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Racial disparities in arthroscopic rotator cuff repair: an analysis of utilization and perioperative outcomes

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Background: There remains a paucity of literature addressing racial disparities in utilization and perioperative metrics in arthroscopic rotator cuff repair procedures.
Methods: The American College of Surgeons National Surgical Quality Improvement Program database was used to evaluate patients undergoing arthroscopic rotator cuff repair from 2010 to 2019. Baseline demographics, utilization trends, and perioperative measures, including adverse events, operative time, length of hospital stay, days from operation to discharge, and readmission, were analyzed.
Results: Of 42,443 included patients, 38,090 (89.7%) were White, and 4353 (10.3%) were Black or African American. Black or African American patients had a significantly higher percentage of diabetes mellitus (23.6% vs. 15.6%), smoking (16.9% vs. 14.8%), congestive heart failure (0.3% vs. 0.1%), and hypertension (59.2% vs. 45.9%). In addition, logistic regression showed that Black or African American patients had increased odds of longer operative time (adjusted rate ratio 1.07, 95% confidence interval 1.05-1.08) and time from operation to discharge (adjusted rate ratio 1.19, 95% confidence interval 1.04-1.37). Disparities in relative utilization decreased as the proportion of Black or African American patients undergoing arthroscopic rotator cuff repair increased (7.4% in 2010 vs. 10.4% in 2019) compared with White patients ($P_{trend} < .0001$).
Conclusion: Racial disparities exist regarding baseline comorbidities and perioperative metrics in arthroscopic rotator cuff repair. Further investigation is needed to fully understand and address the causes of these inequalities to provide equitable care.

Health care in the United States, like many other facets of modern society, is disproportionately affected by differences in race, ethnicity, sex, and socioeconomic status. For example, when analyzing racial identity, Black or African American patients are more likely to have hypertension, diabetes mellitus, and coronary artery disease compared with White patients.[27] Specifically in orthopedics, differences in utilization rates based on patients' race have been observed in total joint arthroplasty.[7,26] Pandya et al demonstrated a lower rate of total knee arthroplasties among minority patients, along with a lower rate of total shoulder arthroplasties among Black males.[26] As such, various government and orthopedic organizations, such as the American Academy of Orthopedic Surgery, Association of Bone and Joint Surgery, Orthopaedic Research Society, and the Department of Health and Human Services, have created initiatives to address racial disparities in orthopedic care.[21,25] However, according to Amen et al and Best et al, the results have shown that disparities continue to exist between Black and White patients regarding utilization, length of stay, and perioperative complication rates in total joint arthroplasty.[2,7,8] Specifically, Black patients tend to have increased lengths

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of stay, risk of mortality, and risk of complications during both total hip arthroplasty and total knee arthroplasty. Although prior research has provided valuable insight into the inequality that exists in orthopedics in North America, there continues to be a paucity of literature specifically addressing the impact of racial disparities on utilization and perioperative measures in arthroscopic rotator cuff repair despite its increase in demand.

Therefore, the primary purpose of this study is to investigate racial disparities among patients undergoing arthroscopic rotator cuff repair procedures by analyzing perioperative measures and trends over an extended time frame. It is essential for clinicians to understand underlying prognostic factors, as well as any other barriers patients must overcome, to provide equitable care at an individual level. We hypothesize that there will be statistically significant differences in the complication rates between White and Black or African American patients.

Materials and methods

Source data

This study used data from the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database from 2010 to 2019. The NSQIP registry serves to provide 30-day postoperative complication data that are collected and stored with the end goal of decreasing the frequency of adverse events and complications.[14,24] The database exhibits a high-quality collection method and undergoes continuous rigorous audits to maintain its validity and accuracy.[11] The database contains more than 300 perioperative variables from over 700 medical institutions within the United States.[11,20,24,30] Importantly, it has been used in previous orthopedic studies to articulate differences in surgical procedures.[13,23] Institutional review board approval was obtained for this study (#2021P001230).

