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## Disparities in postoperative total shoulder arthroplasty outcomes between Black and White patients

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**Background:** Despite the rise in surgical volume for total shoulder arthroplasty (TSA) procedures, racial disparities exist in outcomes between White and Black populations. The purpose of this study was to compare 30-day postoperative complication rates between Black and White patients following TSA.

**Methods:** The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database was queried for all patients who underwent TSA between 2015 and 2019. Patient demographics and comorbidities were compared between cohorts using bivariate analysis. Multivariate logistic regression, adjusted for all significantly associated patient demographics and comorbidities, was used to identify associations between Black or African American race and postoperative complications.

**Results:** A total of 19,733 patients were included in the analysis, 18,669 (94.6%) patients in the White cohort and 1064 (5.4%) patients in the Black or African American cohort. Demographics and comorbidities that were significantly associated with Black or African American race were age 40–64 years ( $P < .001$ ), body mass index  $\geq 40$  ( $P < .001$ ), female gender ( $P < .001$ ), American Society of Anesthesiologists classification  $\geq 3$  ( $P < .001$ ), smoking status ( $P < .001$ ), non-insulin and insulin dependent diabetes mellitus ( $P < .001$ ), hypertension requiring medication ( $P < .001$ ), disseminated cancer ( $P = .040$ ), and operative duration  $\geq 129$  minutes ( $P = .002$ ). Multivariate logistic regression identified Black or African American race to be independently associated with higher rates of readmission (odds ratio: 1.42, 95% confidence interval: 1.05–1.94;  $P = .025$ ).

**Conclusion:** Black or African American race was independently associated with higher rates of 30-day readmission following TSA.

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Total shoulder arthroplasty (TSA) is an effective surgical treatment for a wide range of shoulder disorders. Anatomic TSA is indicated for patients with end-stage glenohumeral osteoarthritis and inflammatory arthritis. Reverse total shoulder arthroplasty (RTSA) is indicated for patients with rotator cuff arthropathy, proximal humerus fracture, rheumatoid arthritis, and revision arthroplasty.<sup>4,13,18,26</sup> The yearly volume of TSA procedures performed grew from 14,000 in 2000 to 47,000 in 2011, followed by a 103.7% increase to 104,575 in 2017.<sup>26</sup> Notably, the proportion of RTSA cases out of all TSA cases increased from 42.2% to 77.9% from 2009 to 2018, reflecting the expansion of indications for RTSA.

Despite the overall rise in surgical volume for TSA procedures, racial disparities exist in terms of TSA utilization rates and

outcomes between White and Black populations. Racial disparities in utilization rates for total hip arthroplasty (THA) and total knee arthroplasty (TKA) have been well-documented in literature.<sup>12,19,20,24</sup> Studies on racial disparity in TSA utilization are limited, but show that it is growing at a fast rate.<sup>8,9</sup> From 1998 to 2016, the Black population had a 72%–80% lower rate of TSA utilization compared to the White population.<sup>8</sup> A recent study looking at data up until 2017 found that even though the total incidence of TSA in Black patients had increased, the incidence in White patients raised significantly more, even regardless of insurance status.<sup>2</sup> This study also found that Black patients had increased odds of complications and mortality.<sup>2</sup>

Given the current trends in racial disparities in TSA utilization and outcomes between Black and White populations, it is important to further investigate these differences in order to reduce these disparities. This is especially important considering the rising popularity of TSA, which is projected to increase to 350,500 procedures in 2025.<sup>26</sup> As such, the purpose of this study was to

