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ORIGINAL ARTICLE

Sex differences in characteristics, utilization, and outcomes of patient undergoing total elbow arthroplasty: a study of the US nationwide inpatient sample

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Abstract The aim of this study was to compare patient characteristics, utilization rates, and outcomes after total elbow arthroplasty (TEA) by sex. We used the nationwide inpatient sample from 1998 to 2011 to study sex-related time trends in patient characteristics, comorbidity, and outcomes after TEA. We used chi-squared test, analysis of variance, and the Cochran-Armitage test to assess differences in utilization rates and characteristics over time by sex and logistic regression to compare mortality, discharge disposition, and the length of hospital stay by sex. Overall TEA utilization 0.45 in 1998 to 0.96 per 100,000 in 2011 ($p<0.0001$). The utilization rates were significantly higher in females compared to males throughout the study period: 0.62 vs. 0.29 in 1998 ($p<0.0001$) and 1.31 vs. 0.70 in 2011 ($p<0.0001$). Compared to males, females undergoing TEA were more likely to be white (79.7 vs. 71.4 %; $p<0.0001$), have rheumatoid arthritis (16.7 vs. 8.1 %; $p<0.0001$), and have Deyo-Charlson index of 2 or more (11.3 vs. 5.9 %; $p<0.0001$) and were older (63.5 vs. 51.4 years; $p<0.0001$). Compared to males undergoing TEA, females had significantly lower mortality, 0.1 vs. 0.4 % ($p=0.03$); lower proportion were discharged to home, 81.9 vs. 89.6 % ($p<0.0001$), and fewer had has index hospital stay above the median, 30.0 vs. 33.0 % ($p=0.01$); most differences were significant after multivariable adjustment. TEA utilization in the USA more than doubled in the last 14 years, with rates higher in females than males. Females had better outcomes after TEA than men. Preoperative risk communication should be sex-specific based on these data.

Keywords Discharge · Hospital stay · Mortality · Outcomes · Sex · TEA · Total elbow arthroplasty · Utilization

Introduction

Total elbow arthroplasty (TEA) is a surgical procedure performed in patients with elbow disorders associated with pain and disability, including end-stage elbow arthritis not responsive to medical treatment, fracture, and post-fracture sequela [1]. TEA leads to significant improvements in pain, function, and quality of life [2]. The pain and function improvements associated with TEA likely contributed to the rapid increase in TEA utilization in the recent years, as evidenced by a 248 % increase in the annual TEA procedure volume in the USA in a recent study of nationwide inpatient sample (NIS) from 1993 to 2007 [3]. On the other hand, a study from the Scottish Arthroplasty register reported a declining overall utilization rate of TEA from 1990 to 2010, primarily due to a decline in the rate of TEA in patients with rheumatoid arthritis (RA), a common underlying diagnosis for TEA [4]. Thus, there is a discrepancy in the results of studies of timetrends in TEA utilization.

TEA studies in the USA have not presented time trend data by the underlying diagnosis. A Norwegian arthroplasty registry study reported that the proportion of TEA patients with an underlying diagnosis of RA decreased from 1996 to 2008, with osteoarthritis (OA) or fracture increased [5]. It is unclear whether the declining rates of TEA in RA patients observed in

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the Scottish and Norwegian registries [4, 5] are generalizable to the U.S.

Even less is known about the effect of sex on TEA utilization and outcomes. TEA procedure rates were higher for women than men during 1993–2007 in the USA [3]. Given this sex difference in TEA utilization, important questions are whether the sex differences in utilization are increasing over time and whether outcomes of TEA differ by sex. Our study objectives were to use a nationally representative sample of US patients to (1) study the sex-related differences in patient characteristics (including underlying diagnosis) and outcomes in the utilization in TEA in the USA and time trends in sex disparity and (2) examine the time trends in overall utilization rates of TEA in the most recent years from 1998 to 2011, by the underlying diagnosis. We hypothesized that compared to males, females will have higher TEA utilization rates, worse outcomes, and different patient characteristics. We also hypothesized that the underlying diagnosis of RA is decreasing and OA increasing over time in patients undergoing TEA in the U.S.