Inclusion criteria

Patients included in this study were adults (aged $\geq$18 years) found in the NSQIP database who underwent an arthroscopic rotator cuff repair procedure according to the Current Procedural Terminology code 29827. Baseline demographics included age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) status, race, smoking status, diabetes mellitus, severe chronic obstructive pulmonary disease, congestive heart failure (CHF), steroid use for chronic condition, and hypertension requiring medication. Total operative time, total length of hospital stay, days from operation to discharge, and readmission were also analyzed. Similar to previous studies using the NSQIP database, adverse events were classified as serious or minor.[12,13,15,23] Serious adverse events included death, reoperation, pulmonary complications (unplanned intubation or ventilator greater than 48 hours), pneumonia, cardiac complications (cardiac arrest or myocardial infarction), renal complications (progressive renal insufficiency or acute renal failure), thromboembolic complications (deep vein thrombosis/thrombophlebitis or pulmonary embolism), deep wound complications (deep incisional surgical site infection, wound dehiscence, or joint space infection), and sepsis. Minor adverse events included superficial surgical site infection and urinary tract infection. Furthermore, trends for serious adverse events, length of total hospital stay, and relative procedure rates over the study length were examined.

Statistical analysis

Statistical analyses were performed using SAS v9.4 (SAS Institute Inc., Cary, NC, USA). Baseline demographic variables as well as outcome variables were analyzed using either chi-squared tests or Fisher's exact tests. Binomial models and logistic regression models were used for continuous and categorical variables, respectively. Cochran-Armitage Trend test was used to discern any significance in relative procedural usage over the study period. Continuous variables are reported as mean ± standard deviation. *P* values < .05 were considered significant.

Results

A total of 42,443 patients were included in this analysis. There were 38,090 (89.7%) White patients and 4353 (10.3%) Black or African American patients. Significant differences between the 2 patient groups were observed regarding age, sex, BMI, diabetes mellitus, ASA class, smoking status, CHF, and hypertension requiring medication ($P < .001$ for all). White patients tended to be older (90.8% vs. 85.2% [>45 years]; $P < .001$) with a higher percentage being males (58.8% vs. 47.6%, $P < .001$). There was a larger proportion of Black or African American patients that were classified as overweight or obese compared with White patients (89.9% vs. 83.8%, $P < .001$). Regarding medical comorbidities, the Black or African American cohort had a larger proportion of patients with diabetes mellitus (23.6% vs. 15.6%), smoking within the past year (16.9% vs. 14.8%), CHF (0.3% vs. 0.1%), and hypertension requiring medication (59.2% vs. 45.9%; $P < .001$ for all). A comprehensive summary of baseline demographics and clinical characteristics is presented in Table I.

Perioperative metrics of arthroscopic rotator cuff repair

Importantly, there were no significant differences between Black or African American and White patients when comparing the length of total hospital stay, readmission, serious adverse events, and minor adverse events. However, statistically significant differences were noted between the 2 cohorts with regard to total operative time and days from operation to discharge. Black or African American patients had a longer mean operative time (94.0 ± 45.7 vs. 88.9 ± 45.9 minutes) and mean time from operation to discharge from the hospital (0.17 ± 2.1 vs. 0.13 ± 1.3 days) when compared with White patients ($P < .001$ for both; Table II).

To further evaluate the differences in outcomes between Black or African American and White patients, a logistic regression analysis was performed while controlling for age, sex, BMI, diabetes mellitus, ASA class, smoking status, CHF, and hypertension (Table III). Compared with White patients, Black or African American patients had an increased risk of experiencing longer total operative time (adjusted relative risk: 1.07, 95% confidence interval [CI] 1.05-1.08, $P < .001$) as well as a longer elapsed time from operation to time of discharge (adjusted relative risk: 1.19, 95% CI 1.04-1.37, $P = .013$).

Trends in arthroscopic rotator cuff repair

When examining relative utilization, the proportion of patients undergoing arthroscopic rotator cuff repair procedures who identified as Black or African American significantly increased from 7.4% in 2010 to 10.4% in 2019 ($P_{trend} < .0001$; Fig. 1). The length of total hospital stay for both Black or African American (coefficient −0.11, $P < .001$) and White patients (coefficient −0.08, $P < .0001$) significantly decreased over the study period. There was no significant difference in length of stay between Black or African American and White patients (adjusted relative risk: 1.03, 95% CI 0.88-1.19), and this association persisted over time ($P_{trend} > .05$). Regarding the rates of serious adverse events, they did not significantly change within patient populations over the study period, nor did they

Table I
Clinical and demographic characteristics of Black or African American and White patients undergoing arthroscopic rotator cuff repair.

