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Research Article

Probability of Undiagnosed Sleep Apnea does not Correlate with Perioperative Complications, Barriers to Discharge or Length of Stay in Upper Extremity Arthroplasty

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Abstract

Background: Obstructive sleep apnea (OSA) increases perioperative risk in patients undergoing orthopaedic procedures. However, this risk may not apply to patients undergoing total shoulder arthroplasty. It is unclear if this is the result of pre-treatment, perioperative treatment, or unique conditions of shoulder arthroplasty. We hypothesized that patients who are identified as high risk for OSA through routine preoperative screening would exhibit a higher incidence of postoperative complications, physiologic barriers to discharge, and length of stay compared to patients previously diagnosed with OSA or those at low risk.

Methods: Retrospective review of 682 patients undergoing upper extremity arthroplasty comparing the rate of significant perioperative clinical events and length of stay between patients diagnosed with OSA and those at low risk, at risk, and high risk of undiagnosed OSA based on screening with the STOP-BANG questionnaire in the pre-operative clinic.

Results: After adjusting for the patient's sex, BMI, age, ASA class, and the Charlson Weighted Comorbidity index, as well as the incidence of smoking, COPD, and asthma; no difference between the sleep apnea groups were observed in terms of postoperative complications, potential physiologic barriers to discharge, length of stay nor discharge disposition.

Conclusion: A patient's STOP-BANG score (risk of undiagnosed obstructive sleep apnea) does not correlate with perioperative outcomes in upper extremity arthroplasty. Preoperative workup and treatment of potentially undiagnosed OSA based on perioperative screening tools may not be warranted based on the absence of a correlation with increased perioperative risk or resource utilization in this population.

Keywords: Perioperative complications; Obstructive sleep apnea; Upper extremity arthroplasty; Barriers to discharge; Length of hospital stay

Abbreviations

OSA: Obstructive Sleep Apnea; CPAP: Continuous Positive Airway Pressure

Introduction

Obstructive sleep apnea (OSA) affects one quarter of adults between the ages of 30 and 70 [1,2]. It is associated with an increased risk of general medical and perioperative complications [3-5]. The prevalence of OSA in patients undergoing orthopaedic surgery is increasing and has been associated with an increased risk of pulmonary and cardiac complications following orthopaedic procedures [3,6-8]. Orthopaedic patients with OSA are more likely to require tracheal intubation and mechanical ventilation in the perioperative period, require more intensive care, and an increased overall length of stay [3].

Preoperative treatment of OSA including continuous positive airway pressure (CPAP) therapy has been associated with a reduction in postoperative risk of complications [6,9]. Surgeons and anesthesiologists, however, do not reliably identify patients with either symptomatic sleep apnea or undiagnosed sleep apnea prior to surgery [10]. The American Society of Anesthesiologists recommends the administration of a screening tool in order to identify those at risk for complications associated with undiagnosed OSA [11]. The "STOP-BANG" score is simple to use and exhibits a high sensitivity in the perioperative setting by stratifying the risk of sleep apnea into 'low risk,' 'at risk,' and 'high risk' categories [12,13]. It is non-diagnostic and patients ultimately require polysomnography in order to establish a diagnosis of OSA and initiate treatment [5].

Whether or not pretreatment is sought, modifiable risk factors may be addressed in the perioperative period as a risk reduction measure for patients with OSA. Expert opinion based on limited evidence suggests that, despite an increased risk of adverse events associated with general anesthesia, the tailoring of general anesthesia

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Table 1: Summary of all study characteristics. Narcotic Reversal – administration of medication with goal of reversal of effects of narcotics within 24 hours of surgery.

Characteristic	Summary
Sex (Male)	301 (44%)
Age	64.5 (11.4)
BMI	29.5 (5.6)
ASA	2.4 (0.6)
Charleston Index	2.9 (1.7)
Asthma (Yes)	105 (15%)
COPD (Yes)	50 (7%)
Smoking Status (Yes)	135 (20%)
Brachial Plexus Block	
Indwelling catheter	173 (26%)
Single shot	487 (74%)
CPAP if OSA (of 154)	57 (37%)
Complications (Yes)	90 (13%)
Barriers to Discharge (Yes)	420 (62%)
Narcotic Reversal	10 (1%)
Length of Stay	2.4 (1.3)

protocols may benefit patients [11,14,15]. Randomized controlled trials have shown that perioperative auto-titrated positive airway pressure treatment improves OSA parameters [16]. When general anesthesia can be avoided, patients with OSA experience a decreased risk of perioperative complications [17]. In the post-operative period, regional blocks should be considered in an attempt to mitigate the need for systemic opioids [11].