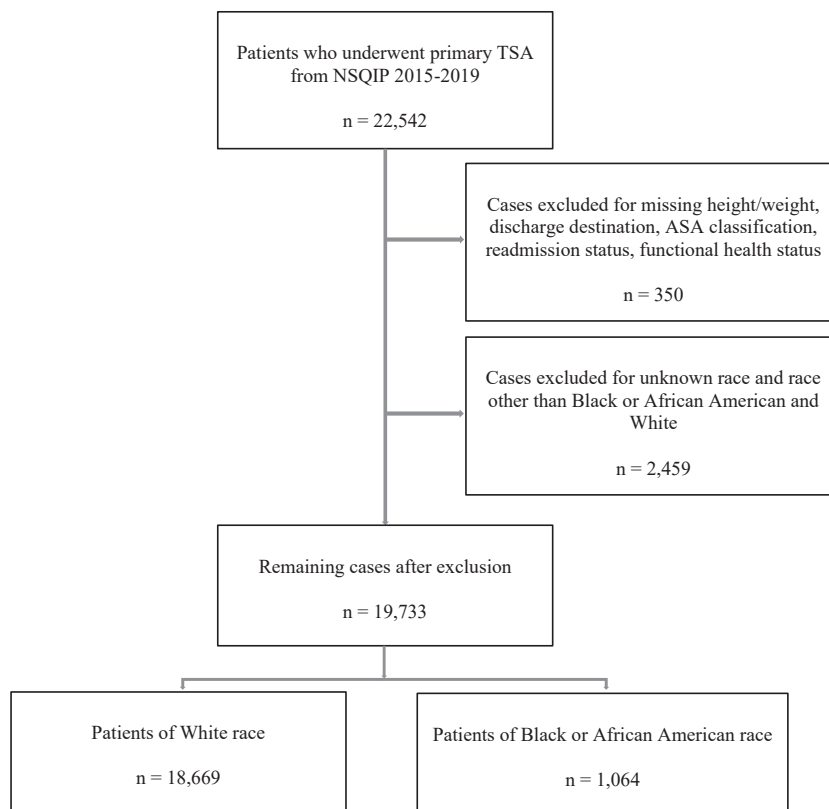
Institutional review board approval was not required for this study.

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**Figure 1** Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) diagram with inclusion and exclusion criteria. TSA, total shoulder arthroplasty; NSQIP, National Surgical Quality Improvement Program; ASA, American Society of Anesthesiologists.

compare 30-day postoperative complication rates between Black and White patients following TSA. We hypothesized that Black patients would have a significantly higher rate of complications overall.

**Methods**

The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database was queried for all patients who underwent TSA between 2015 and 2019. The NSQIP database is fully deidentified; therefore, rendering this study exempt from approval by our University’s institutional review board. Data in the NSQIP database are obtained from over 600 hospitals in the United States and is collected by trained surgical clinical reviewers. The data are periodically audited to maintain high fidelity.

*Current Procedural Terminology* (CPT) code 23472 was used to identify patients who underwent TSA, both anatomic and reverse, from 2015 to 2019. Data from 2020 were not included in the study in order to exclude the effects of the COVID pandemic. Cases for patients younger than 18 years of age or TSA performed for trauma were automatically excluded from the database. Cases were also excluded if any of the following variables had missing information: age, height, weight, functional status, discharge destination, American Society of Anesthesiologists (ASA) classification, and race.

Variables collected in this study included patient demographics, comorbidities, surgical characteristics, and 30-day postoperative complication data. Patient demographics included age, body mass index, gender, functional status, ASA classification, and smoking status. Preoperative comorbidities included insulin-dependent and non-insulin-dependent diabetes, severe chronic obstructive

pulmonary disease, hypertension requiring medication, bleeding disorders, open wound/wound infection, disseminated cancer, and congestive heart failure. Postoperative complications that occurred within a 30-day postoperative period were included in the analysis. Complications included sepsis, septic shock, pneumonia, reintubation, urinary tract infection, stroke, cardiac arrest, myocardial infarction, blood transfusion, deep vein thrombosis, pulmonary embolism, failure to wean off ventilator, deep incisional surgical site infection (SSI), superficial incisional SSI, organ/space SSI, wound dehiscence, readmission, reoperation, non-home discharge, and mortality. Reasons for readmission were collected and identified using the corresponding *International Classification of Diseases, Ninth and tenth Revisions* (ICD-9, ICD-10) codes.

The initial pool of patients was divided by race into 2 cohorts: Black or African American and White. Based on the U.S. census bureau definitions of race provided by NSQIP, White was used to indicate a person having origins in any of the original peoples of Europe, the Middle East, or North Africa. Black or African American was used to indicate a person having origins in any of the black racial groups of Africa. Patient race was reported as per the medical record or self-assigned by the patient. In cases where documentation indicated more than one race, the first race listed was selected by NSQIP.

