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Risk factors for adhesive capsulitis requiring shoulder arthroscopy: A clinical retrospective case series study

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1. Introduction

Adhesive capsulitis is an inflammatory disorder of the shoulder characterized by loss of active and passive shoulder motion secondary to joint capsule contracture.[1] This contracted capsule causes pain with certain movements due to sudden capsular stretching, this can lead to activity restriction, night pain resulting in loss of sleep and overall reduced quality of life.[2] Adhesive capsulitis has been termed 'frozen shoulder', a description first coined by Ernest Codman in 1934.[3] The term 'frozen shoulder' however does not denote the specific pathology associated with adhesive capsulitis but rather numerous etiologies that can cause spasm or adhesions in the shoulder.[3] This term was later refined to adhesive capsulitis by Julius Neviaser in 1945 as he observed the condition to be caused by underlying inflammatory and fibrotic changes in the associated joint capsule and bursa.[4] Numerous conditions can produce a clinical scenario similar to adhesive capsulitis or 'frozen shoulder' including rotator cuff tears, glenohumeral arthritis, crystalline arthropathy and cervical radiculopathy however these conditions are distinct from primary idiopathic capsulitis.[5]

The etiology of idiopathic adhesive capsulitis is not well understood.[1,6] Patients typically present in their 4th to 5th decade of life, women are more commonly affected than men as is the non-dominant arm.[3,6]There is an association with certain disorders including diabetes mellitus, thyroid pathology, cardiovascular disease, cerebrovascular disease, autoimmune disease and Dupuytren's disease.[7] Further, a recent review and meta-analysis has suggested a genetic predilection for adhesive capsulitis.[8] Physical therapy is the initial treatment modality of choice for adhesive capsulitis regardless of symptom duration and can be augmented with anti-inflammatory medications and intra-articular injections. Reports have indicated that adhesive capsulitis is a self-limited disease that can be managed conservatively while others have found that as many as 50% of patients have persistent pain and limited range of motion years after initial diagnosis.[6,9] As such, it is difficult to assess the effectiveness of various treatments and the length of time these interventions should be pursued prior to consideration of operative intervention. Further, risk factors for patients with adhesive capsulitis that requires operative intervention have not been well elucidated in the literature.

The purpose of the study was to identify risk factors that place patients with adhesive capsulitis at risk for requiring arthroscopic operative intervention by utilizing data from the National Surgical Quality Improvement Program (NSQIP) database. This information will allow orthopedic surgeons to more effectively counsel their patients regarding expectations for the likelihood of operative intervention for adhesive capsulitis.

2. Methods

The NSQIP database is a nationally recognized outcomes-based program that collects data from patients undergoing inpatient or outpatient surgery at numerous hospitals across the United States. The NSQIP database was queried from 2006 to 2016 for the following

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Table 1
Shoulder arthroscopy cases.

CPT Code	Description
29805	Arthroscopy, shoulder, diagnostic, with or without synovial biopsy (separate procedure)
29806	Arthroscopy, shoulder, surgical; capsulorrhaphy
29807	Arthroscopy, shoulder, surgical; repair of SLAP lesion
29819	Arthroscopy, shoulder, surgical; with removal of loose body or foreign body
29820	Arthroscopy, shoulder, surgical; synovectomy, partial
29821	Arthroscopy, shoulder, surgical; synovectomy, complete
29822	Arthroscopy, shoulder, surgical; debridement, limited
29823	Arthroscopy, shoulder, surgical; debridement, extensive
29824	Arthroscopy, shoulder, surgical; distal claviculectomy including distal articular surface (Mumford procedure)
29825	Arthroscopy, shoulder, surgical; with lysis and resection of adhesions, with or without manipulation
29826	Arthroscopy, shoulder, surgical; decompression of subacromial space with partial acromioplasty, with coracoacromial ligament (ie, arch) release, when performed (List separately in addition to code for primary procedure)
29827	Arthroscopy, shoulder, surgical; with rotator cuff repair
29828	Arthroscopy, shoulder, surgical; biceps tenodesis

current procedural terminology (CPT) codes relating to shoulder arthroscopy: (CPT codes 29805, 29806, 29807, 29819, 29820, 29821, 29822, 29823, 29824, 29825, 29826, 29827, 29828) (Table 1). Of this population, patients who were given the diagnosis of adhesive capsulitis were compared to those who also underwent shoulder arthroscopy with other diagnoses. There were 63,933 total patients who underwent shoulder arthroscopy, of this cohort 1641 underwent this procedure for a diagnosis of adhesive capsulitis. All patients who underwent shoulder arthroscopy for a diagnosis of infection were excluded.

