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Persisting Racial Disparities in Total Shoulder Arthroplasty Utilization and Outcomes

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Abstract

Objective—The purpose was to study whether racial disparities in total shoulder arthroplasty (TSA) utilization and outcomes have declined over time.

Methods—We used the US Nationwide Inpatient Sample from 1998 to 2011. We used chi-squared test to compare characteristics, Cochran-Armitage test to compare utilization rates, and Cochran-Armitage test and logistic regression to compare time-trends in outcomes by race.

Results—From 1998 to 2011, 176,141 Whites and 7694 Blacks underwent TSA. Compared to Whites, Blacks who underwent TSA were younger (69.1 vs. 64.2 years; $p < 0.0001$), more likely to be female (54.9 vs. 71.0 %; $p < 0.0001$), and have rheumatoid arthritis or avascular necrosis as the underlying diagnosis (1.7 vs. 3.0% and 1.7 vs. 6.1 %; $p < 0.0001$ for both) and a Deyo-Charlson index of 2 or higher (8.5 vs. 16.7 %; $p < 0.0001$). Compared to Whites, Blacks had much lower TSA utilization rate/100,000 in 1998 (2.97 vs. 0.83; $p < 0.0001$) and in 2011 (12.27 vs. 3.33; $p < 0.0001$); racial disparities increased from 1998 to 2011 ($p < 0.0001$). A higher proportion of Blacks than Whites had a hospital stay greater than median in 1998–2000, 62 vs. 51.4 % ($p = 0.02$), and in 2009–2011, 34.4 vs. 27.3 % ($p < 0.0001$); disparities did not change over time ($p = 0.31$). These disparities in utilization were borderline significant in adjusted analyses. There were no

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Contributors JS designed the study. RR obtained the data and performed data programming and data analyses. JS and RR reviewed the analyses. JS drafted the first draft of the manuscript. RR made revisions and edits to the report. All authors approved the final version of the report.

Conflict of Interest There are no financial or non-financial conflicts related directly to this study. JAS has received research and travel grants from Takeda and Savient and consultant fees from Savient, Takeda, Ardea, and Regeneron. RR has no competing interests.

Data Sharing These data are publically available through the HCUP center.

We will share data with any investigator interested in replicating these findings or interested in future collaborations, pursuant to institutional and Institutional Review Board (IRB) regulations, in accordance with patient privacy, confidentiality, and HIPAA laws/regulations.

IRB Approval The study was approved by the IRB at the University of Alabama at Birmingham.

racial differences in proportion discharged to inpatient medical facility in 1998–2000, 15.2 vs. 15.0 % ($p=0.95$), and in 2009–2011, 12.3 vs. 11.1% ($p=0.37$), respectively.

Conclusions—We found increasing racial disparities in TSA utilization. Some disparities in outcomes exist as well. Patients, surgeons, and policy-makers should be aware of these findings and take action to reduce racial disparities.

Keywords

Race; Total shoulder arthroplasty; TSA; Utilization; Outcomes; Mortality; Hospital stay; Discharge; Time-trends

Introduction

Total shoulder arthroplasty (TSA) is an effective surgical treatment of shoulder arthritis and shoulder disorders. TSA is frequently performed for end-stage arthritis of the shoulder, due to rheumatoid arthritis (RA), osteoarthritis (OA), fracture, or other shoulder disorders [1–4]. TSA is associated with reduction in shoulder pain and improvement in shoulder function and quality of life [1, 5–7] and high patient satisfaction [8]. A recent study that used the 1993–2007 US Nationwide Inpatient Sample (NIS) reported that Blacks had lower overall TSA utilization rates compared to Whites with a risk ratio of 0.6 [9]. It is not known whether the racial disparity in TSA utilization is increasing or decreasing in the USA.

