

The Effect of Race on Early Perioperative Outcomes After Shoulder Arthroplasty: A Propensity Score Matched Analysis

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abstract

There is a paucity of data on how racial disparities may affect early outcomes following shoulder arthroplasty. The purpose of this study was to evaluate differences in 30-day complications and readmission rates after shoulder arthroplasty based on race. White and black patients who underwent hemiarthroplasty, anatomic or reverse total shoulder arthroplasty (*Current Procedural Terminology* codes 23470 and 23472) between 2006 and 2015 were identified in the American College of Surgeons National Surgical Quality Improvement Program database. Black patients were propensity score matched 1:4 based on preoperative demographics and comorbidities to white patients. Multivariable analysis was performed to assess postoperative complications based on race. Of the 12,663 patients with shoulder arthroplasty identified, 10,717 (84.6%) were white and 559 (4.4%) were black. Overall, 557 black patients were matched to 2228 white patients, for a total cohort of 2785 patients (mean age, 63.9±11.7 years; female, 61.0%). Surgical indications were similar between black and white patients. The 2 races had similar rates of overall complications, major complications, minor complications, readmissions, and discharge to facility. Mortality was significantly higher among black patients compared with white patients (0.6% vs 0.05%; $P=.033$). Black patients also experienced longer operative time (mean, 126.4 vs 112.5 minutes; $P<.001$) and length of stay (mean, 2.4 vs 2.1 days; $P<.001$). There was a significant disparity with underutilization of shoulder arthroplasty for black patients in the American College of Surgeons National Surgical Quality Improvement Program database. Black and white patients undergoing shoulder arthroplasty experienced similar rates of 30-day complications, readmissions, and discharge to facility. However, black patients experienced greater operative time, total length of stay, and mortality compared with white patients. [*Orthopedics*. 201x; xx(x):xx-xx.]

cular necrosis, rotator cuff arthropathy, and revision arthroplasty.⁴⁻⁸ Numerous studies cite low mortality and complication rates associated with the procedure.⁸⁻¹¹ Eichinger and Galvin¹² described the most common complications following total shoulder arthroplasty as glenoid (6%) and humeral (1%) component loosening, periprosthetic fracture (range, 0.6%-2.3%), rotator cuff tear (1.3%), and infection (range, 0%-4%).

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Shoulder arthroplasty is effective for pain relief and functional improvement among patients with severe

shoulder pathologies.¹⁻³ Common surgical indications include osteoarthritis, rheumatoid arthritis, posttraumatic arthritis, avas-

Although the utilization of shoulder arthroplasty has increased with time, consistent underutilization is seen among black patients.^{8,13-15} Differences in utilization based on race is a well-documented phenomenon for a variety of orthopedic surgical procedures and is often accompanied with higher complication rates and worse outcomes.¹⁶⁻²⁶ Dy et al,²⁴ when evaluating various racial and community socioeconomic factors among patients presenting with a hip fracture, found black patients to be at greater risk for delayed surgery, reoperation, readmission, and 1-year mortality. Similarly, Ibrahim et al²⁰ found that black patients had a significantly higher risk of both infection-related and non-infection-related complications following knee arthroplasty.

Although the impacts of race on total knee and hip arthroplasty are well documented, data are limited on how racial disparities affect early outcomes following shoulder arthroplasty.^{14,23,27-34} Therefore, the purpose of this study was to compare 30-day complications and readmission rates after shoulder arthroplasty between white and black patients using a large national database.

MATERIALS AND METHODS

White and black patients who underwent hemiarthroplasty, anatomic or reverse total shoulder arthroplasty (*Current Procedural Terminology* codes 23470 and 23472) between 2006 and 2015 were identified in the American College of Surgeons National Surgical Quality Improvement Program database. The American College of Surgeons National Surgical Quality Improvement Program database is a validated, risk-adjusted data set submitted by participating hospitals. The data include demographics, surgical profile, and preoperative, intraoperative, and postoperative variables. Thirty-day postoperative mortality and morbidity outcomes are also collected.^{35,36} Demographic data (age, sex, and body mass index), anesthesia type (general, regional, and other/

not reported), American Society of Anesthesiologists classification, comorbidities (hypertension, diabetes, history of pulmonary disease, cardiac disease, smoking, and steroid use), surgical indication, and procedure were extracted.