Several aspects of shoulder and elbow arthroplasty make the theoretical extrapolation of most previously published results to this patient population difficult [18,19]. Supporting this assertion is one large study in which patients undergoing total shoulder arthroplasty had no increased incidence of complications nor cost, and a shorter length of stay compared to the general population [20]. It remains unclear, however, whether those carrying a diagnosis of OSA benefited from the protective effects of preoperative and perioperative treatment or solely the unique conditions of total shoulder arthroplasty. The questions then follow, should patients identified as at risk for OSA be formally evaluated and, if diagnosed, undergo pre-treatment with CPAP before proceeding with elective surgery in an attempt to reduce risk in the perioperative period? Does risk of undiagnosed obstructive sleep apnea, based on the STOP-BANG score, correlate with perioperative complications, barriers to discharge, or length of stay? Is attention to perioperative risk reduction an adequate means of controlling risk to this population?

At the present time, the study institution does not require further diagnostic work-up or treatment of possible OSA in patients identified as at risk based on their STOP-BANG score. Early adherence to CPAP therapy following an OSA diagnosis in the preoperative setting is low [18]; thus, it is unclear whether CPAP use itself or attention to the patient's OSA status in the perioperative period are protective to patient outcomes. We therefore assess for a correlation between postoperative outcomes and calculated OSA risk in upper extremity arthroplasty patients.

Materials and Methods

Following approval by the Institutional Review Board, we performed a retrospective case-control review of the medical record in order to identify all consecutively treated patients meeting the eligibility requirements of undergoing shoulder or elbow arthroplasty at a single tertiary institution treated by a single surgeon between January 2010 and January 2015.

All patients aged at least 18 years or older with recorded pre-operative STOP- BANG scores or a diagnosis of OSA were identified. These patients were then placed into 4 groups based on their OSA diagnosis or STOP-BANG score: OSA diagnosis, high risk for OSA, at risk for OSA, or low risk for OSA. Once these groups were established, we then investigated, through a retrospective chart review, if a statistical difference in the rate of significant perioperative clinical events (determined by the patient's recorded vitals) and length of stay existed among OSA diagnosis and risk groups.

Data summarized in Table 1 was collected with significant clinical events defined according to Table 2. Thresholds for defining significant clinical events were set based on those parameters within the chosen categories that would require further work-up, require additional treatment, delay discharge, change discharge disposition, increase resource utilization or the complexity of care significantly. They are carefully designed relative to the standard operating practices

Table 2: Definition of 'Potential Barriers to Discharge' and 'Complications'.

Potential Barrier To Discharge			Complication
RESPIRATORY	Minor Oxygen Desaturation	SpO2<92% Supplemental O_2 augmentation Supplemental O_2 beyond noon of POD1 O_2 delivery other than nasal cannula while awake	Severe O_2 desaturation (SpO_2<88%), pulmonary edema, bronchospasm, laryngospasm, upper airway obstruction pneumothorax, respiratory failure, specialist consult for acute condition, transfer to higher level of care, or readmission within 90 days
CARDIAC	Tachycardia	Heart rate >120 or 2 readings 5 minutes apart Symptomatic Prompting workup or treatment	Infarction, ischemia, arrest, congestive heart failure exacerbation, new dysrhythmia, specialist consultation for acute condition, transfer to a higher level of care, or readmission within 90 days
	Bradycardia	Heart rate <50 on 2 readings 5 minutes apart Symptomatic Prompting workup or treatment	
	Hypertension	Systolic blood pressure >180 on 2 readings 5 minutes apart Symptomatic Prompting workup or treatment	
	Hypotension	Systolic blood pressure <80 on 2 readings 5 minutes apart Symptomatic Prompting workup or treatment	
NEUROLOGIC	Confusion, Agitation	Clinical diagnosis	Transient ischemic attack, stroke, specialist consultation for acute condition, transfer to a higher level of care, or readmission within 90 days

Table 3: Bivariate Relationships between patient group and each outcome. Narcotic Reversal – administration of medication with goal of reversal of effects of narcotics within 24 hours of surgery. Home Health – Home with skilled home health services. SNF – Skilled Nursing Facility.

