosa	446.0	42	55
Behcets syndrome	136.1	40	119
Henoch-Schonlein Purpura	287.0	33	51
Allergic arthritis	716.2	32	52
Takayasu arteritis	446.7	13	28
Sarcoidosis with arthropathy	713.7	4	6
Arthropathy with Behcets syndrome	711.2	4	2
Kawasaki disease	446.1	2	14
Other inflammatory disorder associated with gastrointestinal disorder	713.3	2	4
Goodpasture's syndrome	446.21	0	0
Total exclusions (number of individual patients)		21,637 (20,953)	52,009 (50,241)
Rheumatoid arthritis patients for study[b]		70,153 (77.0%)	136,720 (73.1%)

[a] International Classification of Disease, Ninth Revision.
[b] Truven MarketScan Database, some patients carried more than one excluded diagnosis code.

Knee arthroplasty changes, 2005 vs 2014

Different changes in TKA usage were noted for the 2 study groups (Table 4). For the RA cohort, the incidence of TKA use decreased slightly from 1.06% to 1.04% from 2005 to 2014, representing a −1.70% change in procedural volume for younger patients with RA. This change, however, did not achieve statistical significance ($P = .65$). In contrast, for the patients with OA, TKA use from 2005 to 2014 *increased* +42.9% from 0.07% to 0.10% ($P < .001$). The difference in rate changes between the groups was also statistically significant (−1.70% vs +42.9%, $P < .001$, Breslow-Day Odds Ratio).

Hip arthroplasty changes, 2005 vs 2014

Similarly, significant THA use differences were noted between the study groups (Table 5). For the RA cohort, THR incidence increased from 0.44% in 2005 to 0.48% in 2014. This represented a 9.0% increase, but the change was not statistically significant ($P = .14$). For the OA group, the frequency of THA rose from 0.04% to 0.06% over the same time period. This represented a significant 66.0% increase ($P < .001$). The difference between the 2 THR groups in THA use was statistically significant (9.0% vs 66.0%, $P < .001$, Breslow-Day Odds Ratio).

Table 2
United States Biologic DMARD Utilization for Rheumatoid Arthritis <65 years of age Truven MarketScan Database 2005 vs 2014.

Medication	Year of FDA approval	Route of administration	RA patients receiving medication 2005	RA patients receiving medication 2014
Rituximab	1997	Intravenous	7	205
Etanercept	1998	Subcutaneous	9772	16,921
Infliximab	1999	Intravenous	237	563
Anakinra	2001	Subcutaneous or intravenous	217	80
Adalimumab	2002	Subcutaneous	4342	13,575
Abatacept	2005	Intravenous		2720
Certloizumab Pegol	2009	Subcutaneous		1378
Tocilizumab	2010	Subcutaneous		759
Tofacitinib	2012	Oral		2027
Golimumab	2009	Subcutaneous		1559
Total RA patients receiving DMARD medications			14,575	39,787

DMARD, Disease-modifying antirheumatic drugs; FDA, United States Food and Drug Administration.; RA, rheumatoid arthritis.

Table 3
Database[a] demographics.

Demographic parameter	Year 2005	Year 2014
Database[a] enrollees aged <65 y	25,035,852	47,258,528
Female enrollees	12,964,920 (51.8%)	24,226,585 (51.3%)
Male enrollees	12,070,932 (48.2%)	23,031,943 (48.7%)
Average age of participant[b]	33.7 years 18.4	33.3 years 18.4
Participants aged 0-17 y	6,612,440 (26.4%)	11,445,630 (24.2%)
Participants aged 18-34 y	6,041,039 (24.1%)	12,725,182 (26.9%)
Participants aged 35-44 y	4,309,362 (17.2%)	7,419,240 (15.8%)
Participants aged 45-54 y	4,538,622 (18.1%)	8,173,572 (17.3%)
Participants aged 55-64 y	3,534,389 (14.2%)	7,494,904 (15.8%)
RA patients (meeting exclusion criteria)[c]	91,106 (0.04%)	186,961 (0.04%)
Female RA enrollees	68,995 (74.9%)	144,437 (76.4%)
Male RA enrollees	23,089 (25.1%)	44,496 (23.6%)
Average age of RA patient[b]	50.2 years 10.8	50.5 years 10.8
RA participants aged 0-17 y	1212 (1.3%)	1604 (0.9%)
RA participants aged 18-34 y	7309 (7.9%)	16,009 (8.4%)
RA participants aged 35-44 y	14, 564 (15.8%)	28,818 (15.3%)
RA participants aged 45-54 y	30,162 (32.8%)	58,518 (31.0%)
RA participants aged 55-64 y	38,837 (42.2%)	83,984 (44.4%)

