J Shoulder Elbow Surg (2018) ■■, ■■–■■

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

ORIGINAL ARTICLE

Shoulder adhesive capsulitis: epidemiology and predictors of surgery

Kiera Kingston, MD[a], Emily J. Curry, BA[a], Joseph W. Galvin, DO[b], Xinning Li, MD[a,*]

[a]*Department of Orthopaedic Surgery, Boston Medical Center/Boston University School of Medicine, Boston, MA, USA*
[b]*Department of Orthopaedic Surgery, Blanchfield Army Community Hospital Orthopedic Clinic, Fort Campbell, KY, USA*

Background: Adhesive capsulitis is characterized by a gradual, painful loss of shoulder motion. This study evaluated patient variables significantly associated with developing adhesive capsulitis compared with a sex-matched control group without adhesive capsulitis. We also sought to determine those factors associated with adhesive capsulitis patients requiring surgical intervention.

Methods: All patients presenting to our hospital with adhesive capsulitis between 2004 and 2014 were identified. Demographic characteristics were collected, and a sex-matched control group was randomly generated from the electronic medical record and used for comparison. Patients who underwent surgical intervention for adhesive capsulitis were also identified, and factors associated with surgical intervention were identified with logistic regression analysis.

Results: Included were 2190 adhesive capsulitis patients with a normal age distribution of 56.4 ± 13.1 years. Most were classified as overweight (30.7%) or obese (27.0%). Compared with controls, adhesive capsulitis patients were more likely to be younger (<50 vs. ≥50 years; odds ratio [OR], 0.69; $P < .001$), obese (OR, 1.26; $P < .001$), black/African American (OR, 1.71; $P < .001$), Hispanic/Latino (OR, 4.85; $P < .001$), or diabetic (OR, 1.12; $P < .001$) and less likely to have hypertension (OR, 0.93; $P = .006$). Overall, 361 subsequently underwent surgical intervention. Older patients, racial minorities, and government-sponsored/uninsured patients were significantly less likely to have surgery for adhesive capsulitis ($P < .01$), whereas workers' compensation patients were 8 times more likely to receive surgery compared with privately insured patients ($P < .001$).

Conclusions: Obesity and diabetes were significantly associated with adhesive capsulitis and should be considered modifiable patient factors. Additionally, younger patients and racial minorities were also significantly more likely to be diagnosed with adhesive capsulitis. Younger, white, and workers' compensation patients were more likely to receive surgery, whereas patients with government-sponsored or no insurance status were more likely to receive nonoperative treatment.

Level of evidence: Level III; Retrospective Cohort Design; Prognosis Study

Keywords: Adhesive capsulitis; frozen shoulder; diabetes; workers' compensation; racial disparities; surgical intervention; obesity

Adhesive capsulitis of the shoulder is characterized by a progressive painful loss of passive and active shoulder range of motion. The condition, which affects 2% to 5% of the general population, is due to chronic inflammation of the capsular subsynovial layer leading to thickening, fibrosis,

This study was deemed Not Human Subjects Research by the Boston Medical Center and Boston University Medical Campus Institutional Review Board (IRB No. H-33103).

*Reprint requests: Xinning Li, MD, Boston University School of Medicine, 850 Harrison Ave, Dowling 2 North, Boston, MA 02115, USA.

E-mail address: Xinning.li@gmail.com (X. Li).

1058-2746/$ - see front matter © 2018 Journal of Shoulder and Elbow Surgery Board of Trustees. All rights reserved.
https://doi.org/10.1016/j.jse.2018.04.004

contracture, and loss of the normal axillary recess.[15] Although commonly referred to as "frozen shoulder," which encompasses the end result of a number of etiologies, adhesive capsulitis is its own distinct pathologic entity.[10,16] Most patients are successfully managed with physical therapy and gentle range of motion exercises. However, surgical intervention is indicated in patients when conservative treatment fails, including physical therapy, home exercises, intra-articular injections, and oral anti-inflammatory medications, with continued pain and limitation in activities of daily living.[3,6,17]

Adhesive capsulitis most commonly affects women between the ages of 40 and 60.[3,11,20,23] Systemic conditions, such as obesity, thyroid dysfunction, cardiac disease, Dupuytren contracture, breast cancer treatment, and neurologic disorders, are thought to increase the risk for developing adhesive capsulitis.[2,3,7,12,18-20,22-24] Furthermore, several studies have shown that the diagnosis is 2 to 4 times more common in diabetic patients than in the general population.[3,19,20] Few studies have examined the epidemiology of adhesive capsulitis in a large urban population compared with a matched control group or determined patient factors associated with requiring surgical intervention.