Outcome	OSA	High Risk	At Risk	Low Risk	P
Complication	20 (13%)	7 (21%)	22 (11%)	41 (14%)	0.444
Barrier (w/ O2 desat)	110 (71%)	24 (71%)	145 (72%)	207 (71%)	0.987
Barrier (w/o O2 desat)	42 (27%)	8 (25%)	63 (32%)	90 (31%)	0.686
Narcotic Reversal	3 (2%)	3 (9%)	2 (1%)	2 (1%)	**0.007**
Length of Stay	2.6 (1.8)	2.6 (1.5)	2.2 (0.7)	2.4 (1.3)	**0.034**
Disposition					
Home	129 (84%)	29 (85%)	176 (88%)	239 (82%)	0.344[a]
Home Health	14 (9%)	3 (9%)	9 (4%)	19 (6%)	
Rehab	0 (0%)	0 (0%)	1 (1%)	2 (1%)	
SNF	11 (7%)	2 (6%)	15 (7%)	33 (11%)	

[a]Since rehabilitation discharges are rare, they were not included in the statistical analysis.

Table 4: Adjusted analyses comparing patient group and each outcome.

Group Comparison	Complications OR (95% CI)	P	Barriers to Discharge OR (95% CI)	P	Length of Stay OR (95% CI)	P
High Risk	0.55 (.21, 1.47)		1.34 (0.62, 2.91)		0.1 (-0.4, 0.6)	
Moderate Risk	1.03 (0.53, 2.02)	0.489	1.03 (0.65, 1.62)	0.786	0.3 (0.1, 0.6)	0.108
Low Risk	0.76 (0.38, 1.52)		1.19 (0.73, 1.94)		0.1 (-0.2, 0.4)	

observed and documented on the orthopaedic in patient wards where the study was completed.

Exclusion from the study included BMI <18 or >45, history of tracheostomy, total or subtotal pneumonectomy, home oxygen use, disorders of the diaphragm or other prior upper- or lower-airway intervention with adverse effects on ventilation. Out of 810 potentially eligible patients, 720 eventually met inclusion criteria. Those excluded on the basis of inclusion criteria lacked recorded STOP-BANG scores or were not seen in the pre-operative anesthesia clinic. After application of exclusion criteria, 682 patients remained eligible for study inclusion. All exclusions were the result of BMI criteria. Every patient's medical record was reviewed 90 days post-surgery to determine if any readmissions, due to significant surgical complications, occurred during that time.

At the study institution, anesthesia is tailored for risk reduction based on OSA/STOP-BANG status, but is not standardized. All patients in the study group underwent general anesthesia with the overwhelming majority receiving a supplementary regional block. If applicable, home CPAP therapy is continued in the perioperative period.

All variables were summarized using means and standard deviations (SDs) or frequencies and percentages. Pearson chi-square tests and ANOVAs were used to assess the bivariate relationship between the sleep apnea groups and the categorical and continuous outcomes, respectively. Due to low expected sample sizes, an exact Pearson chi-square test was used to estimate the relationship between narcotic reversal and the sleep apnea groups. Multivariable linear and logistic regression models were used to assess these relationships adjusted for a subject's sex, age, BMI, ASA Class, Charlson Index, and the incidence of asthma, COPD and smoking. Quadratic or cubic terms may have been used to best represent the relationship between the outcomes and either BMI and age. Since this study is an exploratory study, no corrections for multiple comparisons were used [21]. All inference was performed at the 0.05 level using SAS V9 [4].

Results

Six-hundred eighty-two patients met the eligibility criteria of this study. About one-quarter (N=154, 23%) of patients had previously diagnosed sleep apnea, 34 (5%) were at high risk, 201 (29%) were at risk, and 293 (43%) were at low risk of OSA. Every patient (100%) received a brachial plexus block. The records of 57 of 154 patients with a diagnosis of OSA showed evidence that CPAP had been ordered during the stay, though actual CPAP usage could not be determined, and may have been used despite no recorded order. Summary information for the sample can be seen in Table 1.

Ninety (13%) patients experienced a complication. Most patients exhibited a potential physiologic barrier to discharge if minor oxygen desaturation was considered (N=486, 71%), however, removing minor oxygen desaturation from consideration resulted in 203 instances (30%). A total of 10 (1%) patients required narcotic reversal during the postoperative period. The mean length of stay was 2.4 days (SD=1.3).

Without adjusting for any comorbidities, those at high risk of OSA were found to have a higher rate of narcotic reversal than all other groups (P=0.007) (Table 3). Patients with diagnosed OSA had a longer length of stay compared to those identified as at risk of OSA (P=0.034). Neither incidence of complications, physiologic barriers to discharge (including and excluding minor oxygen desaturation), nor discharge disposition differed significantly between groups. Marginally, no other differences between the sleep apnea groups were discovered.

