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ORIGINAL CONTRIBUTIONS

Perioperative Risks of Untreated Obstructive Sleep Apnea in the Bariatric Surgery Patient: a Retrospective Study

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Abstract
Background The use of continuous positive airway pressure (CPAP) perioperatively in bariatric surgery patients with obstructive sleep apnea (OSA) has been controversial. Although studies have demonstrated that CPAP use is safe in bariatric patients, prior studies have not shown improvement in outcomes in these patients.
Methods A retrospective review of patients who underwent bariatric surgery from 2005 to 2009 was performed. All patients underwent polysomnography preoperatively. Patient age, sex, BMI, comorbidities, polysomnogram data, type of bariatric procedure, length of hospital stay, and postoperative complications were reviewed. The Fisher exact test was used for statistical analysis.
Results Among the 352 patients studied, 47 with apnea-hypopnea index (AHI) ≥5 did not receive CPAP postoperatively. A total of 7/47 (14.9 %) developed postoperative pulmonary complications. There were no non-pulmonary complications. Some 9/305 (2.95 %) with CPAP developed pulmonary complications. There were 26/305 patients with all-cause complications (8.52 %). The AHI was higher in the group receiving treatment. There was a statistically significant difference in pulmonary complications between patients with and those without treatment (p value 0.0002). The average length of stay was 3.0 and 3.2 days in treatment and comparison groups, respectively, a difference that did not reach statistical significance.
Conclusions Patients who did not receive CPAP postoperatively developed more pulmonary complications than those with CPAP, suggesting that CPAP might be beneficial in decreasing pulmonary complications in patients undergoing bariatric surgery. However, further investigation is warranted to better delineate other risk factors due to small sample size in our study group.

Keywords Obstructive sleep apnea · Continuous positive airway pressure · Bariatric surgery · Perioperative risk

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Abbreviations

OSA	Obstructive sleep apnea
CPAP	Continuous positive airway pressure
PSG	Polysomnogram
AHI	Apnea-hypopnea index
BMI	Body mass index
LOS	Length of stay

Introduction

Obesity is a public health problem of epidemic proportions, affecting more than 78 million adults and 12 million children in the USA alone [1]. The disorder is

associated with numerous comorbidities, including systemic hypertension, congestive heart failure, diabetes mellitus, and obstructive sleep apnea [2–4]. In terms of overall health impact, the excess mortality from complications of obesity has been projected to lead to a leveling off or even a decline in current life expectancies [4–6].

Obstructive sleep apnea (OSA) is an especially common comorbidity in obese patients, as excessive body fat deposition may compromise multiple aspects of the respiratory process [7]. The disorder is characterized by recurrent cessation of respiration during sleep, which results in hypoxemia, impaired cardiac function, sympathetic surges, and endothelial dysfunction [2, 3]. Increased incidence of several conditions, including hypertension, congestive heart failure, myocardial infarction, atrial fibrillation, venous thromboembolism, and stroke has been described in patients with significant sleep apnea [2, 3, 8].

Multiple postoperative complications have been associated with OSA, including hypercapnia, hypoxemia, pneumonia, cardiac arrhythmias, cardiac ischemia, myocardial infarction, delirium, and unplanned intensive care unit transfers [9–11]. Pulmonary disturbances are the most commonly reported postoperative complications [10–14].

Given the prevalence of OSA in the obese population is as high as 60 to 90 % [1, 15, 16], OSA is a particular concern in the perioperative management of the bariatric/obesity surgery patient. However, studies on the risk of postoperative complications associated with OSA and the effectiveness of continuous positive airway pressure (CPAP) on mitigating such complications in this population are limited and conflicting [10–12, 17–21]. While OSA is often suspected based on clinical presentation, diagnosis can be difficult as it usually requires polysomnography, which is costly and time consuming. CPAP is a common and effective treatment for obstructive sleep apnea. By maintaining a positive pressure in the airway, CPAP prevents the component of airway collapse that underlies the apneas and hypopneas of obstructive sleep apnea [22]. However, CPAP can be difficult to tolerate and compliance can be challenging.

The considerable prevalence of OSA in the bariatric surgery population, and the potential increased risk of postoperative complications must be balanced against the cost and difficulty of diagnosing and treating OSA preoperatively. Further clarification of the role for postoperative CPAP is especially pertinent. We sought to address this by evaluating the postoperative course of a cohort of bariatric patients who were diagnosed preoperatively with OSA by polysomnography, comparing those who received and those who did not receive CPAP. We hypothesized that CPAP use would decrease postoperative pulmonary disturbances and possibly reduce hospital length of stay (LOS) after bariatric surgery as a result.