The 2002 Institute of Medicine (IOM) report highlighted the racial and ethnic disparities in health care and called for interventions to “confront racial and ethnic disparities in health care” [10]. The first step in eliminating disparities is to define whether there are any racial disparities for the condition of interest. We recently described persisting racial disparities in hip and knee arthroplasty in the USA, two procedures that are well-established [11]. As a newer procedure that is becoming increasingly popular, TSA is condition of public health importance. Our study objectives were to assess whether there are race-related differences in TSA utilization and outcomes after TSA and, more importantly, whether these disparities have changed with time. We hypothesized that compared to Whites, Blacks will have lower utilization rates, higher complication rates, and worse outcomes, but racial disparities in utilization and outcomes will decrease over time.

Methods

Study Sample Selection

In this retrospective cohort study, we used the NIS data from 1998 to 2011 to select all hospitalizations with an International Classification of Disease, ninth revision, common modification (ICD-9-CM) code, 81.80 for TSA. Arthroplasty codes have been shown to be valid [12, 13]. The Institutional Review Board at the University of Alabama at Birmingham approved the study.

Predictors, Outcomes, and Covariates

The independent variable of interest was race, categorized as White or Black; other races/ethnicities were excluded from analyses. The outcomes of interest included mortality,

discharge disposition, and the length of index hospital stay. Mortality associated with the index hospitalization was determined using the variable specified in the NIS. Discharge from the hospital after index hospitalization was categorized as to home (with or without home health care) or inpatient setting (short-term hospital, skilled nursing facility, intermediate care facility, or another type of inpatient facility). The length of index hospital stay was categorized as below or above the overall median hospital stay.

Covariates included age, gender, Deyo-Charlson index, the underlying diagnosis, hospital location and teaching status, primary payer, the hospital bed size, hospital region, and the annual hospital TSA volume. Age was categorized as <50, 50 to <65, 65 to <80, and 80 years. The underlying diagnosis was categorized as RA, OA, fracture, avascular necrosis of the bone (AVN) and other conditions. Medical comorbidity was assessed using the validated Deyo-Charlson index, which consists of 17 comorbidities, based on the presence of ICD-9-CM codes at index admission [14, 15]. The primary payer was classified as Medicare, Medicaid, private insurance, self-pay, and other (no charge and other categories combined). The annual hospital volume was based on the number of TSA and hemishoulder arthroplasties performed per year, as previously [16], and categorized as <5, 5–9, 10–14, 15–24, and 25 procedures/year.

Statistical Analyses

We compared the demographic and clinical characteristics by patient race, using analysis of variance or chi-squared tests as appropriate. Utilization rates for TSA were calculated per 100, 000 patients for each year by dividing the estimates by the total population in the respective category, for the overall cohort and by race. Data weights were applied as recommended to obtain weighted estimates (http://www.hcup-us.ahrq.gov/reports/methods/2003_2.jsp#as). Total US population for the respective year obtained from the US census site was used to calculate TSA utilization rates for the US population (<http://www.census.gov/compendia/statab/cats/population.html>). TSA utilization rates for a given year were compared between Whites and Blacks using chi-squared tests and for time periods (1998–2000 etc.) using Cochran-Armitage test. We used the Cochran-Armitage test for trend to assess time-trends across the years. Logistic regression was used to assess for any disparities in outcomes by race or change in disparity magnitude by using the interaction term, year*race. Analyses were adjusted for gender, Deyo-Charlson score, primary diagnosis, annual hospital TSA volume, hospital location, teaching status, hospital bed size, and hospital region.

Role of Funding Source

This study was not funded by any funding agency.

Results

Patient Characteristics

There were 176,141 Whites and 7694 Blacks who underwent primary TSA between 1998 and 2011, among a total of 256, 934 TSA surgeries (62,505 with missing race; 194,429 with race identified). Compared to Whites, Blacks undergoing TSA were younger by 4.9 years

and more likely to be women, have RA as the underlying diagnosis, have a Deyo-Charlson index score of 2 or higher, and undergo TSA at low-volume hospitals (Supplementary material 1).