RA, rheumatoid arthritis.
[a] Truven MarketScan Claims and Encounters Database patients <65 years of age.
[b] Mean.
[c] Exclusion criteria as listed in Table 1.

DMARD use

Between 2005 and 2014, the number of FDA-approved biologic DMARD medications doubled from 5 to 10. The prescribing data for each medication are presented in Table 2. With expansion of the database, the young RA cohort increased from 70,153 in 2005 to 136,720 in 2104 (+95.0% change). This change was outpaced, however, by increased DMARD utilization as the number of RA cohort enrollees receiving DMARD medications rose from 14,575 in 2005 to 39,787 in 2014 (+173.0% change). From 2005 to 2014, the proportion of patients with RA receiving DMARD medications increased from 20.8% to 29.1% ($P < .001$).

Discussion

Over the past 30 years, different author groups have predicted that a continued ongoing expansion of arthroplasty procedures would occur. In a review of the Nationwide Inpatient Sample, Kurtz et al. evaluated historical arthroplasty rates and predicted that by the year 2030, the demand for THA and TKA would grow substantially in the United States by 673% and 174%, respectively [13]. Using different growth modeling scenarios, Inacio et al. predicted an expansion of TKA volume in the United States between 143% and 855% from 2012 to 2050 [12]. Similarly, Iorio et al. projected that between 2005 and 2030, the number of primary THAs performed in the United States would increase by 101% and that the number of primary TKAs would increase by 565% [5].

The overall results of our investigation using the MarketScan database comparing 2005 vs 2014 are consistent with these historical predictions. We observed significant overall increases in hip and knee arthroplasty rates for patients with OA. Between the years of our investigation, TKA usage in young patients with OA increased 42.9% while THA incidence increased 66.0%. This increase may reflect multiple underlying factors including expanding indications, advances in prosthetic materials, changing patient expectations, and improved implant survivorship. For the patients with RA in our study, TKA and THA usage results were very different. Unlike the OA patient cohort, an expansion of THA and TKA procedures was not observed in the young RA population. In fact, where patients with OA showed a 42.9% rise in TKA, utilization in their RA counterparts was largely unchanged (−1.70%, $P = .65$). Similarly, while the OA group experienced an increase in THA rates of 66.0%, the RA subgroup rate increased by only 9.0%, with the change not reaching statistical significance ($P = .14$). Our findings are consistent with

Table 4
TKA rates: 2005 vs 2014 for patients aged <65 years.

Study group	Y 2005	Y 2014	Utilization rate change	Absolute difference utilization rate change
RA group			−1.07% ($P = .65$)[a]	
Total TKA patients	978	1972		
Percentage of RA patients undergoing TKA	1.06%	1.04%		
Female TKA patients (%)	781 (79.9%)	1527 (77.4%)		
Male TKA patients (%)	197 (20.1%)	445 (22.6%)		44.0% ($P < .001$)[b]
Average age at TKA	55.8 y	56.5 y		
OA Group				
Total OA-TKA patients	18,512	46,734	+42.9% ($P < .001$)[a]	
Percentage of OA patients undergoing TKA	0.07%	0.10%		
Female OA-TKA patients	11,630 (62.8%)	27,559 (59.0%0		
Male OA-TKA patients	6882 (37.2%)	19,175 (41.0%)		
Average age at TKA	57.1 y	57.5 y		

OA, osteoarthritis; RA, rheumatoid arthritis; TKA, total knee arthroplasty.
[a] Pearson's Chi-square test.
[b] Breslow-Day test.

Table 5
THA rates: 2005 vs 2014 for patients aged <65 years.