Variables	Total (N = 42,443), n (%)	Black or African American (n = 4353), n (%)	White (n = 38,090), n (%)	*P* value
Age group				<.001[*,†]
0-24	203 (0.5)	29 (0.7)	174 (0.5)	
25-34	719 (1.7)	106 (2.4)	613 (1.6)	
35-44	3223 (7.6)	508 (11.7)	2715 (7.1)	
45[‡]	38,297 (90.2)	3710 (85.2)	34,587 (90.8)	
Sex				<.001[*,†]
Female	17,960 (42.3)	2280 (52.4)	15,680 (41.2)	
Male	24,483 (57.7)	2073 (47.6)	22,410 (58.8)	
BMI group				<.001[*,†]
Normal (<24.9 kg/m^2)	6559 (15.6)	435 (10.0)	6124 (16.2)	
Overweight (25-29.9 kg/m^2)	14,706 (34.9)	1305 (30.1)	13,401 (35.4)	
Obese (>30 kg/m^2)	20,910 (49.6)	2592 (59.8)	18,318 (48.4)	
Diabetes mellitus	6982 (16.5)	1026 (23.6)	5956 (15.6)	<.001[*,†]
ASA class				<.001[*,†]
1	3269 (7.7)	299 (6.9)	2970 (7.8)	
2	24,310 (57.3)	2350 (54.0)	21,960 (57.7)	
3[‡]	14,844 (35.0)	1704 (39.1)	13,140 (34.5)	
Current smoker (within 1 year)	6361 (15.0)	735 (16.9)	5626 (14.8)	<.001[*,†]
Severe COPD	1384 (3.3)	124 (2.8)	1260 (3.3)	.106[†]
Congestive heart failure	61 (0.1)	15 (0.3)	46 (0.1)	<.001[*,†]
Hypertension requiring medication	20,051 (47.2)	2579 (59.2)	17,472 (45.9)	<.001[*,†]
Steroid use (chronic condition)	876 (2.1)	104 (2.4)	772 (2.0)	.111[†]

ASA, American Society of Anesthesiologist; *BMI*, body mass index; *COPD*, chronic obstructive pulmonary disease.
[*]Statistically significant ($\alpha = 0.05$).
[†]Chi-square test.
[‡]Exact test.

Table II
Comparison of outcomes between Black or African American and White patients following arthroscopic rotator cuff repair.

	Total (N = 42,443)	Black or African American (n = 4353)	White (n = 38,090)	*P* value
Total operative time (mean ± SD)	89.5 ± 45.9	94.0 ± 45.7	88.9 ± 45.9	<.001[*,‖]
Length of total hospital stay (mean ± SD)	0.16 ± 2.4	0.17 ± 2.1	0.16 ± 2.5	.408[‖]
Days from operation to discharge (mean ± SD)	0.1 ± 1.4	0.17 ± 2.1	0.13 ± 1.3	<.001[*,‖]
Any readmission	437 (1.07)	50 (1.19)	387 (1.05)	.417[‡]
Serious adverse events	353 (0.83)	35 (0.80)	318 (0.83)	.832[‡]
Death	10 (0.02)	1 (0.02)	9 (0.02)	1[§,†]
Return to OR	118 (0.28)	9 (0.21)	109 (0.29)	.346[‡]
Pulmonary complications	28 (0.07)	5 (0.11)	23 (0.06)	.202[§,†]
Cardiac complications	31 (0.07)	4 (0.09)	27 (0.07)	.554[§,†]
Renal complications	8 (0.02)	0 (0.00)	8 (0.02)	1[§,†]
Thromboembolic complications	123 (0.29)	14 (0.32)	109 (0.29)	.680[‡]
Deep wound complications	32 (0.08)	3 (0.07)	29 (0.08)	1[§,†]
Minor adverse events	134 (0.32)	13 (0.30)	121 (0.32)	.832[‡]
Superficial surgical site infection	50 (0.12)	3 (0.07)	47 (0.12)	.321[‡]
Urinary tract infection	84 (0.20)	10 (0.23)	74 (0.19)	.618[‡]

SD, standard deviation; *OR*, operating room.
[*]Statistically significant ($\alpha = 0.05$).
[†]Exact test.
[‡]Chi-square test.
[§]Fisher's exact test.
[‖]Negative binomial model.

change between the 2 cohorts over the study period ($P > .05$ for both groups, $P_{trend} > .05$).

Discussion

The results of this critical study add to the ever-growing evaluation of disparities between different racial groups in orthopedics. Specifically, the NSQIP database was used to compare procedure trends and perioperative measures between Black or African American and White patients undergoing arthroscopic rotator cuff repair in the United States. From 2010 to 2019, there was a significant increase in the proportion of Black or African American patients undergoing arthroscopic rotator cuff repairs. Despite differences in baseline demographics, we disproved our hypothesis, as there was a nonsignificant impact on the rate of adverse events between cohorts. In addition, demographic and clinical differences did not dictate the disparities observed in the study, as these differences persisted after adjustment.