Methods

Study Design

We performed a retrospective analysis on a group of 548 patients who had bariatric surgery at the Center of Weight Loss Surgery at Danbury Hospital from 2005 to 2009. As part of the standard preoperative evaluation, all patients considering bariatric surgery had an evaluation by a sleep physician, with polysomnogram (PSG) ordered if clinically indicated. Due to an administrative decision leaving prescription of CPAP at the discretion of an individual's sleep physician for the less severe cases of sleep apnea with an AHI < 15 without significant hypoxemia, a group of patients did not receive perioperative CPAP. The decision to withhold CPAP was a conscious one between the sleep physician and the patient, more so than frank patient non-compliance. Pulmonary function and arterial blood gas testing were also routinely performed. Patients were eligible for our analysis if they underwent bariatric surgery and had had a preoperative PSG. Patients with a documented apnea-hypopnea index (AHI) less than 5 or those in whom PSG was not felt to be clinically indicated were excluded. Sixteen patients were excluded due to erroneous data entry. There were a total of 352 patients fitting our criteria. Sixty-nine and twenty-eight percent of the patients underwent laparoscopic gastric bypass and laparoscopic gastric banding, respectively. The rest of the patients underwent sleeve gastrectomy, open gastric bypass, or retrocolic retrogastric gastrojejunostomy.

The study was approved by the Danbury Hospital institutional review board and the Biomedical Research Alliance of New York. Information retrieved included patient age, sex, height, weight, body mass index (BMI), preoperative comorbidities, polysomnography data, length of hospital stay, and postoperative complications. We reviewed PSG and discharge summaries for patients and screened this cohort for those who were diagnosed with OSA on PSG, but did not receive CPAP perioperatively. A total of 47 patients with documented OSA who did not receive CPAP and 305 patients who received CPAP perioperatively were found. The daily progress notes for each patient in this final cohort were then reviewed to verify postoperative complications.

Statistical Analysis

Statistical analysis was conducted to detect associations between risk of postoperative complications and CPAP use. For continuous data, the groups were compared using an unpaired, parametric *t* test, with the assumption that both populations have the same standard deviation. For categorical data, the Fisher exact test was used to detect associations between risk of postoperative complications and CPAP use. Statistical

significance was defined as $p < 0.05$. JMP software version 11 was used to conduct the analysis.

Results

Patients' Characteristics

There were 47 patients with AHI greater than or equal to 5 who did not receive CPAP postoperatively in our sample. There was a statistically significant lower rate of males in the non-CPAP group (8.5 vs 35 %, $p = 0.0004$—Table 1). The CPAP group also had a statistically significant higher initial AHI on NPSG (9.39 vs 37.98, $p < 0.0001$) and lower oxygen nadir on PSG (82.91 vs 77.50, $p = 0.0004$) before surgery. There were no significant differences between two groups in age ($p = 0.75$), BMI ($p = 0.53$), incidence of diabetes ($p = 0.74$), incidence of hypertension ($p = 0.86$), serum bicarbonate level ($p = 0.64$), or partial pressure of carbon dioxide in arterial blood ($p = 0.54$). None of the 47 patients in the non-CPAP group had significant chronic obstructive pulmonary disease according to pulmonary function tests reviewed.

Perioperative Complications

Table 2 shows the difference in perioperative complications between two groups. In the non-CPAP group, 7 out of the 47 (14.9 %) developed postoperative pulmonary disturbances without other complications. There were no anastomotic leaks, cardiac arrhythmias, wound infections, cases of sepsis, or cases of required mechanical ventilation in the non-CPAP group. Of the 7 patients who developed postoperative pulmonary disturbances in the non-CPAP group, 2 developed pneumonia requiring antibiotic treatment, 3 developed atelectasis, as evidenced by clinical symptoms and supported by imaging studies, 1 developed hypoxemia requiring oxygen supplementation, and 1 developed pneumomediastinum. Of the 9 patients who developed pulmonary complications in the CPAP group, 5 developed pneumonia, 1 developed atelectasis, 1 developed atelectasis and pneumonitis, and 2 had perioperative comorbidities requiring prolonged mechanical ventilation. The rate of postoperative pulmonary complication was significantly higher in the non-CPAP group (14.9 vs 3.0 %, $p = 0.0002$), with an odds ratio of 5.76 ($p = 0.01$). There was no significant difference in the length of hospital stay ($p = 0.48$) or all-cause complications ($p = 0.21$). All-cause complications included urinary tract infection, lap band failure or removal, perforated injury, venous thromboembolism, fever of unclear etiology, small bowel tear, upper gastrointestinal bleed, delay gastric emptying, and anastomotic leak in addition to pulmonary complications stated above.