A total of 22,542 patients who underwent primary TSA were identified in NSQIP from 2015 to 2019. Cases were excluded as follows: 116 for missing height/weight, 8 for missing discharge destination, 24 for missing ASA classification, 2 for missing readmission status, 200 for missing functional health status prior to surgery, and 2459 for unknown race or race listed other than Black or African American and White. Of the 22,542 patients remaining after exclusion criteria, 18,669 (94.6%) patients were included in the

**Table 1**  
Patient demographics/comorbidities for patients of Black or African American race compared to patients of White race.

Characteristic	White		Black		P value
	Number	Percent (%)	Number	Percent (%)	
Total	18,669	100.0	1064	100.0	
Age (yr)					<b>&lt;.001</b>
18-39	95	0.5	17	1.6	
40-64	5036	27.0	499	46.9	
65-74	7769	41.6	348	32.7	
≥75	5769	30.9	200	18.8	
Body mass index (kg/m <sup>2</sup> )					<b>&lt;.001</b>
<18.5	130	0.7	8	0.8	
18.5-29.9	8939	47.9	406	38.2	
30-34.9	4966	26.6	282	26.5	
35-39.9	2647	14.2	189	17.8	
≥40	1958	10.5	179	16.8	
Gender					<b>&lt;.001</b>
Female	10,331	55.3	669	62.9	
Male	8338	44.7	395	37.1	
Functional status prior to surgery					.155
Independent	18,281	97.9	1035	97.3	
Dependent	388	2.1	29	2.7	
ASA classification					<b>&lt;.001</b>
1-2	7894	42.3	358	33.6	
≥3	10,775	57.7	707	66.4	
Smoker					<b>&lt;.001</b>
No	16,826	90.1	836	78.6	
Yes	1843	9.9	228	21.4	
Diabetes mellitus					<b>&lt;.001</b>
No diabetes mellitus	15,404	82.5	787	74.0	
Non-insulin dependent	2325	12.5	186	17.5	
Insulin dependent	940	5.0	91	8.6	
Hypertension					<b>&lt;.001</b>
No	6165	33.0	223	21.0	
Yes	12,504	67.0	841	79.0	
Chronic obstructive pulmonary disease					.305
No	17,367	93.0	981	92.2	
Yes	1302	7.0	83	7.8	
Bleeding disorders					.733
No	18,199	97.5	1039	97.7	
Yes	470	2.5	25	2.3	
Open wound/wound infection					.109
No	18,604	99.7	1057	99.3	
Yes	65	0.3	7	0.7	
Disseminated cancer					<b>.040</b>
No	18,626	99.8	1058	99.4	
Yes	43	0.2	6	0.6	
Congestive heart failure					.931
No	18,542	99.3	1057	99.3	
Yes	127	0.7	7	0.7	
Operative duration (min)					<b>.002</b>
0-79	4966	26.6	199	18.7	
80-128	9274	49.7	528	49.6	
≥129	4429	23.7	337	31.7	

ASA, American Society of Anesthesiologists.  
Bold P values indicate statistical significance with  $P < .05$ .

White cohort and 1064 (5.4%) patients were included in the Black or African American cohort (Fig. 1).

All statistical analyses were conducted using SPSS Software version 26.0 (IBM Corp., Armonk, NY, USA). Patient demographics and comorbidities were compared between cohorts using bivariate logistic regression. Postoperative complications were also compared between cohorts using bivariate logistic regression.

Multivariate logistic regression, adjusted for all significantly associated patient demographics and comorbidities, was used to identify associations between Black or African American race and postoperative complications.

Multivariate logistic regression was also used to identify significant associations between patient variables of Black or African American patients and readmission. This was performed in a backward stepwise fashion described as follows: (1) patient

demographics and comorbidities that were significantly associated with Black or African American race were all initially included in the analysis, (2) variables were eliminated one-by-one, with the highest P value being eliminated first, and (3) variables were eliminated until only statistically significant variables associated with readmission remained. Odds ratios (ORs) were reported with 95% confidence intervals (CIs). The level of statistical significance was set at  $P < .05$ .