The purpose of this study was to evaluate patient variables significantly associated with developing adhesive capsulitis compared with a sex-matched control group without adhesive capsulitis. We also sought to determine those factors associated with adhesive capsulitis patients requiring surgical intervention.

Materials and methods

We performed a retrospective comparative study to identify all patients presenting to a large tertiary referral academic medical center between June 5, 2004, and June 5, 2014, with a diagnosis of adhesive capsulitis (International Classification of Diseases, Ninth Edition) based on diagnosis codes adhesive capsulitis (726.0) with or without shoulder pain (719.41). We also used the Clinical Data Warehouse to identify a randomly generated, sex-matched control group of patients from the electronic medical record without adhesive capsulitis. The Clinical Data Warehouse is a relational database that collects data from our institution's major electronic data systems, including the software systems used for inpatient, outpatient, emergency department, operating room, and billing services. All patient encounters in the electronic medical record were reviewed to confirm the diagnosis.

Demographic information, including sex, age, body mass index (BMI), race, and ethnicity were collected for all patients. The presence of concurrent medical comorbidities was also documented and verified by review of primary care physician notes, which included diabetes mellitus, hypothyroidism, hypertension, lupus, Sjögren syndrome, dermatomyositis, polymyositis, connective tissue disorder, and rheumatoid arthritis. Shoulder pain status, medications, appointment history, and insurance information were collected. Whether the patient underwent surgical intervention for adhesive capsulitis was also recorded based on the following Current Procedural Terminology (American Medical Association, Chicago, IL, USA) codes, which are medical codes used for describing the medical, surgical, and diagnostic services rendered: 29825 (arthroscopic capsular release/lysis of adhesions), 23020 (capsular contracture release), and 23700 (shoulder manipulation under anesthesia). A sex-matched control group of patients without adhesive capsulitis (Table I) was identified to compare demographic and patient-based variables.

Summary statistics were calculated for continuous variables and are reported as means, standard deviations (SD), and ranges. Categoric variables are reported in frequencies and percentages. Group differences for categoric variables were compared using χ^2 tests. In addition, logistic regression was used to determine significant associations between patient-based variables and a diagnosis of adhesive capsulitis and was also used to determine significant associations between patient factors and the need for surgical treatment of adhesive capsulitis. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. All statistical analyses were performed using SAS 9.3 software (SAS Institute Inc., Cary, NC, USA). A P value of <.05 was deemed statistically significant.

Results

Demographic characteristics

Adhesive capsulitis vs. control group

We identified 2,190 patients with adhesive capsulitis and 2,190 control patients without adhesive capsulitis during the 10-year period. The groups were sex-matched, with women comprising 1279 of 2190 patients (58.4%). The average patient age of the adhesive capsulitis group was 56.4 (SD, 13.1) years, with most patients aged 40 to 70 years old (Table I).

Compared with controls, there was a statistically significant higher rate of obesity in patients with adhesive capsulitis ($P < .001$). This was particularly evident, with class 1 obesity (BMI 30-34.9 kg/m^2) documented in 435 patients (27%) vs. 216 controls (20.3%). Black/African American race and Hispanic/Latino ethnicity were also significantly associated with a diagnosis of adhesive capsulitis compared with controls, respectively (OR, 1.71; 95% CI, 1.60-1.84 [$P < .001$]; OR, 4.85; 95% CI, 3.90-6.04 [$P < .001$]).

Diabetes mellitus (55.3%) and hypertension (33.5%) were the most common medical comorbidities in the population. Diabetes was significantly more common in the adhesive capsulitis group, whereas hypertension was less common compared with the control group. Both of these results were statistically significant ($P = .007$).