Study group	Y 2005	Y 2014	Utilization rate change	Absolute difference utilization rate change
RA Group			+9.0% ($P = .14$)[a]	
Total THA patients	408	910		
Percentage of RA patients undergoing THA	0.44%	0.48%		
Female THA patients (%)	299 (73.7%)	640 (70.3%)		
Male THA patients (%)	107 (26.3%)	270 (29.7%)		57.0% ($P < .001$)[b]
Average age at THA	52.4 y	54.7 y		
OA Group				
Total OA-THA patients	8965	28,086	+66.0% ($P < .001$)[a]	
Percentage of OA patients undergoing THA	0.04%	0.06%		
Female OA-THA patients	4252 (47.4%)	13,178 (46.9%)		
Male OA-THA patients	4713 (52.6%)	14,908 (53.1%)		
Average age at THA	56.7 y	55.7 y		

OA, osteoarthritis; RA, rheumatoid arthritis; THA, total hip arthroplasty.
[a] Pearson's Chi-square test.
[b] Breslow-Day test.

smaller scale reports which have suggested relative levelling-off of arthroplasty rates for patients with RA. In a 2010 review of the Rochester Minnesota Epidemiology Project, Singh et al. noted that in the final years of their study, the proportion of patients with RA receiving TKA and THA procedures appeared to decrease [19]. Similarly, in study incorporating patients who underwent total shoulder and total elbow arthroplasties, Young et al. reported a late decrease in the incidence of patients with RA undergoing upper extremity replacements, while the rates of lower extremity arthroplasties did not significantly change [20]. To our knowledge, the present study represents the most current and expansive inquiry into TKA and THA utilization in the RA population.

Over the past 20 years, RA management has evolved from reactionary symptom management to disease-targeted therapy initiated early in the disease process. This change has been initiated with the hopes of preventing articular damage in addition to providing symptom relief [21]. A major component of this change has been the introduction and widespread implementation of biologic DMARD medications as their efficacy has been supported in registry reviews and clinical trials [22–24].

Our results parallel these findings as DMARD use in our young RA group increased from 20.8% of patients in 2005 to 29.1% of patients in 2014% ($P < .001$). Although it is not possible to imply causation, the lack of arthroplasty growth in our RA population coupled with increasing DMARD usage warrants further study.

Our investigation has both strengths and weaknesses which should be highlighted. First, as a large retrospective database investigation, the study is inherently limited by and subject to variances and errors associated with data entry and coding. To reduce this source potential variation, we aimed to create the most "true" cohorts for our RA and non-RA groups and intentionally excluded those patients where coding errors and variances could most easily occur. In our opinion, this process created more accurate RA and OA study groups but led to the exclusion of potentially relevant patients for both years being evaluated and served to decrease the final numbers for the investigation. Second, the present study is unusual in the sheer size of the deidentified participant pool under investigation (more than 46 million individuals) and is the largest to explore changes in RA arthroplasty usage in the United States. Unlike other procedure utilization studies, our investigation concurrently tracks 2 separate populations using the non-RA cohort as a relative "control" during this period of changing rheumatology practice. Third, to our knowledge, this is the first study to simultaneously track arthroplasty utilization rates and DMARD prescribing patterns. Fourth, this work is not a longitudinal study and represents only 2 specific years, 2005 and 2014. As such, we are unable to offer insight into smaller scale prescribing or procedural changes within the last decade of ICD-9 use. Finally, we must underscore that this investigation is inherently limited by the database to (1) patients with health insurance coverage through private carriers and (2) patients younger than 65 years. As such, caution should be exercised in the extrapolation of these findings to other potential populations or demographic groups.

Conclusions

Upon review of the national Truven MarketScan database, it is seen that for OA patients younger than 65 years, the rate of THA and TKA use increased greatly from 2005 to 2014. As such, our results are consistent with past predictions of ongoing arthroplasty growth. In contrast to this general observation, we did not find a comparable increase in arthroplasty use for young patients with RA in the years we examined. Furthermore, from 2005 and 2014, we observed an increase in the proportion of patients with RA receiving DMARD medications from 20.8% to 29.1%. Without outside factors, one would expect arthroplasty rates for patients with RA to have mirrored those observed in the OA group. The finding that THA and TKA rates did not increase for young patients with RA, while those for patients with OA did, may reflect recent advancements in the nonoperative management of RA, such as the use of biologic DMARDs, and further investigation into this correlation is warranted.

Conflict of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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