Materials and methods

Data source, study population, and covariates

We used the nationwide inpatient sample (NIS) data for the years 1998–2011 for our study. The NIS is the largest US inpatient database that gives information about inpatient stays regardless of the insurance coverage of the individual. The NIS has data related to approximately eight million inpatient hospitalizations each year. Our study sample consisted of all the hospitalizations with the International Classification of Diseases, ninth revision, common modification (ICD-9-CM) code 81.84 for primary TEA procedures. The Institutional Review Board at the University of Alabama at Birmingham approved the study.

We categorized the study period as 1998–2000, 2001–2002, 2003–2004, 2005–2006, 2007–2008, and 2009–2011 to examine patient characteristics and outcomes at different periods. Race was categorized as white, black, Hispanic, and others. Age was categorized in to <50, 50 to <65, 65 to <80, and ≥80 years. We calculated Deyo-Charlson comorbidity index, a validated comorbidity measure, for individuals based on the presence of ICD-9-CM codes at the time of admission [26–28]. Annual hospital TEA volume was calculated using unique identifier for each hospital and categorized as <5, 5 to <10, 10 to <15, 15 to <25, and ≥25. The primary diagnosis code associated with each hospitalization was determined to be the underlying diagnosis for TEA and categorized as OA (715.xx), RA (714.xx), aseptic necrosis (733.4X), fracture (812.xx, 813.xx), and other.

Outcomes of interest

Outcomes included mortality, discharge disposition, and length of index hospital stay. Mortality was defined based on whether a patient died related to index hospitalization regardless of whether in hospital, at home, in a medical facility or any other place, as defined in the NIS, and as previously [6]. We categorized discharge disposition of the patients to two categories, home or inpatient. Patients discharged to home were included regardless of whether or not they received home health care. The inpatient category included discharge to short-term hospital, skilled nursing facility, intermediate care facility, or any other type of inpatient facility. All other discharges including death in the hospital, leaving hospital against medical advice, or an unknown destination for discharge were considered as missing. The length of stay was defined as the number of days between the admission date and the discharge date and categorized as above or below the median value, given a non-normal distribution of this variable.

Statistical analysis

Clinical and demographic characteristics of males and females were compared using analysis of variance or chi-squared test, as appropriate. The utilization rates for TEA were calculated per 100,000 patients for each year by dividing the TEA estimates by the total population in the respective category, for overall utilization rates, and rates for males and females. The weighted estimates for TEA utilization were calculated by applying the data weights (http://www.hcup-us.ahrq.gov/reports/methods/2003_2.jsp#as), as recommended. Total US population obtained from the US census site was used to calculate TEA utilization rates for the US population (http://www.census.gov/compendia/statab/cats/population.html). We used the Cochran-Armitage test for trend to assess time trends across the years, overall, and in males and females. We compared the differences in utilization rates between males and females using the chi-squared test to compare the first and last time period and the analysis of covariance (ANCOVA) for comparing gender disparity across the 14-year period, using an interaction term for year and sex. We used logistic regression to compare mortality, the proportion discharged to home and the length.

Results

Cohort characteristics

The mean age of males and females who underwent TEA were 51.4 and 63.5 years, respectively (Table 1). Of the males and females, 71.4 and 79.7 %, respectively, were white (Table 1). Significantly higher proportion of males than females, 1.4 vs.