Operative vs. nonoperative management of adhesive capsulitis

Of the 2190 patients with adhesive capsulitis, 361 patients underwent surgical intervention. The mean annual number of operations was 32.8, with no clear trend in surgical intervention during the 10-year study period and no seasonal variation. Patients aged >70 years and nonwhite patients were less likely to undergo surgical intervention for their adhesive capsulitis (Table II). Most notably, black/African American patients were 59.2% less likely and Hispanic/Latino pa-

Table I Comparison of demographic characteristics for adhesive capsulitis patients vs. the control group

Patient factor	Cases with data No.	Adhesive capsulitis group No. (%)	Controls with data No.	Control group No. (%)	*P* value
Sex	2190		2190		>.99
Male		911 (41.6)		911 (41.6)	
Female		1279 (58.4)		1279 (58.4)	
Age, yr	2190		2180		<.001
<40		199 (9.1)		104 (4.8)	
40-49		457 (20.9)		282 (12.9)	
50-59		684 (31.2)		634 (29.1)	
60-69		500 (22.8)		602 (27.6)	
70-79		250 (11.4)		349 (16.0)	
80-89		90 (4.1)		161 (7.4)	
>89		10 (0.5)		48 (2.2)	
Body mass index, kg/m^2	1614		1062		<.001
<18.5 (underweight)		21 (1.3)		19 (1.8)	
18.5-24.9 (normal)		274 (17.0)		254 (23.9)	
25-29.9 (overweight)		496 (30.7)		346 (32.6)	
30-34.9 (obesity class 1)		435 (27.0)		216 (20.3)	
35-39.9 (obesity class 2)		219 (13.6)		124 (11.7)	
≥40 (morbid obesity)		169 (10.5)		103 (9.7)	
Race	2190		2190		<.001
White		638 (29.1)		1337 (61.1)	
Black/African American		907 (41.4)		593 (27.1)	
Hispanic/Latino		438 (20.0)		71 (3.2)	
Asian/Pacific Islander		90 (4.1)		10 (0.5)	
Middle Eastern		16 (0.7)		1 (0.0004)	
Native American		3 (0.1)		1 (0.0004	
Other		98 (4.5)		177 (8.1)	
Medical comorbidities	1709		749		.007
Diabetes mellitus		572 (33.5)		188 (25.1)	
Hypothyroidism		139 (8.1)		77 (10.3)	
Hypertension		945 (55.3)		459 (61.3)	
Lupus		11 (0.6)		7 (0.9)	
Sjögren syndrome		4 (0.2)		1 (0.1)	
Dermatomyositis		2 (0.1)		0 (0.0)	
Polymyositis		0 (0.0)		1 (0.1)	
Connective tissue disorder		0 (0.0)		0 (0.0)	
Rheumatoid arthritis		36 (2.1)		16 (2.1)	

tients were 37.7% less likely to receive surgery compared with white patients (OR, 0.408 [$P < .001$] and OR, 0.623 [$P = .002$], respectively; Fig. 1).

Insurance type

Insurance type was also significantly associated with whether a patient received surgical treatment for adhesive capsulitis (Table II). Medicare, Medicaid, and free care/health safety net patients were 48.8%, 33.5%, and 56.4% less likely to receive shoulder surgery compared with private insurance patients (Fig. 2). All 3 comparisons reached statistical significance (OR, 0.512 [$P < .001$]; OR, 0.665 [$P = .012$]; and OR, 0.436 [$P < .001$], respectively). However, patients whose care was reimbursed with workers' compensation were 8 times more likely to receive surgery than patients with private or commercial insurance (OR, 8.172; $P = .001$). There were insufficient data to determine whether military or self-pay/uninsured patients received surgery at rates comparable to privately insured individuals.