**Results**

The patient demographics and comorbidities significantly associated with Black or African American race who were aged 40-64 years ( $P < .001$ ), BMI  $\geq 40$  ( $P < .001$ ), female gender ( $P < .001$ ), ASA classification  $\geq 3$  ( $P < .001$ ), smoking status ( $P < .001$ ),

**Table II**  
Bivariate analysis of 30-day postoperative complications for patients of Black or African American race compared to patients of White race.

Postoperative complication	White		Black		P value
	Number	Percent (%)	Number	Percent (%)	
Sepsis	25	0.13	2	0.19	.644
Septic shock	9	0.05	0	0.00	.999
Pneumonia	85	0.46	5	0.47	.945
Reintubation	32	0.17	3	0.28	.573
Urinary tract infection	130	0.70	2	0.19	.065
Stroke	13	0.07	1	0.09	.773
Cardiac arrest	10	0.05	1	0.09	.679
Myocardial infarction	51	0.27	2	0.19	.604
Blood transfusions	340	1.82	17	1.60	.595
Deep vein thrombosis	63	0.34	6	0.56	.250
Pulmonary embolism	49	0.26	4	0.38	.521
Failure to wean off ventilator	21	0.11	1	0.09	.861
Deep incisional SSI	9	0.05	2	0.19	.082
Superficial incisional SSI	36	0.19	3	0.28	.527
Organ/space SSI	35	0.19	5	0.47	.497
Wound dehiscence	9	0.05	1	0.09	.526
Readmission	543	2.91	49	4.61	<b>.002</b>
Reoperation	268	1.44	18	1.69	.497
Non-home discharge	1747	9.36	102	9.59	.739
Mortality	30	0.16	3	0.28	.353

SSI, surgical site infection.  
Bold P values indicate statistical significance with  $P < .05$ .

**Table III**  
Multivariate analysis of 30-day postoperative complications in patients of Black or African American race compared to patients of White race, adjusted for significantly associated patient demographics/comorbidities.

Postoperative complication	Odds ratio	95% CI	P value
Readmission	1.42	1.05-1.94	<b>.025</b>

CI, confidence interval.  
Bold P values indicate statistical significance with  $P < .05$ .

non-insulin- and insulin-dependent diabetes mellitus ( $P < .001$ ), hypertension requiring medication ( $P < .001$ ), disseminated cancer ( $P = .040$ ), and operative duration  $\geq 129$  minutes ( $P = .002$ ) (Table I).

Bivariate analysis was used to determine postoperative complications significantly associated with Black or African American vs. White race (Table II). We identified significantly higher rates of readmission ( $P = .002$ ) in Black or African American patients. White patients had a readmission rate of 2.91%, compared to a readmission rate of 4.61% in Black or African American patients.

After adjusting for the patient variables significantly associated with Black or African American race, multivariate logistic regression identified Black or African American race to be independently associated with higher rates of readmission (OR: 1.42, 95% CI: 1.05-1.94;  $P = .025$ ) (Table III).

Given the significant association between Black or African American race and readmission following TSA, the reasons for readmission were summarized in Table IV. The most common reason for readmission among the Black or African American cohort was pulmonary complication ( $n = 6$ ), which accounted for 12.2% of readmissions. Pulmonary complications included pneumonia, chronic obstructive pulmonary disease, respiratory failure, and hypoxemia. Among surgical-site-related reasons for readmission, wound complications ( $n = 9$ ; 18.4%) were most common. Wound complications included deep incisional SSI, superficial incisional SSI, organ/space SSI, and postprocedural hematoma/hemorrhage.

Multivariate logistic regression was used to identify the patient variables of Black or African American patients associated with readmission (Table V). After using a backward stepwise approach, we identified ASA classification  $\geq 3$  (OR: 2.27, 95% CI: 1.09-4.74;  $P = .029$ ) and disseminated cancer (OR: 9.79, 95% CI: 1.72-55.59;

**Table IV**  
Reasons for 30-day readmission in patients of Black or African American race following total shoulder arthroplasty.

Reason	Number	Percent (%)
Total	49	100
Nonsurgical site related		
Pulmonary complications	6	12.2
Unrelated orthopedic complications	4	8.2
Cardiovascular complications	4	8.2
Neurological complications	3	6.1
Thromboembolic complications	3	6.1
Gastrointestinal complications	2	4.1
Renal complications	2	4.1
Surgical site related		
Wound complications	9	18.4
Pain	1	2.0
Dislocation of prosthesis	1	2.0
Periprosthetic fracture	1	2.0
Other complications/unspecified	13	26.5

$P = .010$ ) as clinically significant predictors of readmission in Black or African American patients.