Table 1 Clinical and demographic characteristics of patients who underwent TEA between 1998 and 2011

	All combined (*N*=31,896)	Males (*N*=9,874)	Females (*N*=21,849)	*p* value (male vs. female)
Age, mean (SD)	60.1	51.4	63.5	<0.0001
Age group				
<50	27.1	48.1	17.3	<0.0001
50 to <65	31.2	27.9	32.9	0.0006
65 to <80	29.6	18.3	34.7	<0.0001
≥80	12.1	5.7	15.1	<0.0001
Race/ethnicity[a]				
White	77.0	71.4	79.7	<0.0001
African-American	7.3	8.5	6.7	0.04
Hispanic	11.0	15.1	9.2	<0.0001
Other	4.6	5.0	4.5	0.34
Hospital volume				
<5	63.6	63.0	64.1	0.52
5 to <10	21.4	21.8	21.2	0.67
10 to <15	7.7	7.6	7.7	0.80
15 to <25	6.4	6.2	6.4	0.80
≥25	0.9	1.4	0.5	n/a
Underlying diagnosis				
Osteoarthritis	10.1	10.8	9.8	0.27
Rheumatoid arthritis	14.0	8.1	16.7	<0.0001
Fracture	49.9	52.2	48.8	0.01
Avascular necrosis	0.1	0.05	0.2	0.12
Other	25.9	28.9	24.5	0.0003
Deyo-Charlson index				
0	58.2	72.2	51.7	<0.0001
1	32.2	21.8	37.0	<0.0001
≥2	9.6	5.9	11.3	<0.0001

[a] Proportion represents that of non-missing values. Race missing is 21 % for males and 23 % for females

0.5 %, underwent TEA at hospitals with annual TEA volume ≥25 ($p<0.0001$). A lower proportion of males than females had RA (8.1 vs. 16.7 %), and a higher proportion had fracture (52.2 vs. 48.8 %) as the underlying diagnosis (Table 1). Deyo-Charlson index score was ≥2 in 5.9 % of males and 11.3 % of females ($p<0.0001$).

Time trends The proportion of males with Deyo-charlson index score of ≥2 increased from 5.1 % in 1998–2000 to 6.1 % in 2009–2011 ($p=0.65$); females, the respective increase was from 8.9 to 15.5 % ($p=0.0002$; Appendix Table 4). Other significant time trends noted in both males and females from 1998 to 2011 were a higher proportion of patients of Hispanic origin, fracture a more common underlying diagnosis and TEA utilization, and higher proportion getting TEA at hospitals with annual TEA volume of 5 to <10 procedures, lower proportion with RA as the underlying diagnosis (Appendix Table 4). We also noted that only in females (and not males) undergoing TEA, in the recent years, there was a higher proportion of patients in age 50 to <65 years and with Deyo-Charlson index of 2 or higher and a lower proportion with osteoarthritis as the underlying diagnosis (Appendix Table 4).

Time trends in TEA utilization rates by sex

TEA utilization rates were 1.5 times in females compared to males in 1998 ($p<0.0001$; Table 2; Fig. 1). Utilization rates for TEA increased in both males ($p<0.0001$) and females ($p<0.0001$) from 1998 to 2011 with an almost doubling of rates over the 14-year period. In 2011, TEA utilization rate was >2 times higher in females compared to males ($p<0.0001$), with a higher difference in absolute rate by sex in 2011 than in 1998 (0.72 vs. 0.33 per 100,000) (Table 2). Sex disparities persisted and did not change significantly over time ($p=0.06$).

TEA outcomes by sex, time trends, and sex disparities

Mortality was significantly higher in males than females who underwent TEA at 0.4 vs. 0.1 % ($p=0.03$; Table 3);

Table 2 Time trends in TEA utilization per 100,000 during the study period 1998–2011

	Weighted estimates from NIS	Total US population	TEA rate per 100,000		
			Overall	Males	Females
1998	1,254	275,854,104	0.45	0.29	0.62
1999	1,553	279,040,168	0.56	0.31	0.80
2000	1,441	282,162,411	0.51	0.35	0.67
2001	1,904	284,968,955	0.67	0.38	0.95
2002	1,779	287,625,193	0.62	0.38	0.84
2003	2,399	290,107,933	0.83	0.46	1.15
2004	2,568	292,805,298	0.88	0.61	1.13
2005	2,473	295,516,599	0.84	0.49	1.16
2006	2,762	298,379,912	0.92	0.63	1.19
2007	2,594	301,231,207	0.86	0.53	1.17
2008	2,432	304,093,966	0.80	0.53	1.06
2009	2,775	306,771,529	0.90	0.54	1.25
2010	2,973	309,349,689	0.96	0.70	1.21
2011	2,987	311,587,816	0.96	0.59	1.31