Black patients were propensity score matched 1:4 based on preoperative demographics and comorbidities to white patients. Propensity score matching is used in observational studies to balance variables between 2 groups and reduce bias, thereby improving the validity of the results.³⁷⁻³⁹

Multivariable analysis was performed to assess postoperative complications based on race. Complications were categorized as major or minor. Major complications included mortality, sepsis, septic shock, deep surgical site infection, wound dehiscence, pulmonary embolism, ventilator use for more than 48 hours, unplanned intubation, myocardial infarction, stroke, or return to operating room. Minor complications included superficial surgical site infection, pneumonia, urinary tract infection, deep venous thrombosis or thrombophlebitis, transfusion, and renal insufficiency. Readmission, discharge to facility, operative time, and total length of hospital stay were also analyzed.

RESULTS

Of the 12,663 patients with shoulder arthroplasty identified, 10,717 (84.6%) were white, 559 (4.4%) were black, 110 (0.87%) were Asian/Pacific Islander, 64 (0.51%) were Native American, and 1213 (9.6%) were of unknown race. After propensity score matching, 557 black patients were matched to 2228 white patients, for a total cohort of 2785 patients with a mean age of 63.9±11.7 years (female, 61.0%) (**Table 1**). Surgical indications were similar between black and white patients (osteoarthritis, 59.2% vs 61.5%; avascular necrosis, 8.1% vs 6.1%; cuff arthropathy, 10.4% vs 11.2%; $P=.564$). Patients in both groups were

most commonly classified as being overweight (24.4% for black and 24.5% for white patients; defined as having a body mass index of 25 to 29 kg/m²) or obese class I (22.6% for black and 22.7% for white patients; defined as having a body mass index of 30 to 34 kg/m²). The most common preoperative comorbidity was hypertension (75% for black and 76.9% for white patients), followed by history of smoking (23.9% for black and 22.5% for white patients).

Black patients and white patients had similar rates of overall complications (9.1% vs 8.6%; odds ratio [OR], 1.03; 95% confidence interval [CI], 0.72-1.47), major complications (2.5% vs 2.9%; OR, 0.83; 95% CI, 0.43-1.58; **Figure 1**), minor complications (6.5% vs 5.4%; OR, 1.23; 95% CI, 0.83-1.83; **Figure 2**), readmissions (2.7% vs 3.5%; OR, 0.79; 95% CI, 0.42-1.49), and discharge to facility (11.5% vs 10.6%; OR, 1.13; 95% CI, 0.83-1.55) (**Table 2**). Mortality reached statistical significance with a higher rate among black patients (0.6% vs 0.05%; OR, 11.83; 95% CI, 1.23-114.00; $P=.033$). Black patients also experienced significantly longer operative time (mean, 126.4 vs 112.5 minutes; $P<.001$) and length of stay (mean, 2.4 vs 2.1 days; $P<.001$) compared with white patients.

DISCUSSION

The influence of race on outcomes after orthopedic surgery, and specifically joint arthroplasty, has been well documented, indicating historically worse outcomes for racial minorities. However, most of the current literature focuses on hip and knee arthroplasty.^{20,30,34,40-42} Given the steady increase in the use of shoulder arthroplasty in the United States, identifying risk factors that affect postoperative outcomes is becoming increasingly important.¹³ This is especially critical as value-based health care solutions focusing on reimbursement based on patient outcomes emerge.⁴³ The authors used propensity score matching of 12,663 cases of shoul-

der arthroplasty from 2006 to 2015 to determine the impact of race on 30-day outcomes. The authors found no significant difference in complications after shoulder arthroplasty between the black and white patients in their cohort; however, they did find significantly greater mortality, length of stay, and operative time among black patients.

Although not the primary aim of the study, the American College of Surgeons National Surgical Quality Improvement Program data identified a significant disparity with underutilization of shoulder arthroplasty for black patients. Overall, 10,717 (84.6%) of the patients were white and only 559 (4.4%) were black who underwent shoulder arthroplasty. This confirms the findings of prior studies on utilization rates for joint arthroplasty.^{30,34,44,45} Yu et al³⁴ found that from 1990 to 2009, black patients accounted for only 5% of 10,538 elective shoulder arthroplasty cases in the state of New York. In addition, they reported that black patients had significantly more comorbid conditions, were more likely to have Medicaid insurance, and were less likely to participate in Medicare. Similarly, Singh and Ramachandran,⁴⁴ when using the US Nationwide Inpatient Sample 1998 to 2011, found a significant disparity in the use of shoulder arthroplasty between white (176,141) and black (7694) patients. The reason for underutilization for black patients is not entirely clear. Possible etiologies include black patients having barriers to care, being more likely to have Medicaid insurance, and being more likely of lower socioeconomic status; racial preferences for nonoperative intervention over surgery; and the perception that arthroplasty is an ineffective treatment.⁴⁶⁻⁴⁹ The profound difference in the use of shoulder arthroplasty between black and white patients warrants further investigation.