**Discussion**

In this study, we reported on 30-day postoperative complications associated with Black or African American race in patients who underwent TSA from 2015 to 2019 using a large national database. Our analysis included 19,733 patients, of which 1064 (5.4%) were of Black or African American race and 18,669 (94.6%) were of White race. Through bivariate analysis, we identified Black or African American race to be significantly associated with higher rates of readmission. After controlling for significantly associated patient demographics and comorbidities, we identified Black or African American race to be independently associated with higher rates of readmission following TSA. Among Black or African American patients, the clinically significant risk factors for readmission were ASA classification  $\geq 3$  and disseminated cancer.

TSA and RTSA are effective treatment options for various shoulder pathologies including osteoarthritis, proximal humerus fracture, and rotator cuff arthropathy.<sup>16</sup> The volume of TSA has been

**Table V**  
Significant predictors for 30-day readmission in patients of Black or African American race.

Characteristic	Odds ratio	95% CI	P value
ASA classification			.029
No	Reference	–	
Yes	2.27	1.09–4.74	
Disseminated cancer			.010
No	Reference	–	
Yes	9.79	1.72–55.59	

CI, confidence interval; ASA, American Society of Anesthesiologists.

increasing yearly and is projected to drastically outpace that of THA and TKA. One study reported a projected increase in TSA of up to 235% from 2017 to 2025, compared to 47% and 22% for THA and TKA, respectively.<sup>7,26</sup> Despite the increasing popularity of TSA, previous studies have identified disparities in the utilization rates of TSA between different races. More specifically, the Black patient population is less likely to undergo TSA compared to the White patient population.<sup>2,8,9</sup>

Racial disparities in treatments and outcomes are a persistent issue in many facets of health care. In the realm of orthopedic surgery, associations between race and outcomes in THA and TKA have been well documented in prior literature. Studies have shown that Black patients frequently require intensive postoperative rehabilitation and experience higher rates of non-home discharge, mortality, venous thromboembolism, blood transfusions, and readmission when compared to White patients.<sup>6,17,20,22,28</sup> A study by Singh et al reported that from 1991 to 2008, the differences in readmission rates after total joint arthroplasty (TJA) between Black and White patients increased from 6% to 24%.<sup>20</sup>

Multiple studies have also demonstrated lower utilization rates of THA and TKA in Black patients compared to White patients.<sup>1,19,20,28</sup> A study by Amen et al reported on disparities in the utilization of outpatient TJA between Black and White patients. This study found that from 2011 to 2019, utilization of outpatient TJA increased from 0.4% to 10.2% in White patients, but only increased from 0.6% to 5.9% in Black patients.<sup>1</sup>

These studies not only indicate that racial disparities are an ongoing issue, but also that the disparities are worsening over time. Recent studies investigating racial disparities with regards to TSA have shown findings similar to those in TKA and THA. A study by Farley et al reported that Black patients were more likely to experience non-home discharge, extended length of stay, and increased costs.<sup>9</sup> They also reported higher rates of perioperative health-care utilization. Another study by Garcia et al investigated TSA patients with equal access to care and found that Black patients were still 45% more likely to return to the emergency department within 90 days postoperatively when compared to White patients.<sup>10</sup> Other studies have reported that the Black patient population in TSA suffered from higher rates of comorbidities, and subsequently, increased rates of complications and mortality.<sup>2,10,21,27</sup>

Although studies have previously reported on differences in complication rates between Black and White patients, the most recent studies only used data up to 2017.<sup>2,9,10</sup> In light of the tremendous growth in TSA surgical volume, it is of increasing importance to monitor racial disparities over time. Several national incentives have already been implemented to address and eliminate racial disparities in health care.<sup>3</sup> In 2011, the U.S. Department of Health and Human Services launched a federal action plan to improve health-care equality to all races and ethnicities.<sup>23</sup> This action plan included increasing availability of data to improve minority population health and assessing improvements in disparities over time.<sup>3,23</sup> The purpose of our study was to use recent data to assess current racial disparities in TSA outcomes.