Cochran-Armitage test of trend across all the years: for overall group, $p<0.0001$; male, $p<0.0001$; female, $p<0.0001$; p value for sex disparities: 1998, $p<0.0001$; 2011, $p<0.0001$; change in sex disparities across all the years: $p=0.02$

differences were significant after multivariable adjustment ($p=0.01$). Significantly more females than males were discharged to an inpatient facility after TEA, 10.4 vs. 18.1 %, a difference of almost twofold ($p<0.0001$; Table 3). The length of index hospital stay was significantly higher in males compared to females, 33 vs. 30 %, with hospital stay above median stay ($p=0.02$). After adjustment for age, Deyo-Charlson index, and the underlying diagnosis, proportion discharged were not different by sex ($p=0.82$), but the length of stay was higher in males compared to females ($p<0.0001$).

Time trends Comparison of 1998–2000 to 2009–2011 rates showed a significant increase in the proportion of patients discharged to inpatient facilities for both males (7.3 to 15.1 %, $p=0.003$) and females (15.2 to 22.5 %, $p=0.001$; Appendix Table 5). Time trends showed that over the 14-year period, there were significant increases in %male ($p<0.0001$) and %female ($p<0.0001$) discharged to inpatient facilities after TEA. Sex disparities in discharge disposition were significant, in 1998–2000 $p=0.002$) and in 2009–2011 ($p=0.0002$). Sex disparities in discharge to inpatient facilities did not decrease over time ($p=0.13$).

The proportion of people who had index hospitalization length of stay greater than median (median, 3 days) increased significantly from 27.1 % in 1998–2000 to 36.5 % in 2009–2011 for males ($p=0.002$), but not for females, 28.2 to 31.9 % ($p=0.13$).; Appendix Table 5). The sex disparities for length of stay were not significant in 1998–2000 ($p=0.74$ but

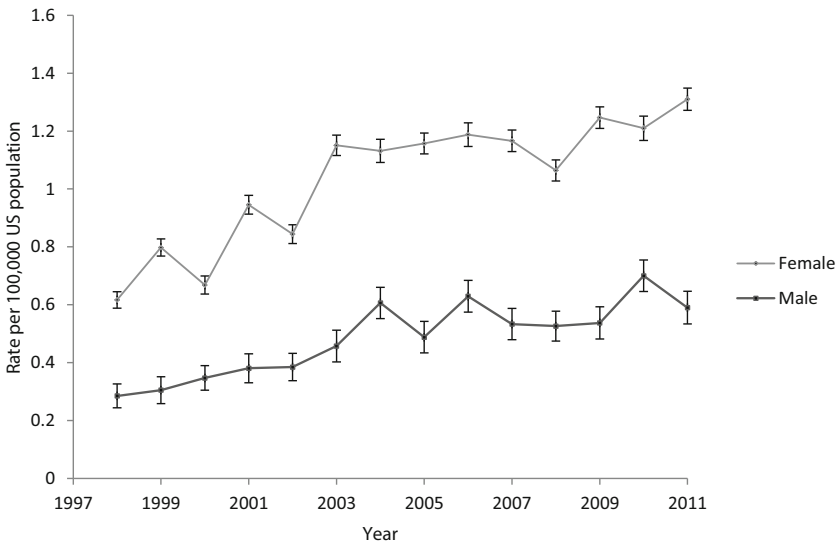

Fig. 1 Time trends in TEA utilization by sex

Table 3 TEA outcomes by gender for the study period 1998–2011

	Total (*N*=31,896)	Males (*N*=9,874)	Females (*N*=21,849)	Unadjusted *p* value[a]	Adjusted *p* value[b]
Mortality, *n* (%)	68 (0.2 %)	41 (0.4 %)	27 (0.1 %)	0.03	0.01
Discharge, *n* (%)					
Inpatient facility	4,970 (15.6 %)	1,022 (10.4 %)	3,943 (18.1 %)	<0.0001	0.82
Home	26,819 (84.4 %)	8,798 (89.6 %)	17,860 (81.9 %)		
Length of stay (>median)	9,857 (30.9 %)	3,262 (33.0 %)	6,556 (30.0 %)	0.02	<0.0001