Discussion

The findings of this study reveal that the mean age of patients diagnosed with adhesive capsulitis, 56.4 (SD, 13.1) years old, falls within previously accepted age ranges. Patient variables of obesity and the presence of a diagnosis of diabetes were significantly associated with developing adhesive capsulitis compared with the sex-matched control group. In addition, younger, white, and Workers Compensation patients were patient factors significantly associated with receiving surgical treatment. Lastly, black/African

Table II Comparison of demographic characteristics for adhesive capsulitis operative group versus nonoperative group

Patient factor	Nonoperative (n = 1829) No. (%)	Operative (n = 361) No. (%)	OR (95% CI)	*P* value
Sex				.064
Male	745 (40.7)	166		
Female	1084 (59.3)	195		
Age, yr				
<40	164 (9.0)	35 (9.7)	Reference	
40-49	362 (19.8)	95 (26.3)	1.23 (0.80-1.91)	.348
50-59	548 (30.0)	136 (37.7)	1.16 (0.78- 1.77)	.477
60-69	426 (23.3)	74 (20.5)	0.81 (0.53-1.28)	.361
70-79	230 (12.6)	20 (5.5)	0.41 (0.22- 0.73)	.002
80-89	89 (4.9)	1 (0.3)	0.05 (0.00- 0.28)	.0001
≥90	10 (0.5)	0 (0.0)	N/A	N/A
Body mass index, kg/m^2	1347	267		.434
<18.5 (underweight)	18 (1.3)	3 (1.1)		
18.5-24.9 (normal)	230 (17.1)	44 (16.5)		
25-29.9 (overweight)	421 (31.3)	75 (28.1)		
30-34.9 (obesity class 1)	349 (25.9)	86 (32.2)		
35-39.9 (obesity class 2)	184 (13.7)	35 (13.1)		
≥40 (morbid obesity)	145 (10.8)	24 (9.0)		
Race				
White	479 (26.2)	159 (44.0)	Reference	
Black/African American	799 (43.7)	108 (29.9)	0.408 (0.31-0.53)	<.001
Hispanic/Latino	363 (19.8)	75 (20.8)	0.623 (0.46-0.85)	.002
Asian/Pacific Islander	84 (4.6)	6 (1.7)	0.216, 0.08-0.48)	.0001
Middle Eastern	13 (0.7)	3 (0.8)	0.377 (0.20-0.67)	.001
Native American	3 (0.2)	0 (0.0)	N/A	N/A
Other	88 (4.8)	10 (2.8)		
Medical comorbidities				
Diabetes mellitus	492 (26.9)	80 (22.2)		.061
Hypothyroidism	115 (6.3)	24 (6.6)		.797
Hypertension	811 (44.3)	134 (37.1)		.011
Lupus	9 (0.5)	2 (0.6)		.701
Sjögren syndrome	4 (0.2)	0 (0.0)		>.999
Dermatomyositis	2 (0.1)	0 (0.0)		>.999
Polymyositis	0 (0.0)	0 (0.0)	N/A	N/A
Connective tissue disorder	0 (0.0)	0 (0.0)	N/A	N/A
Rheumatoid arthritis	33 (1.8)	3 (0.8)		.256
Insurance type	1825	361		
Commercial/private	382 (20.9)	88 (24.4)	Reference	
Medicare	492 (27.0)	58 (16.1)	0.512 (0.36-0.73)	.0001
Medicaid	614 (33.6)	94 (26.0)	0.665 (0.48-0.9)	.012
Workers' compensation	46 (2.5)	87 (24.1)	8.172 (5.36-12.6)	<.001
Self pay/uninsured	14 (0.8)	0 (0.0)	N/A	N/A
Military	1 (0.1)	0 (0.0)	N/A	N/A
Charity	249 (13.6)	25 (6.9)	0.44 (0.27-0.69)	.0001
Auto insurance	27 (1.5)	9 (2.5)	1.45 (0.62-3.12)	.357

OR, odds ratio; *CI*, confidence interval; *N/A*, not applicable.

American, Hispanic/Latino, and those with government-sponsored insurance (Medicare/Medicaid) were significantly less likely to undergo surgery for their adhesive capsulitis.