Despite receiving increasing attention and awareness over time, racial and eth-

Table 1

Characteristics of 1:4 Propensity Score Matched Cohort, Shoulder Arthroplasty

Characteristic	No. (%)		P
	White Patients	Black Patients	
Total	2228	557	
Age			.669
18-60 y	804 (36.1)	208 (37.3)	
61-69 y	696 (31.2)	178 (32.0)	
≥70 y	728 (32.7)	171 (30.7)	
Female	1358 (61.0)	340 (61.0)	1.00
Body mass index			.977
Normal (18.5-24 kg/m ²)	333 (14.9)	90 (16.2)	
Underweight (<18.5 kg/m ²)	21 (0.9)	4 (0.7)	
Overweight (25-29 kg/m ²)	545 (24.5)	136 (24.4)	
Obese class I (30-34 kg/m ²)	505 (22.7)	126 (22.6)	
Obese class II (35-40 kg/m ²)	374 (16.8)	90 (16.2)	
Obese class III (40+ kg/m ²)	450 (20.2)	111 (19.9)	
Anesthesia			.934
General	2125 (95.4)	530 (95.1)	
Regional	54 (2.4)	15 (2.7)	
Other/not reported	49 (2.2)	12 (2.2)	
American Society of Anesthesiologists classification			.769
1-2	723 (32.5)	185 (33.2)	
≥3	1505 (67.5)	372 (66.8)	
Hypertension	1714 (76.9)	418 (75.0)	.377
Diabetes	328 (14.7)	79 (14.2)	.799
History of pulmonary disease	303 (13.6)	75 (13.5)	.989
History of cardiac disease	45 (2.0)	13 (2.3)	.765
History of smoking	501 (22.5)	133 (23.9)	.520
Steroid use	148 (6.6)	38 (6.8)	.955
Non-independent functional status	135 (6.1)	28 (5.0)	.408
Surgical indication			.564
Osteoarthritis	1369 (61.5)	330 (59.2)	
Avascular necrosis	137 (6.1)	45 (8.1)	
Cuff arthropathy	250 (11.2)	58 (10.4)	
Revision arthroplasty	89 (4.0)	20 (3.6)	
Trauma	114 (5.1)	31 (5.6)	
Unknown	269 (12.1)	73 (13.1)	
Procedure			.714
Hemiarthroplasty	442 (19.8)	115 (20.6)	
Total shoulder arthroplasty	1786 (80.2)	442 (79.4)	

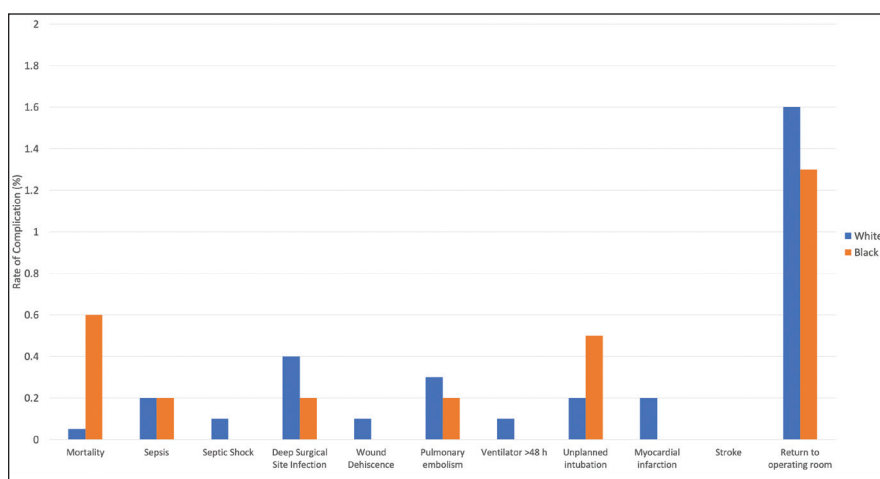


Figure 1: Summary of major complications after shoulder arthroplasty based on race.