Patient demographics collected included age, gender, body mass index (BMI; kg/m^2), smoking status, and medical comorbidities (diabetes, hypertension, chronic obstructive pulmonary disease, and congestive heart failure.) Continuous variables are reported as mean ± standard deviation. Categorical variables are reported as counts and percentage of whole. Continuous variables were compared with a student t-test while categorical variables were compared with Pearson chi-square tests. Risk factors for diagnosis of adhesive capsulitis were identified first using univariate analysis and then subsequent significant variables ($p < 0.05$) were selected for multivariate logistic regression analysis. Alpha level was set at $p < 0.05$ with a Bonferroni correction adjusting for multiple comparisons. All data and statistical analyses were performed using JMP Pro (version 13.0, SAS, Cary, NC).

3. Results

A total of 63,933 patients who met inclusion criteria were analyzed. Of these, 1,641 underwent shoulder arthroscopy for a diagnosis of adhesive capsulitis while 62,292 underwent shoulder arthroscopy for other diagnoses. Patients undergoing shoulder arthroscopy for adhesive capsulitis were an average age of 52.3 ± 14.6 years, a much larger percentage of the cohort were female, and diabetic compared with the overall shoulder arthroscopy population (58.0% vs 38.8%, $p < 0.0001$) and (14.9% vs 4.6%, $p < 0.0001$). A larger percentage of patients who underwent shoulder arthroscopy without a diagnosis of adhesive capsulitis had a BMI > 30 (43.4% vs 38.4%, $p < 0.0001$) (Table 2).

Multivariate analysis demonstrated female sex [OR 2.19 (95% CI: 1.98–2.42); $p < 0.0001$] and diabetes [OR 3.914 (95% CI: 2.83–4.53), $p < 0.0001$] are independent risk factors for undergoing shoulder arthroscopy for adhesive capsulitis. Contrarily, BMI > 30 demonstrated a protective effect for patients undergoing shoulder arthroscopy for adhesive capsulitis [OR 0.71 (95% CI: 0.64–0.78), $p < 0.0001$] (Table 3). In a subset analysis, post-menopausal females (females with age > 45) undergoing shoulder arthroscopy, had a significantly higher risk of having a diagnosis of adhesive capsulitis [OR 2.08 (95% CI: 1.89–2.3); $p < 0.0001$].

4. Discussion

Adhesive capsulitis of the shoulder remains a challenging clinical problem as a large percentage of patients can have prolonged symptoms with varying responses to both non-operative and operative interventions.[9] Understanding which risk factors lead to the need for operative intervention for this problem will better help practitioners guide treatment and counsel patients. Our study found that female sex [OR 2.19, $p < 0.0001$], post-menopausal women [OR 2.08, $p < 0.0001$] and diabetes [3.914, $p < 0.0001$] were significant risk factors for undergoing shoulder arthroscopy with a diagnosis of adhesive capsulitis. These findings are consistent with previous reports in the literature for the development of adhesive capsulitis.

Diabetes is a well-recognized risk factor for the development of both primary and secondary adhesive capsulitis.[10,11] Additionally, diabetes has been implicated in the development of adhesive capsulitis post-operatively.[10] Other systemic disorders have also been identified as risk factors for adhesive capsulitis. In a large population based study, Huang et al. demonstrated that patients with hypothyroidism have a 1.22 times risk of developing the disease when compared to the general population.[12] Similar to diabetics, patients with hypothyroidism also

Table 2
Patient characteristics.

Characteristic	Shoulder Arthroscopy Cases (n = 63,933)	Adhesive capsulitis diagnosis (n = 1,641)	Without Adhesive Capsulitis Diagnosis (62,292)	*p*-value[+]
Age, mean ± SD	52.3 ± 14.6	53 ± 10.2	52.3 ± 14.7	0.0076
female (%)	25,111 (38.8)	952 (58)	24,159 (38.8)	< **0.0001**
BMI > 30 (%)	27,667 (43.3)	630 (38.4)	27,037 (43.4)	< **0.0001**
Smoker (%)	11,436 (17.9)	271 (16.5)	11,165 (17.9)	0.14
Diabetes (%)	3,081 (4.8)	244 (14.9)	2,837 (4.6)	< **0.0001**
Hypertension (%)	24,130 (37.7)	634 (38.6)	23,496 (37.7)	0.45
COPD (%)	1,676 (2.6)	39 (2.4)	1,637 (2.6)	0.53
CHF	87 (0.14%)	2 (0.1)	85 (0.1)	0.87

COPD-chronic obstructive pulmonary disease; CHF – congestive heart failure.
+P-values < 0.00625 considered significant after Bonferonni correction.