After adjusting for the patient's sex, BMI, age, ASA class, and the Charlson Weighted Comorbidity index, as well as the incidence of smoking, COPD, and asthma, no difference between the sleep apnea

groups for any outcome were observed (Table 4).

Discussion

Obstructive sleep apnea (OSA) in the population of patients undergoing elective orthopaedic surgery is increasing and imparts a significantly increased risk of perioperative adverse events and resource utilization [3-8]. Preoperative treatment with CPAP along with measures taken in the perioperative period is advocated in order to mitigate these risks [6,9-11]. Because physician recognition of patients at risk of undiagnosed sleep apnea in the pre-operative period is poor, screening indices are recommended in order to identify patients undiagnosed but at risk for OSA [11-13]. At our institution, patients identified as being at risk based on such screening are not currently required to seek polysomnography nor pre-operative treatment of OSA prior to undergoing elective upper extremity arthroplasty procedures. Anesthesia is, however, tailored to the patient's perceived risk of OSA.

In our study group, adjusted for possible confounding, there was no significant difference in length of stay, complication rate, nor potential physiologic barriers to discharge between sleep apnea risk groups. Unadjusted, those untreated but at high risk of OSA, had a statistically significant greater chance of requiring narcotic reversal when compared to patients with diagnosed OSA. Though the effects of preoperative treatment cannot be excluded as a possible reason for this observation, it may alternatively represent an increased attention to the risks of patients with documented OSA in the perioperative period compared to those at risk but without an official diagnosis of OSA. Comparison to the diagnosed sleep apnea group is limited due to an incomplete data set as it pertains to perioperative CPAP use.

Consistent with some previous work, patients with documented OSA had a marginally but statistically significant increased length of stay compared to patients at risk of OSA. Patients at high risk but undiagnosed and untreated for OSA had a similar length of stay compared to patients with OSA. It is possible that the increased length of stay in patients with OSA may be related to less than half of this group having evidence of CPAP being ordered during their stay. Because of charting practices relative to this particular parameter, it is impossible to say that the observed incidence of CPAP orders accurately reflects actual CPAP use. Because of this limitation, it is difficult to make meaningful comparisons between risk groups and patients with diagnosed OSA. Thus, conclusions relating to perioperative risk based on the findings of this study are best applied to STOP-BANG risk groups relative to one another, and not to patients with previously diagnosed obstructive sleep apnea. A lack of orders, importantly, however, may illustrate a less than optimal attention to perioperative CPAP therapy by providers, whether or not it is actually utilized (thanks to either the patient or other providers in the care system). If the order status is reflective of actual CPAP use, this may explain the unadjusted increased length of stay observed in this patient group.

When comparing the incidence of potential physiologic barriers to discharge in this population, those identified as at risk or high risk of OSA exhibited no clinically significant difference compared to patients previously treated for OSA and those at low risk of OSA based on a widely-used screening tool. Likewise, no connection between the incidences of perioperative complications was tied to obstructive sleep apnea risk group.

Despite the possibility that a significant portion of the population (based on recorded data) with sleep apnea did not receive CPAP therapy, we did not observe a statistically significant difference in rates of significant clinical events between patients with OSA and those with a low risk of OSA. This finding is consistent with prior work showing no increased risk of OSA in upper extremity arthroplasty patients [20]. That study did not take into account the possibility of undiagnosed OSA nor pre-operative screening. Several possible explanations exist for this observation including the possibility that anesthesia tailored to patients with OSA has been effective at decreasing the relative risk to this patient population. Also, different surgical and/or post-operative conditions unique to upper extremity arthroplasty may contribute to this discrepancy.

Though the current work is retrospective, it does represent the only investigation of its type in patients undergoing upper extremity arthroplasty. It is the first study to examine the prognostic utility of OSA screening tools for predicting risk in the perioperative period for patients undergoing orthopaedic surgery, wherein OSA has been shown to predict significant risk to patients [6]. In this cohort of patients, the risk of perioperative complications, barriers to discharge, nor length of stay appeared be affected by sleep apnea risk groups as identified by the STOP-BANG. Further work is required to compare risk groups to those previously diagnosed with obstructive sleep apnea, however, a high risk of undiagnosed sleep apnea discovered during the preoperative work-up for elective shoulder or elbow arthroplasty may not warrant preoperative diagnosis and treatment of possible OSA.

Conclusion

A patient's STOP-BANG score (risk of undiagnosed obstructive sleep apnea) does not correlate with perioperative outcomes in upper extremity arthroplasty. Preoperative workup and treatment of potentially undiagnosed OSA based on perioperative screening tools may not be warranted based on the absence of a correlation with increased perioperative risk or resource utilization in this population.

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