Components of Metabolic Syndrome as Significant Risk Factors for Postoperative Complications Following Total Shoulder Arthroplasty: Hypertension, Diabetes, and BMI > 30

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Disclosures: We have nothing to disclose.

INTRODUCTION: Total shoulder arthroplasty (TSA) is an effective surgical procedure that has rapidly increased in usage over recent years. Metabolic syndrome (MetS) is defined as a pathologic condition that places patients at risk for cardiovascular disease and type 2 diabetes mellitus due to the combination of insulin resistance, hypertension, central obesity, and hyperlipidemia [1]. The purpose of this study was to analyze the relationship between MetS and adverse 30-day postoperative outcomes following TSA. We hypothesize that MetS will significantly increase cardiac and renal complications following TSA.

METHODS: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was queried for all patients who underwent both anatomic and reverse TSA between 2015 and 2020. After exclusion, 26,613 patients remained with 23,717 in the MetS cohort and 2,896 in the no MetS cohort. Metabolic syndrome was defined as the presence of BMI > 30 kg/m^2, diabetes mellitus, and hypertension. Patient demographics and comorbidities were compared between cohorts using bivariate logistic regression analysis. Multivariate binomial logistic regression, adjusted for all significant demographics and comorbidities, was then used to identify the postoperative outcomes independently associated with metabolic syndrome.

RESULTS: A total of 26,613 patients remained after exclusion criteria, with 23,717 (89.1%) in the no MetS cohort and 2,896 (10.9%) in the MetS cohort. On multivariate analysis, MetS was found to be an independent predictor of postoperative pneumonia (OR 1.61, 95% CI 1.02-2.55; p = 0.042), renal insufficiency (OR 4.09, 95% CI 1.67-10.00; p = 0.002), acute renal failure (OR 4.17, 95% CI 1.13-15.31; p = 0.032), myocardial infarction (OR 2.11, 95% CI 1.21-3.69; p = 0.009), nonhome discharge (OR 1.41, 95% CI 1.24-1.60; p < 0.001), and prolonged hospital stay > 3 days (OR 1.44, 95% CI 1.25-1.66; p < 0.001).

DISCUSSION: Prior research on MetS in TSA patients shows increased risk of complications following orthopedic surgery. Previous studies have shown increasing trends of MetS patients undergoing TSA and reported MetS to be an independent risk factor for multiple medical and surgical complications such as deep infection, joint instability, venous thrombosis, and pulmonary embolism to be significantly higher in the MetS group following TSA [2,3].

Within 30 days following TSA, we identified metabolic syndrome to be an independent predictor of postoperative pneumonia, renal insufficiency, acute renal failure, myocardial infarction, nonhome discharge, and prolonged hospital stay > 3 days. Insulin resistant states, such as those seen in metabolic syndrome, can cause immune dysregulation, which may increase a patient's likelihood of infectious complications [4]. Additionally, BMI > 35 kg/m^2 can significantly increase risk of postoperative medical complications, including renal insufficiency and failure, due to oxidative stress and endothelial dysfunction [5,6]. MetS is also a well-known risk factor for cardiovascular disease, and increased risk of postoperative myocardial infarction and other adverse cardiovascular events have been reported [2,7]. Furthermore, immune dysregulation may impact leukocyte counts, and preoperative leukocytosis has been identified as an independent predictor of additional postoperative complications following TSA, such as bleeding transfusions and non-home discharge [8]. Non-home discharge and longer length of stay are important complications to consider, as previous studies have shown these outcomes to lead to increased hospital costs, decreased bone strength, and impaired return to independent functional status among diabetic patients [9,10]. Our study is limited to the 30-day surveillance available on the ACS-NSQIP database, and other potential contributing factors including severity of each comorbidity and specific indications for surgery were unable to be analyzed.

SIGNIFICANCE/CLICINAL RELEVANCE: This study adds to the literature regarding risk factors among MetS patients undergoing orthopedic surgery. This can guide physicians in preoperative optimization and assist in operative decision making to minimize adverse outcomes.

REFERENCES: [1] Alberti, et al., Circulation. 2009; [2] Murphy, et al., Int Orthop. 2016; [3] Marigi, et al., J Shoulder Elbow Surg. 2021; [4] Andersen, et al., Adv Nutr. 2016; [5] Gupta, et al., J Shoulder Elbow Surg. 2014; [6] Zhang, et al., Transl Res. 2017; [7] Guofeng, et al., Bone Joint Res. 2020; [8] Ling, et al., JSES International. 2023; [9] Lung, et al., J Orthop Surg Res. 2019; [10] Macey, et al., J Bone Joint Surg Am. 1989.

IMAGES AND TABLES:

Characteristic	No Metabolic Syndrome Number	No Metabolic Syndrome Percent	Metabolic Syndrome Number	Metabolic Syndrome Percent	p-value
Total	23,717	100.0%	2,896	100.0%	
Age					
18-39	4	0.02%	140	4.8%	**0.001**
40-64	6,574	27.7%	744	25.7%	**<0.001**
65-74	9,703	40.9%	1,420	49.0%	--
≥75	7,300	30.8%	728	25.1%	**<0.001**
Gender					**0.017**
Female	13,147	55.4%	1,673	57.8%	
Male	10,570	44.6%	1,223	42.2%	
ASA Classification					**<0.001**
1-2	10,867	45.8%	421	14.5%	
≥3	12,850	54.2%	2,475	85.5%	
Functional status					**<0.001**
Independent	23,248	98.0%	2,798	96.6%	
Dependent	469	1.9%	98	3.4%	
Current smoker					**<0.001**
No	21,201	89.4%	2,663	92.0%	
Yes	2,516	10.6%	233	8.0%	
Dyspnea					
No	22,226	93.7%	2,592	89.5%	--
Moderate Exertion	1,424	6.0%	290	10.0%	**<0.001**
At Rest	67	0.3%	14	0.5%	**0.048**
COPD					**<0.001**
No	22,192	93.6%	2,650	91.5%	
Yes	1,525	6.4%	246	8.5%	
CHF					**<0.001**
No	23,581	99.4%	2,855	98.6%	
Yes	136	0.6%	41	1.4%	
Open wound/wound infection					**0.013**
No	23,640	99.7%	2,878	99.4%	
Yes	77	0.3%	18	0.6%	
Bleeding disorders					**0.004**
No	23,143	97.6%	2,800	96.7%	
Yes	574	2.4%	96	3.3%	

ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease; CHF, congestive heart failure

Figure 1. Patient Demographics and Comorbidities in Patients with and without Metabolic syndrome following TSA. Bold p-value indicates statistical significance with p-value set to <0.05.

Postoperative Complication	Odds Ratio	95% CI	p-value
Pneumonia	1.61	1.02-2.55	**0.042**
Renal insufficiency	4.09	1.67-10.00	**0.002**
Acute renal failure	4.17	1.13-15.31	**0.032**
Myocardial infarction	2.11	1.21-3.69	**0.009**
Sepsis	1.74	0.80-3.78	0.159
Bleeding transfusions	1.11	0.85-1.46	0.438
Reoperation	1.28	0.95-1.72	0.109
Readmission	1.19	0.97-1.47	0.098
Nonhome discharge	1.41	1.24-1.60	**<0.001**
Prolonged hospital stay	1.44	1.25-1.66	**<0.001**

Figure 2. Multivariate Analysis of 30-day Postoperative Outcomes in Patients with and without Metabolic syndrome following TSA, adjusted for significant demographics and comorbidities. Bold p-value indicates statistical significance with p-value set to <0.05.