[a] Unadjusted logistic regression was used for all outcomes of interest

[b] Logistic regression was adjusted for age, race (missing race was considered a category), volume, Deyo-Charlson index score, hospital location and teaching status, insurance, hospital bed size, hospital region and primary diagnosis except for mortality where volume hospital bed size and hospital region excluded due to 0 or very low numbers in any category of these variables

showed a trend towards significance in 2009–2011 (p=0.07.). Unadjusted analyses showed a trend that disparities in hospital length of stay may have a non-significant trend over time (p=0.12). After multivariable adjustment for age, race, Deyo-Charlson score, and hospital volume, sex disparities for length of stay did not change over time (p=0.79).

Time trends in overall TEA utilization and the underlying diagnosis

The overall TEA utilization rate increased from 0.45/100,000 in 1998 to 0.96/100,000 in 2011 (p<0.0001; Fig. 2). The proportion of females with RA undergoing decreased by 56 %, OA decreased by 18 % and fracture increased by 60 %, comparing the first to the last study period, all significant (p<0.0001; Appendix Table 4). In men, the respective changes were −47, −65, and +58 %, all significant comparing last to the first period (Appendix Table 4).

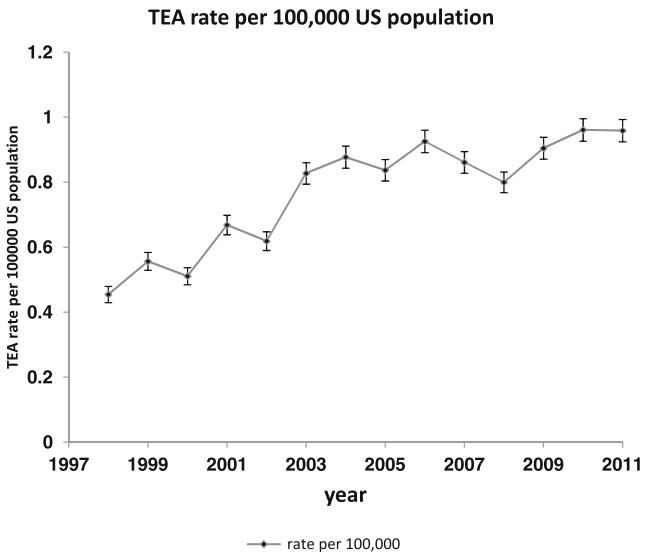

Fig. 2 Time trends in the overall utilization of TEA

Discussion

Our study provides contemporary US data for TEA utilization and outcomes for females and males. Examination of time trends revealed several interesting observations. Several study findings merit further discussion.

First, all three key outcomes after TEA we studied differed significantly by sex. Mortality rates were lower in females, which is consistent with findings from a recently published systematic review of post-arthroplasty mortality [7]. One previous study focused on sex differences in knee arthroplasty outcomes using Pennsylvania database reported higher mortality in males compared to females, consistent with results of our study [8]. Our study extends this finding to TEA and to a US representative sample.

We noted that females had a shorter index hospital stay compared to males. To our knowledge, this is an interesting and novel finding, despite the fact that females were older and had high Deyo-Charlson index, which would be expected to lead to worse outcome, i.e., longer index hospital stay, indicating that adjusted differences may be even higher. In a recent study using Medicare data, females had a lower risk of 30-day readmission after primary total knee arthroplasty than men [9], indicating potentially less inpatient healthcare resource utilization by females compared to males after TEA.

