


Healthcare Costs and Resource Utilization: The Impact of Gender on Outcomes of Total Joint Replacement

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Abstract

Introduction: Gender disparities exist in healthcare affecting patient care and lead to greater healthcare financial burden. The purpose of this study was to determine the impact of gender disparities on postoperative complications and readmission rates for Total Joint Replacement (TJR).

Methods: A retrospective analysis of a large national healthcare database was queried to identify patients who underwent TJR (total hip arthroplasty, total knee arthroplasty, total shoulder arthroplasty) between 2017 and 2021. Patient demographics including age, race, gender and comorbidities were collected. Logistic regression and odds ratio analyses assessed for associations between gender (defined as either male or female at birth) and postoperative medical and prosthetic complications. Length of stay, readmission status at 30, 60 and 90 days postoperatively and ER readmission up to 90 days were collected.

Results: A total of 16,940 patients (62% female) with an average age of 71 years were included in this study. The average length of stay was 3.5 days for female patients and 3.3 days for male patients ($p < 0.001$). There was no significant difference in the incidence of postoperative medical complications based on gender ($p = 0.2367$). Male patients were 21% less likely to experience prosthetic complications compared to female patients ($p = 0.0035$). Male patients were 18% more likely to be readmitted to the hospital within 30 days ($p = 0.0038$) and 13.3% more likely within 60 days ($p = 0.0066$). No gender differences were found for hospital readmissions ($p = 0.0915$) or ER visits ($p = 0.3287$) within 90 days of TJR.

Conclusion: Overall male patients were more likely to be readmitted at 30 and 60 days after TJR, but female patients did have a greater risk of prosthetic complications and longer length of stay. Male gender appears to negatively impact healthcare resource utilization creating concerns for increased cost after TJR in the 30-day and 60-day

postoperative period.

Keywords: Gender, Total Hip Arthroplasty; Total Knee Arthroplasty; Total Shoulder Arthroplasty; Readmission Rates; Complications

Level of Evidence: III; Retrospective study.

Introduction

Gender-based differences impact all areas of healthcare, affecting utilization, patient care and outcomes [1-5]. Failing to address and account for these differences is a missed opportunity to alleviate disparity and reduce the mounting financial healthcare

burden [6-8]. Despite the high incidence of joint replacement procedures, with over 1 million total hip and total knee replacement procedures performed each year in the United States, there is limited research exploring gender differences in outcomes of TJR [1,3,4,9-16]. In addition, there is a recent concern surrounding readmission rates and their resulting unplanned and costly outcomes for the patient and healthcare system [17-20]. The mean cost of readmission following primary TJR has been found to be between \$10,000 and \$18,000 in the last few decades [21-24]. A national sample of U.S. acute care hospitals found that although the 30-day readmission rate for Total Knee Arthroplasty (TKA) saw a reduction of 16% from 2009-2014, mean costs per stay increased [24]. Furthermore, the demand for primary total joint arthroplasty has been predicted to rise significantly, with Total Shoulder Arthroplasty (TSA), Total Hip Arthroplasty (THA) and TKA projected to increase by 67.2%, 71.2% and 84.9% respectively by 2030 [25,26]. With the rising utilization and cost orthopaedic surgery as well as the shift in focus to value-based care, factors affecting this paradigm are critical.

Several studies have demonstrated gender differences in various aspects of TJR including need, utilization, complications and outcomes [2,4,7,13,27-31]. However, the character of the disparities varies depending on factors such as the particular joint affected and the outcome measured [1,11,14,16,31,32]. Prior studies have found underutilization of TJR in cases of severe arthritis and the degree of underuse is greater in women who also present with worse symptoms and greater disability compared to men [4,13,29]. Gender disparities have been identified in postoperative complications following TSA, THA and TKA [3,12,13]. Men were found to have an increased risk of death, surgical site infection, cardiac arrest, return to the operating room and readmission while women had an increased risk of urinary tract infection and blood transfusion as well as a slightly higher venous thromboembolism risk [33,34]. Women have a higher prevalence of Osteoarthritis (OA) and present to surgery with more advanced OA than men, which may explain some of the gender disparities in joint replacement [4,13,35]. Cherian, et al., demonstrated that despite the fact that women showed greater improvement from their baseline after TKA, women were found to have worse functional scores both prior to surgery and postoperatively up to 7 years compared to men [1]. Women have also been found to have longer hospital stays and were more likely to be discharged to a rehabilitation facility after THA and TKA [33,36,37]. Additionally, although women who undergo TSA are often older, have higher Body Mass Index (BMI) and have worse preoperative functional scores than men, Donigan, et al., found that female gender alone predicted worse functional outcomes, while age, medical comorbidities, obesity and preoperative range of motion did not [32,38,39].