In the adjusted analyses, Black or African American patients were noted to have a statistically significant increase in odds for longer operative time (5.1 minutes) and time from operation to discharge (.04 days or 57.6 minutes); however, the clinical relevance of these findings will require further investigation. Of note, value-based health care has been a growing enterprise in the United States, and future correlations with time-driven activity-based costing may reveal the true economic impact of these differences.[22]

A multitude of baseline demographic factors was significantly different between Black or African American and White patients. Specifically, Black or African American patients exhibited higher

Table III
Adjusted analysis comparing perioperative and postoperative metrics between Black or African American and White patients following arthroscopic rotator cuff repair.

Outcomes	Adjusted OR[†]/Adjusted RR[‡]	95% CI		*P* Value
Readmission	1.03[†]	0.76	1.40	.8274
SAE	0.96[†]	0.68	1.37	.8329
MAE	0.84[†]	0.48	1.47	.5496
Total operative time	1.07[‡]	1.05	1.08	<.0001[*]
Length of total hospital stay	1.03[‡]	0.88	1.19	.7290
Days from operation to discharge	1.19[‡]	1.04	1.37	.0130[*]

ASA, American Society of Anesthesiologists; *BMI*, body mass index; *CHF*, congestive heart failure; *CI*, confidence interval; *OR*, odds ratio, *RR*, risk ratio; *SAE*, serious adverse event; *MAE*, minor adverse event.
All values computed relative to White patients.
All values adjusted for age, sex, BMI, diabetes mellitus, ASA class, smoking status, CHF, and hypertension.
[*]Statistically significant ($\alpha = 0.05$).
[†]Adjusted OR.
[‡]Adjusted RR.

rates of smoking, hypertension, and greater BMIs. Smoking has been noted in the literature to impair wound healing, reduce bone mass, and decrease spinal fusion.[3,28,31] Furthermore, Kashanchi et al demonstrated that smoking is a significant predictor of complications and readmission following arthroscopic rotator cuff repair.[18] In addition, as reported by Ateschrang et al, a BMI >30 kg/m^2 is associated with higher retear rates after rotator cuff repair along with lower patient-reported outcome scores.[6] Finally, the differences in hypertension between cohorts in this study is consistent with prior data, as a recent analysis by Aggarwal et al stated that the rate of hypertension is significantly higher in Black patients compared with White patients (45.3% vs. 31.4%).[1]

Although there is a paucity of similar literature for arthroscopic rotator cuff repair, previous studies have examined the impact of racial discrepancies in joint arthroplasty.[2,5,10,26] For example, Amen et al reported a large incongruity in the utilization of hip arthroplasty based on race.[2] Moreover, there were significant differences between the complication rates of Black and White patients in knee arthroplasty, with the difference increasing from 2006 (6.1% vs. 5.1%, respectively) to 2015 (6.0% vs. 3.9%, respectively).[2] Similarly, Best et al found that Black patients had increased odds of experiencing a multitude of adverse events, such as death (odds ratio: 2.88] and acute myocardial infarction (odds ratio: 1.43).[7] However, Schairer et al found that race did not have a significant effect on readmission in shoulder arthroplasty when comparing readmission rates among different racial groups.[29]

Recently, a study performed by Johnson et al discussed the association of race on outcomes in arthroscopic rotator cuff repair from 2016 to 2018 using the NSQIP and TriNetX Research Network databases.[17] After propensity score matching, the study reported a significant difference in operative times between minority and White patients. Although this study sheds critical insight into the impact of race in arthroscopic rotator cuff repair, it was particularly limited in its overall investigation time frame and stratification of cohorts. Notable trends include significant decreases in operative times for both Black or African American and White patients as well as increased relative utilization for Black or African American patients from 2010 to 2019. There was a nonsignificant difference between changes in operative time over the study period, suggesting the original disparity persisted over time. Analysis of readmission, serious, and minor adverse events displayed nonsignificant differences between Black or African American and White patients. Moreover, despite a small, nonsignificant increase in serious adverse events over the study period for both patient cohorts, this trend was not significantly different between racial identities.