An important observation was that a higher proportion of females, compared to males, were discharged to non-home settings, similar to a previous study in hip arthroplasty [10]. This might be at least partially be due to a lower social support to females compared to males, perceived and real [11]. Social support is a strong predictor of discharged to home vs. non-home settings [12–14]. Dependence on family member increases the likelihood of successful discharge to home [15]. With females in the usual caregiver role, it is reasonable for females to have a concern about role-reversal, i.e., their spouse's ability to be a full-time caregiver. Future studies need to examine whether interventions to improve family member/social support can decrease the discharge to non-home settings and reduce health care costs.

Some patient characteristics changed significantly over time both males and females. We noted significant differences in patient characteristics between males after TEA in unadjusted analyses.. Overall, compared to males, females undergoing TEA were more likely to have RA (8.1 vs. 16.7 %) and less likely to have fracture (52.2 vs. 48.8 %) as the underlying diagnosis. Females were older and had higher Deyo-Charlson index compared to males, which would be expected to lead to worse outcome, i.e., longer index hospital stay, indicating that adjusted differences may be even higher. Time trends revealed that Deyo-Charlson index increased significantly in females, but not in males. On the other hand, complications after TEA did not seem to worsen over time, in both females and males. This is an important observation, indicating that careful preoperative and perioperative management and the implementation of a more efficient post-arthroplasty discharge planning and care coordination [16] might be helping us prevent higher health care utilization and costs that are anticipated due to increasing complexity of patients undergoing TEA.

We also noted that a higher proportion underwent TEA in hospitals with higher annual TEA volume of 5 to <10 procedures in the more recent years, which is very desirable, given that hospital and surgeon volume have been linked to arthroplasty outcomes [17–19]. These observations indicate that epidemiology of TEA is changing. Outcome studies using data across several years should take these time-related differences in consideration in analysis and interpretation of findings.

The overall TEA utilization rates more than doubled over the 14-year period from 1998 to 2011 for both males and females in our study. This supports the previous finding of a twofold increase in total TEA utilization from 1993 to 2007 from the same dataset [3], now extended to a more current period and both sexes. However, the finding of increasing TEA utilization over time in the USA is in contrast to those from European arthroplasty registry studies that do not show a similar pattern [4, 5]. Country setting (USA vs. Scotland and Netherlands) and differences in health care delivery system (multiple payer system vs. socialized medicine), practice patterns, and the underlying diagnoses (higher proportion with fracture in the USA and with RA in European registries) may partially explain these opposite time trends in TEA utilization in USA vs. Europe. Future studies should assess whether this gap is increasing or decreasing over time.

We noted significant reduction in the proportion of TEA patients with RA and increase in those with fracture as the underlying diagnosis were noted over time, which extend a similar finding from European registries [4, 5] to a representative US sample. Our observation of a reduction in the proportion of the TEA patients having osteoarthritis as the underlying diagnosis is a new finding to our knowledge, slightly in contrast to the finding from the Norwegian registry [5]. Interestingly, the declines in the underlying diagnosis for osteoarthritis was higher in males compared to females, another finding that needs to be confirmed in future studies.

Some patient characteristics changed significantly over time, both males and females. These included a higher proportion of patients with fracture and a lower proportion with RA as the underlying diagnosis in the recent years. This confirms a similar observation from the Scottish and Norwegian registries and extends this to a US setting [4, 5].

Study findings must be interpreted considering study limitations. NIS excludes federal facilities including Veterans Affairs and military hospitals; however, the proportion of Americans receiving care from these facilities is small, and it is unlikely that this would lead to a large bias in estimates. NIS does not provide longitudinal follow-up; therefore, we were unable to assess for readmission rates and outcomes after the index hospital discharge. NIS does not allow distinction of unilateral from bilateral TEA during the index hospitalization; however, given the rarity of simultaneous bilateral, this under estimation is likely small.

Conclusions

In conclusion, in this 14-year study of patients undergoing TEA, sex differences in TEA utilization were evident. TEA utilization rate was higher in females than males. Important differences in clinical and demographic characteristics of males and females undergoing TEA were noted, and over time, some characteristics changed more in females than males. Females had better outcomes than males undergoing TEA, with lower mortality and a shorter hospital stay. We also noted a significant increase in the annual TEA utilization in the USA, as well as significant changes in the underlying diagnoses, which also differed somewhat by sex. Studies need to examine what factors predispose males to worse outcomes after TEA compared to females, whether these factors are amenable to interventions, and to better understand the changing epidemiology of underlying diagnosis for TEA.