Race and TSA Utilization

In 1998, annual TSA utilization was significantly higher in Whites compared to Blacks, 2.97 vs. 0.83/100,000 (Table 1). Significant increases in TSA utilization rates were noted over time from 1998 to 2000 to 2008 to 2011 in both Whites and Blacks ($p<0.0001$ for both; Table 1; Fig. 1). The increase in TSA utilization rates was similar in men and women for Blacks and Whites, except that the baseline rates in 1998 were higher in women compared to men (Fig. 2). Similar slopes for time-related increase in TSA utilization were seen in all age-groups in both Whites and Blacks, except for age <50 (Fig. 2).

Race and TSA Outcomes

With all years combined, compared to Whites, the proportion of Blacks with hospital stay more than median was significantly higher, 34.4 vs. 44.6 % (Table 2). A higher proportion of Blacks than Whites had length of hospital stay greater than the median hospital stay in 1998–2000, 51.4 vs. 62% (relative difference, 17 %; $p=0.016$) and in 2009–2011, 34.4 vs. 27.3 % (relative difference, 21 %; $p=0.002$, Table 2). Racial disparities did not change over time ($p=0.31$). Adjusted analyses revealed that there was a non-statistically significant trend for race disparity in hospital stay in 1998–2000 ($p=0.06$) and 2009–2011 ($p=0.07$); disparities did not change significantly over a 14-year period ($p=0.09$).

Post-TSA rates of discharge to inpatient facility were low, <15 % for both Whites and Blacks. Discharge to inpatient facility was similar for Whites and Blacks in 1998–2000 and 2008–2010 ($p=0.95$ and $p=0.37$, Table 2), with no significant time-trends in racial disparity ($p=0.95$). Adjusted comparisons revealed similar findings ($p=0.2$). Mortality rate was very low for both Whites and Blacks undergoing TSA, 0.1 and 0.1 %, respectively, which did not allow any meaningful comparisons (Table 2).

Discussion

In this 14-year study of nationally representative US data, we found that TSA utilization rates increased for both Whites and Blacks from 1998 to 2011. There was a significant difference in TSA utilization rates between Whites and Blacks in 1998, 2.97 vs. 0.83/100,000 and in 2011, 12.27 vs. 3.33/100,000. White-Black disparity in TSA utilization did not decrease over time. The absolute difference in utilization rate was 2.14/100,000 in 1998 and 8.94/100,000 in 2011. This persistent, and worsening, racial disparity in TSA utilization is quite concerning.

Racial disparities in hip and knee arthroplasty have been described [11]. Blacks had 31–40 % lower utilization rates compared to Whites over an 18-year period, 1991–2008, with no evidence of decline in disparities [11]. The disparities in utilization noted in our study for TSA over a similar period range from 72 to 80 % lower rates in Blacks compared to Whites, i.e., more impressive racial differences than those noted for other populations undergoing arthroplasty. Several reasons may underlie these differences between studies, including the

type of joint (upper vs. lower extremity) and the differences in patient familiarity, perceived need, and acceptability of the procedure. The implant survival rates for TSA are similar to that of knee/hip arthroplasty [17, 18], and therefore, implant survival is unlikely to be a reason for these racial disparities. However, patient familiarity and perception of the success of TSA, a relatively newer procedure, may be low.

Several factors have been postulated to contribute to racial disparities, including more barriers to health care access [19–21], lower socioeconomic status [22, 23], lower health literacy and numeracy [24], poorer physician-patient communication [25–28], higher medication non-adherence [29], and more risk averseness to therapies [30–35]. Blacks may have lesser access to subspecialist surgeons that perform TSA that may also contribute to this disparity. In fact, racial minorities are less likely to undergo arthroplasty as compared to Whites and perceive more risk and less benefit from arthroplasty [36–38]. The Institute of Medicine recommends that after detection and descriptions of disparities, monitoring progress toward the elimination of health care disparities is needed [39, 40]. Now that the disparity in TSA utilization has been described, concerted efforts are needed to determine the reasons for disparities and target interventions to eliminate them.