Despite advancements in our understanding of gender differences surrounding TJR, results have been inconsistent with some studies finding no gender differences or differences only in some outcome measures [40-42]. The limited and occasionally contradicting results in the literature merit a closer look at gender disparities in TJR and the impact of patient gender on complications and healthcare utilization has not been well established. The purpose of this study was to determine the impact of gender disparities on postoperative complications and readmission rates following TJR.

Methodology

Patient Selection and Data Collection

A retrospective chart review and analysis of a large national healthcare network database was queried to identify patients who underwent Total Joint Arthroplasty (TJA) (THA, TKA or TSA) between 2017 and 2021. Patients were included if they were ≥ 18 years of age and had a documented TJA. Patient demographics including age, gender (defined as either male or female at birth), Body Mass Index (BMI), race and comorbidities (narcotic drug abuse, tobacco use, diabetes mellitus, hypertension, renal failure, vascular disease) were collected. Outcome measures collected included length of stay, complications, hospital readmission status at 30, 60 and 90 days and ER visits up to 90 days. Complications were separated into postoperative medical and prosthetic complications. Postoperative medical complications included sepsis, bacterial infections, disruption of the surgical wound and embolism or thrombosis. Prosthetic complications included hardware failure, aseptic loosening, periprosthetic fracture, dislocation, instability, wear and osteolysis.

Statistical Analysis

All statistical analyses were performed using SAS software, version 9.4 (SAS Institute, Cary, NC, USA). Categorical variables were compared using a chi-squared test and continuous variables were compared using analysis of variance. Multivariate logistic regression analysis was performed to assess for associations between complications with patient gender. Odds ratio estimates and 95% confidence intervals were calculated for each of the composite outcomes for patients undergoing TJA. A p-value < 0.05 determined significance.

Results

A total of 16,940 patients (62% female) with a mean age of 71 years and mean BMI of 29.5 kg/m² were included. The average age was 72 years for females and 69.9 years for males. The average length of stay was 3.5 days for female patients and 3.3 days for male patients ($p < 0.001$). Male patients had a higher prevalence of tobacco use (10.8% vs. 7.4%; $p < 0.001$), type 2 diabetes (25.6% vs. 22.8%; $p < 0.001$) and renal failure (10.4% vs 6.3%; $p < 0.001$) while female patients had higher prevalence of hypertension (58.9% vs. 62.4%; $p < 0.001$) (Table 1). Additionally, the female cohort had a greater proportion of Black and Hispanic patients and a smaller proportion of White patients compared to males (all, $p < 0.001$).

Postoperative Complications

Postoperative medical complications occurred in 2.57% ($n=435$ patients) of patients whereas postoperative prosthetic complications occurred in 4.56% ($n=772$ patients) of patients (Table 2). There was no significant difference in the likelihood of postoperative medical complications between genders (Odds Ratio (OR)=0.980, $p=0.2367$). Male patients were less likely to experience prosthetic complications when compared to female patients (OR=0.790, $p=0.0035$) (Table 3). The most common medical complication in male patients was sepsis (1.07%), whereas infection was most common in female patients (1.23%) (Table 4). The most common prosthetic complication in male patients was aseptic loosening (1.07%), whereas hardware failure was the most common in female patients (1.3%) (Table 5). Overall, 1.5% ($n=252/16,940$) of patients required revision surgery.

Readmission Rates

When assessing for hospital readmission rates postoperatively, 8.6% ($n = 1461$ patients) of patients were readmitted within 30 days, 14% ($n=2370$ patients) were readmitted within 60 days and 20.3% ($n = 3446$ patients) were readmitted within 90 days. Furthermore, 7.18% ($n = 1216$ patients) of patients visited the ER within 90 days (Table 2). Male patients were 18% more likely to be readmitted to the hospital within 30 days (OR=1.178, $p = 0.0038$) and 13.3% more likely within 60 days (OR=1.133, $p=0.0066$) (Table 3). No gender differences were found for 90-day hospital readmissions (OR=1.070, $p=0.0915$) or ER visits (Odd Ratio=1.062, $p=0.3287$) for TJR cohort.