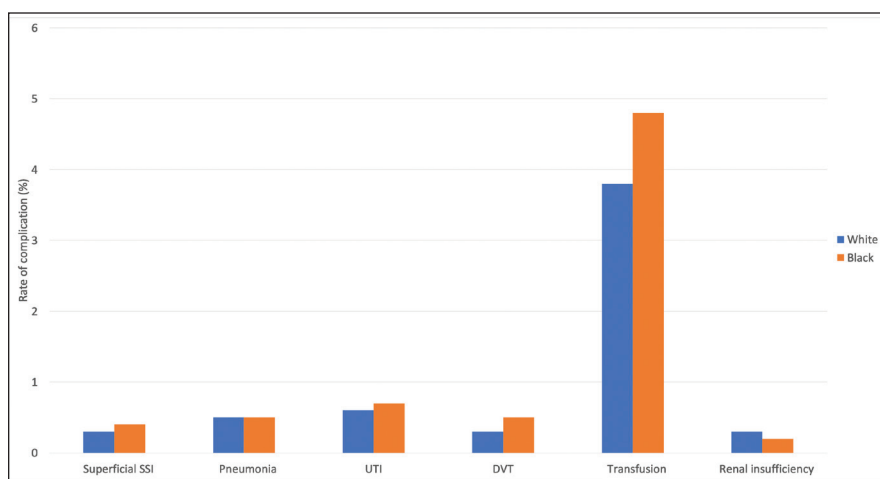


Figure 2: Summary of minor complications after shoulder arthroplasty based on race. Abbreviations: DVT, deep venous thrombosis; SSI, surgical site infection; UTI, urinary tract infection.

interventions at the level of the government, state, community, and individual health care provider.

In contrast to studies citing an association between complications and race after hip and knee arthroplasty, the authors found similar complication rates (both major and minor complications) following shoulder arthroplasty between black and white patients.^{14,20,30,32,42,58-60} D'Apuzzo et al⁵⁸ determined that black race was an independent risk factor (OR, 1.24; 95% CI, 1.15-1.52) for readmission after knee arthroplasty. Similarly, Ibrahim et al²⁰ noted that non-infection-related and infection-related complications following knee arthroplasty were significantly higher among black patients compared with white patients (relative risk, 1.5 vs 1.42; 95% CI, 1.08-2.10 vs 1.06-1.90). Lavernia and Villa,³² on examining 2142 primary total hip and total knee arthroplasties, found that black patients had significantly worse postoperative outcomes but acknowledged that the difference was likely not clinically significant. Although the current study did not show a difference in complications after shoulder arthroplasty between black and white patients, several variables that the authors did not account for may have affected their results. For example, Ponce et al⁶¹ analyzed a large cohort of patients using the Nationwide Inpatient Sample and found that those undergoing shoulder arthroplasty with preexisting alcohol use disorders had a greater likelihood of perioperative complications. This variable was not collected or included in the current multivariable analysis, which may have affected the results. Similarly, Li et al⁵⁷ showed that insurance status affects perioperative medical and surgical complication rates after shoulder arthroplasty, with private insurance status imparting a lower complication rate compared with Medicaid and Medicare status. The inability to account for these variables and control for other factors limits the validity of the findings. How-

nic disparities continue to exist in the US health care system.^{50,51} These inequalities result in a significant financial burden, with estimates of costs from a span of 3 years (2003-2006) totaling more than \$1 trillion.⁵² Eliminating these disparities has been an ongoing effort, with the landmark 2003 Institute of Medicine report, *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*, outlining a multilevel approach that included recommendations such as increasing awareness among the general public that these inequalities exist, increasing the proportion of underrepresented minorities among health profes-

sionals, and conducting further research in this area.⁵³ Expanding access to health insurance has shown promising results in decreasing racial disparities for some medical fields.⁵⁴ Unfortunately, following Medicaid expansion, orthopedic surgery has shown less promising results, with studies reporting persistent barriers to care despite having insurance coverage. An association was also found between Medicare/Medicaid insurance and higher rates of postoperative complications.⁵⁵⁻⁵⁷ Therefore, reducing racial and ethnic disparities in health care, and more specifically in orthopedic surgery, will require a multipronged approach, with