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Conflict of interest There are no financial conflicts related directly to this study. J.A.S. has received research and travel grants from Takeda and Savient and consultant fees from Savient, Takeda, Allergan, and Regeneron. R.R. has no conflicts.

IRB approval The study was approved by the Institutional Review Board (IRB) at the University of Alabama at Birmingham.

Appendix

Table 4 Sex-specific time trends in characteristics of patients undergoing TEA from 1998 to 2011

	1998–2000		2001–2002		2003–2004		2005–2006		2007–2008		2009–2011		% Change last period–first period		*p* values for males followed by females
	M (*N*= 1,284)	F (*N*= 2,964)	M (*N*= 1,077)	F (*N*= 2,607)	M (*N*= 1,525)	F (*N*= 3,385)	M (*N*= 1,632)	F (*N*= 3,542)	M (*N*= 1,577)	F (*N*= 3,431)	M (*N*= 2,780)	F (*N*= 5,920)	M	F	
Mean age	52.4	63.4	51.7	62.3	51.2	62.0	50.2	64.3	51.2	63.9	51.8	64.4			<0.0001 <0.0001
Age group															
<50	47.0	20.1	49.8	21.1	48.9	20.5	52.4	15.3	48.9	15.8	44.8	14.4	−4.7	−28.4	0.58 0.003
50–64	25.1	27.9	26.4	30.2	26.7	33.1	23.1	33.1	29.3	35.4	32.3	34.9	28.7	25.1	0.03 0.005
65–79	23.3	35.5	17.1	37.6	17.6	33.3	20.1	35.5	18.5	32.8	15.7	34.6	−32.6	−2.5	0.01 0.72
≥80	4.6	16.5	6.7	11.1	6.8	13.1	4.4	16.1	3.4	15.9	7.2	16.2	56.5	−1.8	0.16 0.86
Race															
White	75.3	85.3	78.9	80.9	77.2	79.9	69.1	78.7	72.1	81.5	65.3	76.3	−13.3	−10.6	0.01 0.001
Black	11.2	5.3	5.1	5.3	6.5	6.8	7.0	7.3	9.6	5.0	9.7	8.4	−13.4	58.5	0.59 0.05
Hispanic	8.8	5.3	10.8	8.8	13.8	10.9	16.8	9.1	15.3	9.7	18.7	9.9	112.5	86.8	0.002 0.02
Other	4.6	4.1	5.2	5.0	2.6	2.4	7.2	4.9	3.0	3.8	6.2	5.5	34.8	34.1	0.38 0.31
Hospital volume															
<5	85.1	78.0	65.7	70.1	59.2	58.0	60.2	63.6	62.0	59.8	56.1	60.7	−34.1	−22.2	<0.0001 0.003
5 to <10	9.4	15.0	16.8	16.0	21.9	18.7	21.6	19.6	20.0	25.0	30.6	26.9	225.5	79.3	<0.0001 0.02
10 to <15	5.6	7.0	9.1	7.8	6.0	6.4	9.4	9.4	12.7	11.1	4.8	5.9	−14.3	−15.7	0.82 0.78
15 to <25	0	0	8.5	6.1	13.0	16.9	4.2	6.2	5.3	4.0	6.2	5.3	–	–	–
≥25	0	0	0	0	0	0	4.6	1.2	0	0	2.4	1.2	–	–	–
Underlying diagnosis															
OA	16.1	10.7	11.0	9.1	11.3	10.6	11.4	9.4	8.9	10.9	8.6	8.8	−46.6	−17.8	0.001 0.23
RA	15.9	25.6	13.2	20.6	5.3	17.7	7.7	16.3	5.9	14.8	5.5	11.2	−65.4	−56.3	<0.0001 <0.0001
Fracture	38.5	36.3	40.4	42.0	50.1	46.1	53.9	50.5	56.2	49.4	61.0	58.1	58.4	60.1	<0.0001 <0.0001
Avascular necrosis	0	0	0	0.4	0	0.3	0	0.3	0.3	0.2	0	0	–	–	–
Other	29.6	27.4	35.5	27.9	33.3	25.2	27.1	23.7	28.6	24.6	24.9	21.7	−15.9	−20.8	0.20 0.009
Deyo-Charlson score, %															
0	69.4	52.9	71.4	52.4	75.6	53.6	71.7	50.2	72.1	50.1	72.4	51.5	4.3	−2.6	0.42 0.59
1	25.5	38.2	23.7	41.6	19.5	36.9	22.6	39.0	19.7	37.5	21.5	33.0	−15.7	−13.6	0.22 0.03
≥2	5.1	8.9	4.9	6.0	4.9	9.4	5.7	10.8	8.3	12.4	6.1	15.5	19.6	74.2	0.56 0.0002