	Male	Female	Total	
	Avg. or No. (%)	Avg. or No. (%)	Avg. or No. (%)	p-value
No. of Patients	6,443	10,497	16,940	
Age, y	69.9	72	71.2	
Average BMI, kg/m ²	29.6	29.4	29.5	
Race				
Asian	39 (0.6)	92 (0.9)	131 (0.8)	0.05233
Black	654 (10.2)	1435 (13.7)	2,089 (12.3)	< 0.001*
Hispanic	1359 (21.1)	2718 (25.9)	4,077 (24.1)	< 0.001*
Other	78 (1.2)	125 (1.2)	203 (1.2)	0.90103
White	4313 (66.9)	6127 (58.4)	10,440 (61.6)	< 0.001*
Length of stay, days	3.3	3.5	3.4	< 0.001*
Modifiable Risk Factors				
Narcotic drug abuse	234 (3.5)	353 (3.4)	587 (3.5)	0.35223
Tobacco use	696 (10.8)	780 (7.4)	1,476 (8.7)	< 0.001*
Diabetes mellitus	1663 (25.8)	2407 (22.9)	4,072 (24)	< 0.001*
Type 1 Diabetes	11 (0.2)	16 (0.2)	27 (0.2)	0.76922
Type 2 Diabetes	1652 (25.6)	2393 (22.8)	4,045 (23.9)	< 0.001*
Hypertension	3792 (58.9)	6545 (62.4)	10,337 (61)	0.0058*
Renal failure	668 (10.4)	657 (6.3)	1,325 (7.8)	< 0.001*
Vascular disease	184 (2.9)	265 (2.5)	449 (2.7)	0.19329

Table 1: Patient demographics.

Outcome	Male	Female	Total
Postoperative medical complications	2.52% (n=163)	2.59% (n=272)	2.57% (n=435/16,940)
Postoperative prosthetic complications	3.96% (n=255)	4.93% (n=517)	4.56% (n=772/16,940)
Readmission at 30d	9.51% (n=613)	8.08% (n=848)	8.6% (n=1461/16,940)
Readmission at 60d	15.07% (n=971)	13.33% (n=1399)	14% (n=2370/16,940)
Readmission at 90d	21.43% (n=1381)	19.67% (n=2065)	20.3% (n=3446/16,940)
ER visit at 90d	7.56% (n=487)	6.94% (n=729)	7.2% (n=1216/16,940)

Table 2: Complications and readmission rates by gender.

Outcome	Odds Ratio (M v F)	95% CI	p-value
Postoperative medical complications	0.980	(0.795-1.058)	0.2367
Postoperative prosthetic complications	0.790	(0.674-0.925)	0.0035*
Readmission at 30d	1.178	(1.054 - 1.316)	0.0038*
Readmission at 60d	1.133	(1.035-1.240)	0.0066*
Readmission at 90d	1.070	(0.989-1.156)	0.0915
ER visit at 90d	1.062	(0.941-1.199)	0.3287

M, male; F, female; CI, confidence interval; *, p<0.01.

Table 3: The effect of gender on complications and readmission rates.

Complication	Male	Female	Incidence
Infection	1.04% (n=67)	1.23% (n=129)	1.16% (196/16,940)
Sepsis	1.07% (n=69)	0.94% (n=99)	0.99% (n=168/16,940)
Embolism or thrombosis	0.36% (n=23)	0.39% (n=41)	0.4% (n=64/16,940)
Disruption of the surgical wound	0.06% (n=4)	0.03% (n=3)	0.04% (n=7/16,940)
Total	2.52% (n=163)	2.59% (n=272)	2.57% (n=435/16,940)

No., number.

Table 4: Postoperative medical complications by gender.

Complications	Male	Female	Incidence
Hardware failure	1.07% (n=69)	1.30% (n=136)	1.21% (n=205/16,940)
Aseptic loosening	1.13% (n=73)	1.21% (n=127)	1.18% (n=200/16,940)
Periprosthetic fracture	0.47% (n=30)	0.88% (n=92)	0.72% (n=122/16,940)
Dislocation	0.81% (n=52)	0.86% (n=90)	0.84% (n=142/16,940)
Instability	0.29% (n=19)	0.48% (n=50)	0.41% (n=69/16,940)
Wear and osteolysis	0.19% (n=12)	0.21% (n=22)	0.2% (n=34/16,940)
Total	3.96% (n=255)	4.93% (n=517)	4.56% (n=772/16,940)

No., number.

Table 5: Postoperative prosthetic complications by gender.

Discussion

Gender differences have the potential to significantly impact outcomes following TJR. Previous literature has demonstrated disparities in outcomes of total joint replacement based on gender [1,3,7,11-13,15,27,28,30,31]. However, few are based on analysis of large national databases and are limited to clinical or functional outcomes [15,27-29,32]. To better understand the impact of gender on healthcare cost and utilization, we need risk-stratified studies to understand the impact of gender on readmission rates and postoperative complications after TJA. Our results suggest that overall gender was not a critical factor associated with

postoperative medical complications, but female patients may need to be aware of their increased risk of prosthetic complications after TJR. A better understanding and what factors lead to increased early prosthetic complications and how to best address these. Our results also demonstrated that males were more likely to have increased healthcare costs in the first 60 days postoperatively with higher early readmissions postoperatively compared to females.