Table 2

Multivariable Regression Predicting Complication After Shoulder Arthroplasty^a

Factor	White Patients	Black Patients	P	Multivariable Logistic Regression ^b	
				Adjusted Odds Ratio (95% Confidence Interval)	P
Total, No.	2228	557			
Any complication, No.	167 (8.6)	45 (9.1)	.802	1.03 (0.72-1.47)	.874
Major complication, No.	56 (2.9)	12 (2.5)	.690	0.83 (0.43-1.58)	.569
Mortality	1 (0.05)	3 (0.6)	.036	11.83 (1.23-114.00)	.033
Sepsis	4 (0.2)	1 (0.2)	1.00	0.98 (0.08-11.50)	.988
Septic shock	2 (0.1)	0 (0)	1.00	-	-
Deep surgical site infection	9 (0.4)	1 (0.2)	.692	0.79 (0.06-9.53)	.850
Wound dehiscence	3 (0.1)	0 (0)	.885	-	-
Pulmonary embolism	7 (0.3)	1 (0.2)	.929	0.68 (0.08-5.75)	.722
Ventilator >48 h	2 (0.1)	0 (0)	1.00	-	-
Unplanned intubation	4 (0.2)	3 (0.5)	.298	2.76 (0.52-14.59)	.233
Myocardial infarction	4 (0.2)	0 (0)	.707	-	-
Stroke	1 (0.5)	0 (0)	1.00	-	-
Return to operating room	36 (1.6)	7 (1.3)	.673	0.79 (0.34-1.81)	.575
Minor complication, No.	120 (5.4)	36 (6.5)	.376	1.23 (0.83-1.83)	.305
Superficial surgical site infection	6 (0.3)	2 (0.4)	1.00	1.04 (0.19-5.85)	.962
Pneumonia	11 (0.5)	3 (0.5)	1.00	1.18 (0.32-4.42)	.802
Urinary tract infection	13 (0.6)	4 (0.7)	.952	1.04 (0.31-3.54)	.949
Deep venous thrombosis or thrombophlebitis	6 (0.3)	3 (0.5)	.559	2.14 (0.50-9.16)	.305
Transfusion	84 (3.8)	27 (4.8)	.298	1.33 (0.85-2.11)	.216
Renal insufficiency	6 (0.3)	1 (0.2)	1.00	0.58 (0.05-6.98)	.665
Readmission	61 (3.5)	12 (2.7)	.510	0.79 (0.42-1.49)	.471
Discharge to facility	236 (10.6)	64 (11.5)	.593	1.13 (0.83-1.55)	.427
Multivariate Linear Regression					
				Adjusted Coefficient (95% Confidence Interval)	P
Operating time, mean (SD), min	112.5 (51.8)	126.4 (56.7)	<.001	13.75 (8.90-18.59)	<.001
Total length of stay, mean (SD), d	2.1 (1.7)	2.4 (2.2)	<.001	0.37 (0.21-0.53)	<.001

^aAll covariates from Table 1 were inserted into each multivariable model. Odds ratios were not calculated if no complications were present.

^bDashes indicate insufficient results to compare groups.

ever, these are inherent weaknesses of any observational study. The authors reduced bias by using propensity score matching and including variables shown to be strong independent predictors of outcomes after arthroplasty.

One of the most important findings of this study was that in this cohort of

patients, there was a significantly higher rate of 30-day postoperative mortality among black patients compared with white patients. Although the overall risk of mortality was small in both groups (0.6% vs 0.05%; $P=.033$), the finding of increased mortality for black patients after shoulder arthroplasty has been sup-

ported extensively in numerous other surgical fields and subspecialties of orthopedic surgery.^{42,62-66} Mahomed et al⁶⁷ noted that blacks had a significantly greater risk of death compared with whites following total hip replacement (OR, 1.5%; 95% CI, 1.0-2.1). The authors also noted an increased mean operative time among

black patients compared with white patients (126.4 vs 112.5 minutes; $P < .001$), a factor that has been previously identified as an independent predictor for increased complications following total shoulder arthroplasty.⁶⁸ A longer hospital stay (2.4 vs 2.1 days; $P < .001$) was also noted to be significantly different between black and white patients, a factor that may be linked to the increased operative time and that is also associated with increased risk of infection.^{69,70} However, longer hospital stay is also often associated with whether the patient was discharged to home or to an inpatient rehabilitation facility. Jain et al⁸ analyzed data from the Nationwide Inpatient Sample from 1990 to 2000 for all patients undergoing shoulder arthroplasty. They found that patients discharged to inpatient rehabilitation facilities had significantly longer hospital stays compared with those discharged home. However, in the current cohort, the authors did not find a significant difference in the discharge location (inpatient rehabilitation vs home) for black and white patients. The current results are in line with others suggesting an association between race and length of stay following arthroplasty.^{44,71,72}

The current results have several limitations. A large national database such as the American College of Surgeons National Surgical Quality Improvement Program database relies on the accuracy of the reporting practitioners; thus, coding errors are possible. By design, the retrospective nature of this study means that causal determinations cannot be made. The authors were unable to evaluate the impact of insurance or socioeconomic status, both of which have been associated with worse outcomes.^{40,57,73}

CONCLUSION

An analysis of the most recent available national data during a 10-year period indicated that, outside of mortality, complications for shoulder arthroplasty are not different between black and white

patients. However, certain cost-driving metrics, including length of stay and operative time, were significantly longer for blacks compared with whites. The causes of these differences are unknown. In addition, racial discrepancies in the use of shoulder arthroplasty persist and are likely multifactorial. To determine how they can be addressed and resolved, drivers of racial disparities in shoulder arthroplasty should be studied further.

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