Several studies of demographic characteristics of patients with shoulder adhesive capsulitis, have shown that women aged 40 to 60 are most commonly affected.[3,6,11,19,20,23] Women comprised 58.4% of our study patient population, which confirmed prior epidemiologic study findings.[11,20] Most of our patients were 40 to 70 years old, with the group aged 50 to 59 years having the highest rate of adhesive capsulitis (Table I). However, 25.1% of adhesive capsulitis patients were <40 or >70 years old.[3,11,20,23]

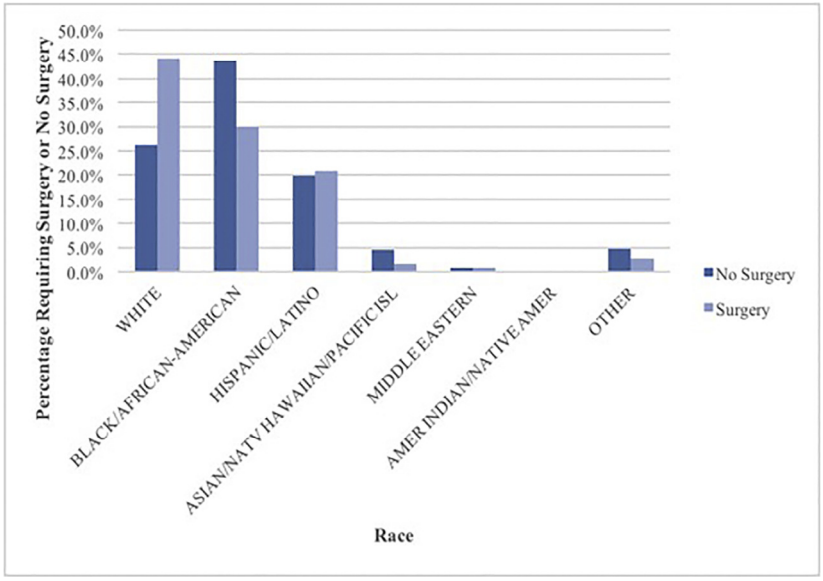

Figure 1 Prevalence of surgery dependent on patient race. Black/African American, Hispanic/Latino, Asian/Native Hawaiian/Pacific Islander, and other racial minorities were significantly less likely to receive surgery compared with white patients.

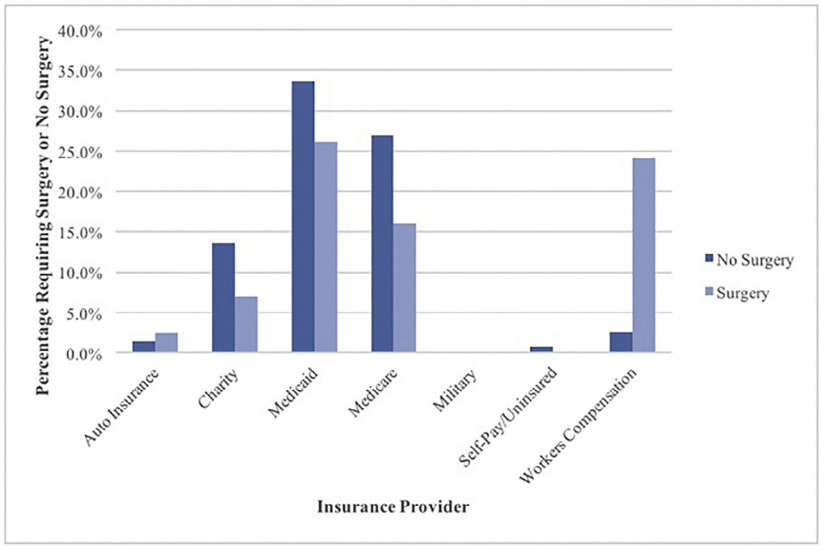

Figure 2 Prevalence of shoulder surgery dependent on insurance provider. Patients with private or commercial insurance were more likely to receive surgery relative to Medicare, Medicaid, and free care/health safety net patients. Workers' compensation patients were 8 times as likely to receive surgery.

This relatively high rate of adhesive capsulitis in the young and elderly is likely associated with increased rates of obesity and diabetes in our institution's population compared with Centers for Disease Control and Prevention reported United States (US) national averages. In 2014, the Centers for Disease Control and Prevention reported 64.1% of the US population[8] was overweight or obese compared with 74.3% in our control group and 81.7% in the adhesive capsulitis group. Several studies have also documented the alarming increase in early-onset type 2 diabetes mellitus (age <40 years) and a high rate (18.7%) of diabetes in the elderly (age >75 years).[21] The expanding age range for diabetes diagnosis in the US, coupled with its strong association with adhesive capsulitis, likely contributed to the age findings in our study population.