Table 3
Univariate and multivariate analysis for risk factors for adhesive capsulitis.

Risk Factor	Univariate OR (95% CI)	*p*-value	Multivariate OR (95% CI)	*p*-value
Age	1.003 (0.999, 1.003)	0.06	0.997 (0.993, 1)	0.077
Female	2.183 (1.977, 2.411)	< **0.0001**	2.19 (1.98, 2.423)	< **0.0001**
BMI > 30	0.813 (0.734, 0.899)	< **0.0001**	0.705 (0.635, 0.782)	< **0.0001**
Smoker	0.906 (0.793, 1.034)	0.14	0.903 (0.79, 1.033)	0.14
Diabetes	3.66 (3.179, 4.215)	< **0.0001**	3.914 (2.834, 4.528)	< **0.0001**
Hypertension	1.04 (0.94, 1.1.5)	0.46		
COPD	0.902 (0.654, 1.244)	0.53		
CHF	0.884 (0.22, 3.632)	0.87		

COPD-chronic obstructive pulmonary disease; CHF – congestive heart failure.
+P-values < 0.00625 considered significant after Bonferonni correction.

have a higher incidence of post-operative stiffness. [10]Further risk factors that have been identified include cerebrovascular disease, coronary artery disease, autoimmune disease as well as Dupuytren's.[10] Genetic predisposition to the development of adhesive capsulitis has also been observed, patients of caucasian ethnicity, positive family history and those with HLA-B27 positivity have a higher predilection for the disease.[8] We were unable to assess many of these risk factors secondary to the limitations of data collected in the NSQIP database, however we did not note any statistically significant effects of ethnicity.

In addition to the above risk factors, women are more frequently affected by adhesive capsulitis than men which raises the question of the role of sex hormones in the pathophysiology of the disease.[13] To our knowledge there are no clinical studies evaluating testosterone, estrogen, luteinizing hormone or follicle stimulating hormone levels in patients who develop adhesive capsulitis. Interestingly, TGF-B a key growth factor in the development of adhesive capsulitis is inhibited in-vitro by testosterone, which could in part explain a lower incidence in men.[14]

In addition to risk factors for arthroscopic management of adhesive capsulitis, we noted that a BMI > 30 demonstrated a protective effect, [OR 0.71 (95% CI: 0.64–0.78), p < 0.0001]. A similar finding was also observed by Wang el al, who noted a lower body weight and subsequently BMI was associated with an increased risk of adhesive capsulitis.[11] Further, they noted for every kilogram of lower body weight, there is a 3% increased risk of adhesive capsulitis.[11] This phenomenon is unexpected as most other risk factors for adhesive capsulitis (i.e. diabetes, hypothyroidism) are associated with increased BMI.

Limitations of our study include all those naturally inherent to retrospective database studies. Creation of the database relies on accurate, consistent record keeping for each individual patient which can be challenging in modern electronic medical records. Despite these shortfalls, NSQIP data has been validated and utilized in orthopedic research.[15] Although a large number of patients were available for analysis, specific information pertaining to adhesive capsulitis was not able to be obtained. Risk factors such as hypothyroidism, Dupuytren's disease, cerebrovascular disease, coronary artery disease, family history and HLA-B27 positivity were unable to be assessed. In addition, analyzing only patients undergoing shoulder arthroscopy inherently introduces selection bias though we were interested in risk factors for patients undergoing operative intervention. The intent of our study was to determine which risk factors might predispose a patient to require operative intervention for adhesive capsulitis, no new risk factors were identified however the protective effect of an elevated BMI is interesting to note as only one other study has observed this effect.

5. Conclusions

Our study demonstrates that female sex, specifically women > 45 years old and diabetes are significant risk factors for undergoing shoulder arthroscopy for the diagnosis of adhesive capsulitis. An elevated BMI appears to confer a modest protective effect. Understanding the risk factors for adhesive capsulitis that requires shoulder arthroscopy will help orthopedic surgeons more appropriately counsel patients regarding their risk of failing non-operative management.

Declaration of competing interest

There are no Conflicts of Interest for any of the authors regarding this study or the results subsequently obtained.

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