M male, *F* female, *OA* osteoarthritis, *RA* rheumatoid arthritis

[a] Proportion represents that of non-missing values for race. Race missing for males: 1998–2000, 21.9 %; 2001–2002, 21.3 %; 2003–2004, 27.4 %; 2005–2006, 22.2 %; 2007–2008, 21.3 %; 2009–2010, 14.3 %; females: 1998–2000, 26.3 %; 2001–2002, 25.7 %; 2003–2004, 24.4 %; 2005–2006, 29.4 %; 2007–2008, 25.1 %; 2009–2011, 12.6 %

Table 5 Sex specific time-trends in outcomes of patients undergoing TEA from 1998 to 2011

	1998–2000		2001–2002		2003–2004		2005–2006		2007–2008		2009–2011		% Change Last period-first period		*p*-values for Males followed by females[ac]	*P*-values for gender disparity[b]	
	M	F	M	F	M	F	M	F	M	F	M	F				Unadjusted	Adjusted*
Mortality, n (%)	4 (0.3)	0 (0)	11 (1.0)	4 (0.1)	0 (0)	9 (0.3)	10 (0.6)	5 (0.1)	5 (0.3)	5 (0.1)	11 (0.4)	5 (0.1)	33.3	–	Males 0.008 0.63 Females – 0.93	– 0.20 0.86	– – — –
Discharge, *n* (%)																	
Home	1187 (92.7)	2509 (84.8)	998 (93.7)	2225 (85.5)	1384 (91.3)	2868 (85.0)	1482 (91.4)	2900 (82.2)	1399 (89.0)	2776 (81.0)	2347 (84.9)	4581 (77.5)	−8.4	−8.6	Males 0.003 <0.0001 Females 0.001 <0.0001	0.002 0.0002 0.13	0.25 0.10 0.05
Inpatient facility	93 (7.3)	450 (15.2)	67 (6.3)	378 (14.5)	131 (8.7)	507 (15.0)	140 (8.6)	627 (17.8)	173 (11.0)	650 (19.0)	418 (15.1)	1330 (22.5)					
Length of hospital stay>median	349 (27.1)	837 (28.2)	289 (26.9)	728 (27.9)	470 (30.8)	931 (27.5)	612 (37.5)	1184 (33.4)	528 (33.5)	990 (28.8)	1014 (36.5)	1886 (31.9)	34.7	13.1	Males 0.01 <0.0001 Females 0.13 <0.0001	0.74 0.07 0.12	0.97 0.001 0.79

[a] The two *p*-values represent the following: (1) males between first and last time period; (2) females between first and last time period

Logistic regression and Cochran Armitage test of trend were used for these analyses

[b] The three *p*-values represent: (1) sex disparity in 1998–2000; (2) sex disparity in 2009–2011; (3) change in disparity magnitude across all the year categories. *adjusted for age, race, Deyo-charlson-score, hospital volume, hospital location and teaching status, insurance, hospital bed size, hospital region and primary diagnosis

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