Patients diagnosed with adhesive capsulitis have high rates of comorbid conditions, most notably diabetes. As a result of a lack of clear pathophysiology and significantly high rates of comorbid prediabetes and diabetes, many authors have hypothesized that diabetes may play a central role in the pathogenesis of adhesive capsulitis. Prior research points to high serum glucose increasing the rates of collagen glycosylation and crossing linking in the shoulder capsule tissue leading to inflammation, fibrosis, contracture, and significant limitations in range of motion.[4,5] In a cohort of patients

presenting with adhesive capsulitis and no medical history of diabetes, Tighe et al[20] reported that the prevalence of diabetes was 38% (34 of 88) and prediabetes was 33% (29 of 88) as determined by blood testing. This equated to a prevalence of 71% (63 of 88). Austin et al[1] similarly reported the prevalence of diabetes as 10 times higher in patients with adhesive capsulitis.

The most common comorbidities in our study population included hypertension (55.3%), diabetes (33.5%), and hypothyroidism (8.1%). However, compared with the sex-matched control group, patients with adhesive capsulitis were 12% more likely to have diabetes (OR, 1.12; 95% CI, 1.07-1.19; $P < .001$) but 7% less likely to have hypertension (OR, 0.93; 95% CI, 0.88-0.98; $P = .006$). These data provide further evidence that diabetes is significantly associated with adhesive capsulitis of the shoulder. Orthopedic surgeons should consider this diagnosis in diabetic patients presenting with shoulder pain and stiffness. In addition, in older patients diagnosed with adhesive capsulitis, primary care physician evaluation is indicated if there is clinical concern for diabetes.

According to the 2014 National Diabetes Statistics Report, 29 million (9% of general population) in the US have diabetes, with increased prevalence seen in the Hispanic (12.8%), African American (13.2%), and Native American (15.9%) populations.[9] We found that 60.1% of patients with adhesive capsulitis in our study population identified as black/African American or Hispanic/Latino, which have the second- and third-highest prevalence of diabetes nationally. Given the national trends and even higher prevalence of diabetes in our institution's control patients (26.1%) and adhesive capsulitis patients (33.5%), this may explain the disproportionate number of black/African American and Hispanic/Latino patients within our study population.

Although 55.3% of adhesive capsulitis patients had hypertension, the diagnosis was more common in the control group (61.3%). These numbers approach the high prevalence of hypertension reported in the general adult population as 74.3% for men and 70.2% for women in a large sample of men and women aged between 45 and 83.[13] Patients with adhesive capsulitis in our patient population were 7% less likely to have hypertension (OR, 0.93; 95% CI, 0.88-0.98, $P = .006$) compared with controls. Bridgman et al[3] found that 14% (2 of 14) of nondiabetic patients with adhesive capsulitis had comorbid hypertension, whereas Austin et al[1] reported significantly higher rates of adhesive capsulitis in patients using antihypertensives (50% greater) compared with the general population. In our cohort, hypertension alone was not significantly associated with adhesive capsulitis; however, hypertension as a part of a larger metabolic syndrome could be a risk factor and play a role in the pathogenesis of adhesive capsulitis, as noted by previous authors.[1]

An association of other endocrine, cardiac, and neurologic disorders with adhesive capsulitis has been shown.[2,3,7,11,12,18-20,22,23] Hypothyroidism was found in 8.1% of our patients with adhesive capsulitis; however, the rate was lower than the 10.3% in our control population. Despite a lower rate of thyroid disorders among our patients compared with our control population, overall rates of thyroid dysfunction are significantly higher than previously reported. Wright et al[23] found that 9% of female patients and 5.9% of all patients had underlying thyroid disorders; however, the authors did not distinguish whether patients were hypothyroid or hyperthyroid. Although Cakir et al[7] found that 10.9% of patients with underlying thyroid dysfunction had adhesive capsulitis and that adhesive capsulitis was most commonly seen in subclinical thyrotoxicosis, the authors looked solely at patients with thyroid dysfunction, which limits comparison with our study.

