

Gender Disparities Affecting Postoperative Outcomes after Total Elbow Arthroplasty: Utilization of the ACS-NSQIP

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INTRODUCTION: There is a rise in total elbow arthroplasty (TEA) procedures performed each year in the United States. Relative to other arthroplasties, TEA's are completed at lower volumes, but the rise in TEA procedures each year warrants evaluation of postoperative complications between genders and races. Gender differences in postoperative outcomes are not fully understood and several studies in literature describe variations in outcomes following orthopedic surgeries. The purpose of this study is to investigate gender disparities in 30-day postoperative outcomes of TEA.

METHODS: We selected cases from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) public use files between 2006 and 2020 for the Current Procedural Terminology (CPT) code 24363 "Under Repair, Revision, and/or Reconstruction Procedures on the Humerus (Upper Arm) and Elbow." This code indicates an elbow arthroplasty with the distal humerus and proximal ulnar prosthetic replacement, e.g., total elbow. Male and female gender was coded from the sex variable. Composite outcomes were created for wound outcomes (superficial surgical site infection (SSI), deep wound infection, organ space infection, dehiscence), pulmonary outcomes (pneumonia, prolonged intubation, reintubation), venous thromboembolic outcome (pulmonary embolism and deep vein thrombosis - DVT), major adverse cardiovascular event or MACE (cardiac arrest, myocardial infarction, stroke), and renal outcomes (acute kidney injury). Other outcomes of interest included 30-day in-hospital mortality, hospitalization length of stay beyond 3 days, sepsis, urinary tract infection (UTI), bleeding requiring transfusion, and return to the operating room. We used the Fisher exact test to examine univariable associations of race with preoperative variables and outcomes. R project (version 4.1.2) was used for the preprocessing of data, to calculate all the univariate associations, and for descriptive statistics. We then used multivariate logistic regression to examine the association of gender with each outcome, adjusting for preoperative variables that might have acted as confounders. Preoperative variables with univariable Fisher P < 0.20 with gender were eligible to be included: diabetes, chronic obstructive pulmonary disorder (COPD), hypertension, steroid use, chronic kidney disease, and thrombocytopenia. We used stepwise selection, including variables with multivariable P < 0.20 in the final model for each outcome in order to adjust for potential confounders. SAS (version 6.1.9 Cary, North Carolina, USA) was used for data analysis with P < 0.05 considered significant. Blank values were originally coded as -99, and they were converted to NA for R statistics, left blank for SAS, and ignored for multivariate logistic regression. In the logistic models, for each outcome, we adjusted the female odds ratio using the male patients as our reference group.

RESULTS: A total of 788 patients were found to have had an elbow arthroplasty from 2006 through 2020 as shown in **Figure 1**, and from those 22.8% (180) were males and 77.2% (608) were females. The average number of procedures performed in each of the years was 52.53 procedures, unequally distributed. In **Figure 1**, the largest number of procedures were completed in 2016 (94), with 2017 (87), 2014 (86), and 2015 (65) trailing very closely behind. In terms of gender distribution, females had between two and five times as many procedures completed in any given year, with 75 procedures completed in 2017, and 71 procedures completed in 2016. Males had the largest number of procedures done in 2016 (23), 2018 (20), and 2014 (20). After adjusting for preoperative variables with a P < 0.20 in univariable analysis, a few of the 30-day postoperative outcomes still had higher adjusted odds ratio (aOR) of occurring in females in comparison with males (**Table 1**). Female patients had significantly higher adjusted odds than males in having MACE (aOR: 2.300, 95% confidence interval [CI]: 0.379-13.954, p<0.0001), transfusion requirement (aOR: 1.381, 95% [CI]: 0.127-15.002, p<0.0001), and return to operating room (aOR: 2.384, 95% [CI]: 0.992-5.728, p<0.0001).

DISCUSSION: Our study demonstrated a higher prevalence of TEA in females compared to males in all years assessed in the NSQIP database. This finding confirms data in existing literature. Females are more likely to undergo TEA secondary to joint arthropathies including rheumatoid arthritis (RA) and osteoarthritis (OA). RA is known to present more frequently in women by association with sex hormones (estrogen) and its propensity to enhance secretion of proinflammatory cytokines, subsequent survival of autoreactive clones, and contribution to increased susceptibility to autoimmune diseases. Analysis of our primary outcome yielded a significant increase in odds of MACE, transfusion requirements, and return to the operating room for females when compared to males, 30 days after a TEA. TEA indication increases with age secondary to late-stage complications of RA. Increased transfusion requirements in females confirm findings in literature evaluating other forms of arthroplasty. A combination of increased patient age secondary to long-term complications of arthropathies paired with an increased prevalence of elective surgery in females may explain our findings.

SIGNIFICANCE/CLINICAL RELEVANCE: TEA is on the rise with odds of 30-day postoperative outcomes similar in females compared to male patients. Future research is needed to confirm the odds of postoperative outcomes and assess methods to ensure operative outcomes remain analogous between genders.

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Postoperative Variable	Adjusted OR	Lower 95% CI	Upper 95% CI	P value
Wound Outcomes	1.821	0.329	10.066	0.9567
Pulmonary Outcomes	3.135	0.268	36.601	0.9497
VTE	0.703	0.133	3.725	0.6789
MACE	2.300	0.379	13.954	<0.0001
Renal Outcomes	0	0	0	
Sepsis	10.607	0.849	132.528	0.9510
UTI	< 0.001	< 0.001	> 999.999	0.9596
Transfusion Required	1.381	0.127	15.002	<0.0001
Return to Operating Room	2.384	0.992	5.728	<0.0001
Length of stay ≥ 3 Days	0.954	0.625	1.457	0.1585
Still in Hospital	11.590	0.411	326.667	0.9605

Table 1. aOR for postoperative outcomes by gender: male patients were used as a reference group. Missing values were ignored. Bolded P values indicate significant OR after adjusting for preoperative variables.

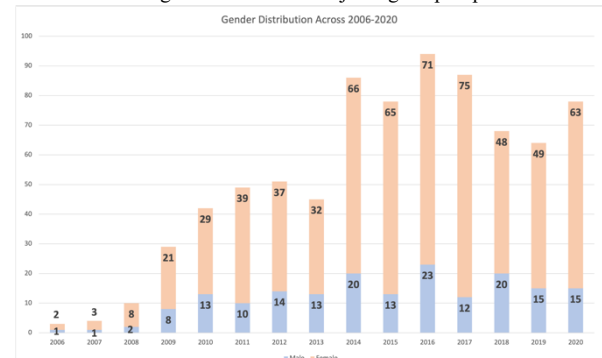


Figure 1. 788 elbow arthroscopy patients over the 2006-2020 timeline, separated into female and male gender.