Another interesting finding from our study was that the index hospital stay was longer in Blacks compared to Whites; 44.6 vs. 34.4 % had hospital stay greater than the overall median hospital stay. The length of stay decreased by more than 40 % in both Blacks and Whites in our study, similar to the 56–60% reduction in hospital length of stay in Whites and Blacks who underwent primary knee or hip arthroplasty in the USA from 1991 to 2008 [11]. The magnitude of White-Black disparities and time-trends in length of stay in our TSA cohort is similar to that described for knee/hip arthroplasty [11]. Due to the absence of other studies of TSA outcome disparities following TSA, comparisons are limited to studies of knee/hip arthroplasty. There was no decrease in White-Black disparity in hospital stay during the 14-year study period. Relative White-Black differences in proportion with index hospitalization >median stay were 17 % in 1998–2000 and 21 % in 2009–2011. This persisting racial disparity is a reminder to the policy makers that more effective public campaign and/or policy changes may be needed to eliminate these disparities. Some racial disparities in hospital stay were attributable to other differences between Whites and Blacks, such as comorbidity and other hospital characteristics, as evident with unadjusted vs. adjusted analyses, which provide additional targets for intervention.

Mortality and discharge disposition did not differ significantly by race, a comforting study finding. Mortality was rare, so an absence of difference by race is more likely due the lack of power to detect small differences in mortality, although it is possible that there were no real differences. Discharge disposition was similar among Whites and Blacks, and a very small proportion, 15 %, was discharged to an inpatient facility. This rate is much lower than that noted for primary knee/hip arthroplasty, which was 40–50 % in the most recent period, 2006–2008 in Medicare population [11]. The impact of the surgery on ambulation and daily activities (shoulder less than knee/hip arthroplasty) and differences in patient populations (all comers vs. Medicare population) may explain these differences.

Annual TSA utilization quadrupled from 1998 to 2011, confirming a similar finding from a previous study [9]. The increase in utilization in age <50 was limited and the increased utilization was most remarkable in 65–79 year old. The patterns were similar in Whites and Blacks, but slopes seemed somewhat different.

We noted a slightly lower prevalence of OA in Blacks vs. Whites undergoing TSA, which is similar to previously noted lower prevalence of doctor-diagnosed arthritis in Blacks compared to Whites, 19 vs. 24 % [41]; most prevalent type of arthritis in adults is OA. A lower prevalence of shoulder fracture in Blacks vs. Whites as the underlying reason for TSA has been well-documented in other studies [42–44]. These similarities with other studies of the US studies are reflective of our national, representative sample obtained from the NIS.

Our study has several limitations. NIS does not include military and Veterans Affairs medical centers, leading to potential underestimation of utilization rates; however, a small proportion of all arthroplasties in the USA are performed in the Veterans Affairs/military hospitals, and therefore, this bias is likely small. NIS only counts hospitalizations and not surgeries, meaning that unilateral and bilateral surgeries during a single hospitalization cannot be distinguished. In the absence of widespread performance of bilateral TSA, this underestimation is likely very small.

Conclusions

In conclusion, in a 14-year study of time-trends in racial disparities of TSA, we found persisting White-Black disparities in TSA utilization rates from 1998 to 2011. We found that length of index hospital stay was longer in Blacks compared to Whites, and the disparities did not decrease over time. Post-TSA rates of mortality and discharge to inpatient facility were low and did not differ by race. Policy makers need to address these persisting racial disparities in TSA utilization and outcomes at the policy level. Patients and surgeons need to be aware of these differences also so that they can improve communication and address these at the patient-physician or policy level, to the extent possible.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Fig. 1.
Time-trends in TSA Black White utilization by race

Fig. 2.
Race-specific time-trends in TSA utilization in Black and White patients by gender (**a, b**)
and age group in Whites (**c**) and Blacks (**d**)