Controversy exists over the best treatment modalities for adhesive capsulitis, but the general agreement is that conservative methods, such as corticosteroid injections and physical therapy, are exhausted before surgery or manipulation under anesthesia. Our data indicate that age is significantly associated with whether patients were treated with surgery, with younger patients more likely to undergo surgery. This is likely attributed to younger patients having a lower perioperative risk profile, and they are less likely to adhere to the prolonged nonoperative course required due to activity demands. In contrast, patients in our group aged 70 to 79 and 80 to 89 were significantly less likely to receive surgery.

Race was also significantly associated with patients' treatment course. White patients were 2 to 4 times more likely to receive surgery compared with black/African American, Hispanic/Latino, Asian/Native Hawaiian/Pacific Islander, and other nonwhite patients. From 2010 to 2012, the national prevalence of diabetes among black/African American (13.2%), Hispanic/Latino (12.8%), Asian/Native Hawaiian/Pacific Islander (9.0%), and Native American/Alaskan Native (15.9%) was significantly greater than that seen in non-Hispanic white individuals (7.6%).[9] Similar trends are seen in obesity, coronary artery disease, hypertension, and stroke.[5,8] With significantly higher rates of medical comorbidities seen in racial and ethnic minorities nationally, we hypothesize that minorities at our institution were deemed to be poorer surgical candidates, possibly due to their medical comorbidities. That age, insurance provider, or surgeon bias played a role in this discrepancy is also possible.

Lastly, patients with workers' compensation were 8 times as likely to receive surgery as part of their course of treatment than patients with private or commercial insurance. Makhni et al[14] found that after correcting for time to payment, workers' compensation reimbursements in Massachusetts yielded 57% (proportion of paid total charges) for orthopedic procedure encounters, which was significantly greater than the 21% yield for Medicare reimbursements. Revenue generated from workers' compensation was 2.64 times greater than revenue generated by Medicare for orthopedic procedures and 2.30 times greater than revenue generated by Medicare for orthopedic clinic encounters and procedures combined.[14] The disparity in reimbursement may create treatment bias for orthopedic surgeons. In addition, patients with

workers' compensation may need to return to work sooner, thereby needing a "quick fix." These patients may be unwilling to exhaust conservative treatment before progressing to more invasive treatment options.

Limitations of the study include those inherent to any retrospective comparative study. The study relied on providers documenting correctly in the medical record. In addition, although we were able to compare patients with adhesive capsulitis to controls at our own institution, the study population may not be representative of other institutions or nationally, limiting the generalizability of this study.

Also, sex-matched controls were used because age was not available for every control selected. The sex-matched control population had a smaller percentage of patients aged <49 years and a higher percentage of patients aged >70, which limited our ability to provide groups matched by age and sex.

Conclusion

The mean age of adhesive capsulitis in our population falls within the previously accepted age range. Obesity and diabetes were significantly associated with developing adhesive capsulitis and should be considered as modifiable patient factors. Younger, white, and workers' compensation patients were patient variables significantly associated with receiving surgical treatment. Government-sponsored insurance status was also significantly associated with nonoperative treatment. Reasons for greater surgical intervention in these particular subgroups should be evaluated with prospective studies.

Acknowledgments

The authors thank Linda Rosen for her assistance with pulling the data for this study from our institutional database and Joseph Nguyen, MPH, from Sansom Consulting, for his assistance with data analysis.