Although previous literature has demonstrated gender differences in postoperative outcomes of TJR, our findings did not see these differences sustained [7,11,13,14,30]. When analyzing a large national inpatient sample that underwent TKA and THA Basques, et al., found that while males had a lower rate of any adverse event including Urinary Tract Infection (UTI), Deep Venous Thrombosis/Pulmonary embolism (DVT/PE) and blood transfusion, they experienced increased rates of death, acute kidney injury, cardiovascular complications and infection when controlling for baseline characteristics [12]. Additionally, although female patients were more likely to be discharged to an extended care facility compared to male patients, male patients were found to have higher hospital costs [33,43]. These results confirm previous literature yielding similar results [34,38,44,45]. Similar findings have been identified in TSA, with female patients being at increased risk of extended length of stay, postoperative thromboembolic events and blood transfusion [3,7,12,13,31]. Hung, et al., demonstrated that female patients undergoing TSA may be at greater risk for periprosthetic fracture and aseptic loosening compared to male patients who are at greater risk for periprosthetic infection and revision surgery [46]. In comparison, our study found that females were more likely to experience prosthetic complications that included hardware failure, aseptic loosening, periprosthetic fracture, dislocation, instability, wear and osteolysis. However, postoperative medical complications were not found to be significantly different across genders in our investigation. Specifically, we did not find males to be more likely to experience adverse events such as sepsis, bacterial infections, disruption of the surgical wound and embolism or thrombosis. In perspective with the previous literature overall, our findings suggest that as we continue to improve our outcomes with lower complication rates, there still remain gender differences. The variations in outcome differ between studies but overall concerns for prosthetic complications need to be further evaluated for females in terms of implant selection and optimization to prevent these types of complications. Furthermore optimizing resource utilization and social support to decrease length of stay and need to extended care facilities is specifically important for female patients undergoing TJA.

Our study also offers insight into the frequency and timing of readmission across genders suggesting that men are more likely to experience early readmission following TJR. Readmission following TJR places significant financial strain on the healthcare system and can be a major stressor for the patient and the surgeon [18,22,24,30]. Previous studies have failed to identify gender disparities in readmission rates while others have suggested gender is a significant predictor of readmission in the short and long term [42,47-50]. Further, many of these are limited by relatively small cohorts, short observation periods and contradicting results [42,48,49,51,52]. Zmistowski, et al., analyzed 10,633 primary total joint arthroplasty admissions and indicated male sex to be a significant independent predictor of readmission at 30 days [53]. In contrast, Chung, et al., found that female sex was associated with decreased risk of readmission as far out as 90 days [47]. Our study builds on those findings, suggesting that males are at increased risk of early readmission up to 60 days following TJR and perhaps even up to 90 days, we found the association of readmission and male gender trended towards significance ($p=0.0915$).

The limitations of this study stem from its retrospective nature and its use of a large dataset created from routinely collected data deriving from an electronic health record. The potential issue of coverage and representativeness in large datasets is less of a concern, as our study is a large dataset of a number of different hospitals and it looks at relative associations and utilizes an appropriate sampling strategy for the population of interest. A relative limitation of this study is that it is an analysis of total joint replacement broadly and lacks subset analyses by procedure type that may have provided additional information regarding the impact of gender disparities for each specific procedure. However, our purpose was to provide a broad view of gender differences in complications and readmission following total joint replacement to provide an understanding of how gender may impact the cost and utilization of TJR using a large national healthcare network database. Future studies should aim to analyze national databases for gender disparities within specific procedure types and revision procedures. The strengths of this study are its relatively large sample from a national database compiling data from multiple hospitals and our ability to use multivariate analysis to control for several confounding variables simultaneously.

Conclusion

Overall male patients were more likely to be readmitted at 30 and 60 days after TJR, but female patients did have a greater risk of prosthetic complications and longer length of stay. Male gender appears to negatively impact healthcare resource utilization creating concerns for increased cost after TJR in the 30-day and 60-day postoperative period. This has important implications, as prior literature has demonstrated that early readmissions are more likely to be preventable and respond to hospital-based interventions. This is critical to understand in a bundled payment and outpatient surgery environment.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Statement

The project did not meet the definition of human subject research under the purview of the IRB according to federal regulations and therefore was exempt.

Informed Consent Statement

Informed consent was obtained from all participants included in the study.

Authors' Contributions

All authors contributed equally to this paper.

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