Table 1

Time-trends in TSA utilization by race/ethnicity

Year	White		Black		Percent difference ^a White-Black (%)	Absolute White-Black difference per 100,000
	TSA estimates from NIS	Rate per 100,000	TSA estimates from NIS	Rate per 100,000		
1998	5812	2.97	274	0.83	72.1	2.14
1999	5799	2.95	266	0.80	72.9	2.15
2000	5014	2.56	172	0.50	80.5	2.06
2001	5221	2.66	245	0.70	73.7	1.96
2002	6572	3.35	364	1.03	69.3	2.32
2003	6294	3.20	272	0.76	76.3	2.44
2004	9909	5.04	403	1.12	77.8	3.92
2005	10,393	5.28	436	1.20	77.3	4.08
2006	12,286	6.24	477	1.30	79.2	4.94
2007	13,740	6.97	574	1.55	77.8	5.42
2008	17,891	9.07	716	1.92	78.8	7.15
2009	23,057	11.68	893	2.37	79.7	9.31
2010	29,916	15.15	1319	3.47	77.1	11.68
2011	24,234	12.27	1278	3.33	71.72	8.94

p values derived from the Cochran-Armitage test of trend from 1998 to 2011: White, *p*<0.0001; Black, *p*<0.0001. *p* values using chi-squared test for White-Black disparity in TSA utilization: 1998, *p*<0.0001; 2011, *p*<0.0001. White-Black disparity over 14 years compared using the interaction term of year with race using the linear regression model, *p*<0.0001

^aPercent difference was calculated as (White-Black)*100/White

Table 2

Time-trends in TSA outcomes by race

	All patients 1998–2011		1998–2000		2001–2002		2003–2004		2005–2006		2007–2008		2009–2011		Percent change last–first period		<i>p</i> value ^a	
	W	B	W	B	W	B	W	B	W	B	W	B	W	B	W	B	Unadjusted	Adjusted ^b
Length of stay >median, <i>n</i> (%)	60,678 (34.4)	3431 (44.6)	8540 (51.4)	442 (62)	5272 (44.7)	324 (53)	6032 (37.2)	355 (52.6)	8641 (38.1)	518 (56.7)	11,137 (35.2)	592 (45.8)	21,057 (27.3)	1200 (34.4)	–42	–41	0.02	0.06
Discharge, <i>n</i> (%) ^c																	<0.001	0.07
Home	153,061 (87.1)	6719 (87.5)	14,040 (84.8)	606 (85)	9997 (85.2)	545 (91)	14,209 (87.9)	572 (94.6)	19,714 (87.1)	794 (87.8)	27,466 (86.9)	1101 (85.3)	67,634 (87.7)	3102 (88.9)			0.31	0.09
Inpatient facility	22,721 (12.9)	956 (12.5)	2525 (15.2)	107 (15)	1735 (14.8)	55 (9.2)	1955 (12.1)	104 (15.4)	2931 (12.9)	111 (12.2)	4123 (13.1)	190 (14.7)	9452 (12.3)	389 (11.1)	–19	–26	0.95	0.65
Mortality, <i>n</i> (%)	194 (0.1)	4 (0.1)	52 (0.3)	0	24 (0.2)	0	19 (0.1)	0	5 (0.02)	4 (0.5)	24 (0.1)	0	70 (0.1)	0	–67	–	0.37	0.23
																	0.95	0.20
																	–	–

W White, B Black, – (*en dash*) numbers too low for any meaningful comparison

^aThree *p* values in the table are as follows: first *p* value denotes race disparity in 1998–2000, second *p* value denotes the change in disparity magnitude for all study periods including 1998–2000 and 2009–2011

^bThe *p* values in the same order as above, adjusted for gender, age, Deyo-Charlson score, TSA utilization hospital volume, hospital location and teaching status, primary payer, hospital bed size, hospital region, and primary diagnosis

^cDischarge status was missing for 66 patients: 62 White and 4 Black patients