Disclaimer

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

1. Austin DC, Gans I, Park MJ, Carey LJ, Kelly JD. Do diabetes and hypertension precede the development of adhesive capsulitis? U Penn Orthop J 2013;23:33-5.
2. Bowman CA, Jeffcoate WJ, Pattrick M, Doherty M. Bilateral adhesive capsulitis, oligoarthritis and proximal myopathy as presentation of hypothyroidism. Br J Rheumatol 1988;27:62-4.
3. Bridgman JF. Periarthritis of the shoulder and diabetes mellitus. Ann Rheum Dis 1972;31:69-71.
4. Brownlee M, Cerami A, Vlassara H. Advanced glycosylation end products in tissue and the biochemical basis of diabetic complications. N Engl J Med 1988;318:1315-21.
5. Brownlee M, Vlassara H, Cerami A. Nonenzymatic glycosylation and the pathogenesis of diabetic complications. Ann Intern Med 1984;101:527-37.
6. Bunker TD. Frozen shoulder: unravelling the enigma. Ann R Coll Surg Engl 1997;79:210-3.
7. Cakir M, Samanci N, Balci N, Balci MK. Musculoskeletal manifestations in patients with thyroid disease. Clin Endocrinol (Oxf) 2003;59:162-7. https://doi.org/10.1046/j.1365-2265.2003.01786.x
8. Centers for Disease Control and Prevention. Nutrition, physical activity and obesity: data, trends and maps. Atlanta, GA: Centers for Disease Control and Prevention, 2015.
9. Centers for Disease Control and Prevention. Diabetes: data and statistics. Atlanta, GA: Centers for Disease Control and Prevention, 2015.
10. Codman EA. The shoulder: rupture of the supraspinatus tendon and other lesions in or about the subacromial bursa. Boston, MA: Thomas Todd Co; 1934.
11. Hand C, Clipsham K, Rees JL, Carr AJ. Long-term outcome of frozen shoulder. J Shoulder Elbow Surg 2008;17:231-6. http://dx.doi.org/10.1016/j.jse.2007.05.009
12. Hsu JE, Anakwenze OA, Warrender WJ, Abboud JA. Current review of adhesive capsulitis. J Shoulder Elbow Surg 2011;20:502-14. http://dx.doi.org/10.1016/j.jse.2010.08.023
13. Lacruz ME, Kluttig A, Hartwig S, Löer M, Tiller D, Greiser KH, et al. Prevalence and incidence of hypertension in the general adult population: results of the CARLA-Cohort Study. Medicine (Baltimore) 2015;94:e952. http://dx.doi.org/10.1097/MD.0000000000000952
14. Makhni EC, Li R, Day CS. Worker's compensation: how do orthopedic surgeons fare? Am J Orthop (Belle Mead NJ) 2011;40:E71-7.
15. Neviaser AS, Neviaser RJ. Adhesive capsulitis of the shoulder. J Am Acad Orthop Surg 2011;19:536-42.
16. Neviaser JS. Adhesive capsulitis of the shoulder: a study of the pathological findings in periarthritis of the shoulder. J Bone Joint Surg Am 1945;27:211-22.
17. Reeves B. The natural history of the frozen shoulder syndrome. Scand J Rheumatol 1975;4:193-6.
18. Smith S, Devaraj VS, Bunker TD. The association between frozen shoulder and Dupuytren's disease. J Shoulder Elbow Surg 2001;10:149-51.
19. Thomas SJ, McDougall C, Brown ID, Jaberoo MC, Stearns A, Ashraf R, et al. Prevalence of symptoms and signs of shoulder problems in people with diabetes mellitus. J Shoulder Elbow Surg 2007;16:748-51. http://dx.doi.org/10.1016/j.jse.2007.02.133
20. Tighe CB, Oakley WS Jr. The prevalence of a diabetic condition and adhesive capsulitis of the shoulder. South Med J 2008;101:591-5. http://dx.doi.org/10.1097/SMJ.0b013e3181705d39
21. Wilmot E, Idris I. Early onset type 2 diabetes: risk factors, clinical impact and management. Ther Adv Chronic Dis 2014;5:234-44. http://dx.doi.org/10.1177/2040622314548679
22. Wohlgethan JR. Frozen shoulder in hyperthyroidism. Arthritis Rheum 1987;30:936-9.
23. Wright V, Haq AM. Periarthritis of the shoulder. I. Aetiological considerations with particular reference to personality factors. Ann Rheum Dis 1976;35:213-9.
24. Yang S, Park DH, Ahn SH, Kim J, Lee JW, Han JY, et al. Prevalence and risk factors of adhesive capsulitis of the shoulder after breast cancer treatment. Support Care Cancer 2017;25:1317-22. http://dx.doi.org/10.1007/s00520-016-3532-4