Our study found that Black patients who underwent TSA had significantly higher rates of female gender, ASA classification  $\geq 3$ , current smoking status, non-insulin- and insulin-dependent diabetes mellitus, hypertension requiring medication, disseminated cancer, and operative duration  $\geq 129$  minutes when compared to White patients. Our findings are consistent with those from the aforementioned studies that reported higher rates of comorbidities in Black patients.<sup>2,10,21,27</sup> These previous studies identified higher rates of comorbidities overall, but did not distinguish specific comorbidities. In contrast, our study identified the specific comorbidities that had significantly higher rates in the Black patient population. Interestingly, Black patients were more likely to have longer operative times, which may indicate increased case complexity that could have contributed to the development of postoperative complications.

Our study identified Black race to be significantly associated with higher rates of readmission following TSA compared to White patients. This is consistent with previous studies that reported higher perioperative health-care utilization rates and increased costs in Black patients who underwent TSA.<sup>9,10</sup> Higher rates of readmission were also reported in Black patients who underwent TKA and THA.<sup>20</sup> The most common reason for readmission among Black patients was due to pulmonary complication (n = 6), followed by cardiovascular and unrelated orthopedic complication (n = 4 each).

To better understand the perioperative factors influencing readmission, we used multivariate analysis to determine factors in Black patients that were associated with readmission. Our multivariate analysis identified ASA classification  $\geq 3$  and disseminated cancer in Black patients as clinically significant risk factors for readmission following TSA. Although this may seem intuitive as patients with ASA  $\geq 3$  or disseminated cancer are generally sicker, these findings do not shed much light on why Black patients are readmitted at a disproportionately higher rate, as we controlled for both variables in our analysis. Rather, our analysis suggests that the underlying reason for higher rates of readmission in Black patients is multifactorial and encompasses factors that are not medically documented. Our findings further suggest that while initiatives are in place to eliminate racial disparities in health care, these disparities continue to persist.

The persistence of racial disparities in orthopedic surgery is likely complex in nature. One study suggested that racial disparities stem from various sources including implicit bias from the provider, socioeconomic status, limited access to high quality hospitals, and baseline health.<sup>11</sup> Additionally, differences in levels of social support and preferences toward orthopedic surgery may contribute to these disparities.<sup>25</sup> For example, Chapman et al reported higher odds of choosing watchful waiting in rotator cuff repair among the Black patient population, which may represent an overall higher threshold for orthopedic surgery.<sup>5</sup> Similarly, in a study on TKA, Black patients were less willing to undergo surgery than White patients (62% vs. 80%, respectively).<sup>14</sup> Due to the elective nature of TSA, parallels can be drawn from these studies to TSA.

Our study was limited to the information available on the NSQIP database. As mentioned in the methods section, race was determined by the first race listed in the medical record; therefore, patients of mixed race were not accurately represented. Due to inherent characteristics of the database, we also could not account for perioperative variables such as experience of the surgeon, institution where the procedure was performed, and postoperative rehabilitation. These perioperative variables may be important to consider, given that Black patients were more likely to have longer operative times. We also could not account for perioperative social factors that could influence the differences in postoperative outcomes between races. Additionally,



postoperative complications in NSQIP are only considered within a 30-day postoperative period. Therefore, we could not account for long-term complications following TSA such as instability, loosening, and periprosthetic fracture.<sup>15</sup> A follow-up period encompassing 90-day global complications would likely yield further disparities in these long-term complications. A longitudinal study that includes data on more social factors may be more insightful into the underlying cause for racial disparities, although the sample size may be a limitation.

Regardless of these limitations, we used a large national database to provide an update on the racial disparities in postoperative complications following TSA. Moreover, we identified specific comorbidities significantly associated with Black patients who underwent TSA and determined the clinically significant risk factors for readmission.

## Conclusion

Black or African American race is independently associated with higher rates of 30-day readmission following TSA. Among Black or African American patients, ASA classification  $\geq 3$  and disseminated cancer are clinically significant risk factors for readmission following TSA, with pulmonary complication being the most common reason for readmission. As the surgical volume for TSA continues to grow, racial disparities in outcomes must continue to be investigated in efforts to reduce these disparities.

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