A variety of factors have been referenced as possible causes for Black-White disparities. For example, previous literature has documented differences in medical understanding of joint surgery, significant distrust in the medical system, and a lack of cultural competence among physicians.[19,20] Some studies have postulated that Black patients may be more likely to engage in nonsurgical forms of care, such as prayer and herbal medicine, when compared with White patients.[4,9,16] Importantly, multiple initiatives have been developed to combat discrepancies in health care, such as the AAOS/ORS/ABJS Musculoskeletal Healthcare Disparities Research Symposium and the HHS Action Plan to Reduce Racial and Ethnic Health Disparities. In 2010, The AAOS/ORS/ABJS research symposium identified 3 main avenues to focus on to achieve their goal of lessening the burden of musculoskeletal disparities: increasing diversity in orthopedic staff, research, and education.[25] Although there have been positive advances in the realm of arthroscopic rotator cuff repair over the past decade, there continue to be critical improvements. It is imperative for physicians and policymakers alike to construct realistic and meaningful initiatives to guarantee that every person, regardless of racial identity, receives the best possible care.

Limitations

Although this study critically examines racial disparities in arthroscopic rotator cuff repair and benefits from its extended period and large patient population, it is not without limitations. The NSQIP database is limited to capturing events within 30 days postoperatively and thus may potentially underestimate the rates of adverse events due to complications occurring outside of this period. Moreover, the NSQIP database is restricted to evaluating adverse events strictly occurring in patients who seek medical care at participating institutions. Information regarding the clinical characteristics of the rotator cuff tears (ie, size, chronicity, tendon quality, degree of retraction, etc.) and specific details of the procedures (ie, number and type of anchors, sutures, etc) are not captured in the database, and their potential impact could not be assessed. Furthermore, postoperative rehabilitation protocols are not incorporated in the NSQIP database, and their effect on certain complications (ie, deep vein thrombosis) could not be evaluated. Finally, as a result of the large number of patients included in this study, the analyses performed may reveal statistically significant differences that are not clinically significant. Despite these limitations, the NSQIP database has been used to provide novel, valuable insight for assessing operative and clinical characteristics as well as 30-day outcomes.[12,13,15,23] Importantly, the use of a large national database such as the NSQIP is essential for studies on national policy and disparities such as the present study. This is particularly important for studies on racial and socioeconomic disparities and studies that assess utilization because smaller, single surgeon studies may not have adequate sample size and may not be generalizable to the national patient population.

Conclusion

With the increasing popularity of arthroscopic rotator cuff repair procedures, it is imperative to evaluate and address the influence of racial disparities. The difference in operative time and days from operation to discharge was statistically longer for Black or African American patients; however, the clinical relevance of

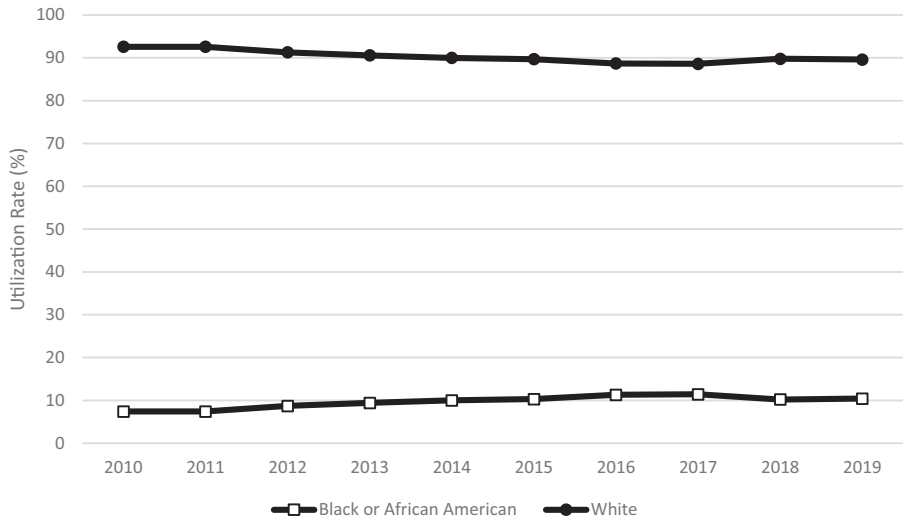

Figure 1 Trends in relative utilization of arthroscopic rotator cuff repair among Black and White patients between 2010 and 2019.

these findings remains unclear. In addition, Black or African American patients constitute a relatively smaller proportion of arthroscopic rotator cuff repair patients, although this difference has significantly decreased over time. Further investigation is needed to fully understand and address causes of inequalities in arthroscopic rotator cuff repair to provide equitable care.

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