Table 1 Basic demographics and risk factors for experimental and comparison groups

	No CPAP	CPAP	Odd ratio	*p* value
Age [mean ± SEM]	48.02 ± 1.70	47.47 ± 0.63		0.75
Male sex [%]	8.5	35	5.89	0.0004
Diabetes [%]	30	33	1.17	0.74
Hypertension [%]	60	58	0.94	0.86
Body mass index	48.7 ± 1.68	49.7 ± 0.55		0.53
Initial NPSG AHI	9.39 ± 0.70	37.98 ± 1.92		<0.0001
O_2 nadir	82.91 ± 0.81	77.50 ± 0.57		0.0004
HCO_3	25.43 ± 0.41	25.61 ± 0.13		0.64
pCO_2	39.26 ± 0.72	39.68 ± 0.24		0.54

Data are presented as mean ± standard error of the mean unless otherwise stated

NPSG nocturnal polysomnography, *O_2 nadir* oxygen nadir, *HCO_3* serum bicarbonate level, *pCO_2* partial pressure of carbon dioxide in arterial blood

Table 2 Length of stay, pulmonary complications, and all-cause complications for experimental and comparison groups

	No CPAP	CPAP	Odds ratio	*p* value
Length of stay	3.00 ± 0.12	3.20 ± 0.11		0.48
Pulmonary complications [%]	15	3	5.76	0.0002
All-cause complications [%]	15	8.9	1.88	0.21

Discussion/Conclusion

In this retrospective cohort study, we compared the postoperative outcome of patients undergoing bariatric surgery with or without perioperative CPAP use. We evaluated postoperative complications within 30 days of surgery and length of initial hospitalization for each patient. Our hypothesis that CPAP use would decrease postoperative pulmonary disturbances and possibly affect hospital length of stay after bariatric surgery was supported by an increase in the observed pulmonary complication rate and a positive odds ratio in patients who did not receive CPAP compared to those that did. There was also an increase in all-cause complications in the non-CPAP group, but was not statistically significant. This could have been due to the lack of non-pulmonary complications in our study group as a result of the small sample size.

Average AHI and male to female ratio was significantly higher while oxygen nadir was significantly lower in the CPAP group compared to the non-CPAP group. Although previous studies have not shown an association between severity of OSA by AHI and increased risk of perioperative complications [23], one might intuitively expect a higher rate of pulmonary complications in patients with a higher AHI, higher male to female ratio, and lower oxygen nadir. However, we observed that the patients with fewer risk factors for OSA and less severe disease, when untreated,

demonstrated a higher rate of pulmonary complications. This suggests that perioperative CPAP use may be beneficial in patients with OSA who undergo bariatric surgery.

While previous studies have also suggested that OSA does not seem to increase the risk of postoperative hypoxemic episodes in morbidly obese patient in the first 24 h after bariatric surgery [24], our study included pulmonary complications beyond hypoxemic episodes, such as pneumonia, pneumonitis, atelectasis, and pneumomediastinum up to 30 days after bariatric surgery. This might have resulted in the difference in our results compared to Ahmad et al.

The similarity in LOS between patients with or without CPAP therapy may be explained by the presence of major non-pulmonary complications in our comparison group, which made the length of stay significantly higher in those patients. However, as mentioned above, the lack of non-pulmonary complications in our study group could have been because of the small sample size. Delays in discharge or returns to the emergency departments were seen in a number of patients with perioperative pulmonary complications.

Although we were successful in demonstrating that pulmonary disturbances were much more common in our study group with untreated OSA, our study is limited by several factors. First, since most patients with OSA were placed on CPAP, the sample size for the non-CPAP group was small compared to our CPAP group. This might have resulted in a lack of power to demonstrate a difference in the length of stay between the two groups. Moreover, our data collection only included a limited assessment of the comorbidities in our patient population, limiting our ability to analyze the association of risk factors and complications as in previous published studies [25–27]. Lastly, the study population was selected from patients who underwent PSG in our sleep center prior to surgery so patients without a sleep study in our center were omitted from this study. We feel this effect is minimal since every patient that underwent bariatric surgery in our hospital was seen by a sleep center physician preoperatively.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in this study are in accordance with the ethical standards of the institutional and national research committees and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent For this type of study, formal consent is not required.

Disclosure Statement This was not an industry-supported study. None of the authors have received any grants to fund this research.

Other Contributions Joann Petrini, PhD, MPH, research director in the Original Clinical Research Department at Danbury Hospital, performed research assistance and review of the manuscript.

References

1. Hallowell PT, Stellato TA, Schuster M, et al. Potentially life-threatening sleep apnea is unrecognized without aggressive evaluation. Am J Surg. 2007;193:364–7.
2. Malhotra A, Loscalzo J. Sleep and cardiovascular disease: an overview. Prog Cardiovasc Dis. 2009;51(4):279–84.
3. Malhotra A, White DP. Obstructive sleep apnoea. Lancet. 2002;360:237–45.
4. Olshansky SJ, Passaro DJ, Hershow RC, et al. A potential decline in life expectancy in the United States in the 21st century. N Engl J Med. 2005;352(11):1138–45.
5. Peeters A, Barendregt JJ, Willekens F, et al. Obesity in adulthood and its consequences for life expectancy: a life-table analysis. Ann Intern Med. 2003;138(1):24–32.
6. Allison DB, Downey M, Atkinson RL, et al. Obesity as a disease: a white paper on evidence and arguments commissioned by the Council of the Obesity Society. Obesity (Silver Spring). 2008;16(6):1161–77.
7. Crummy F, Piper AJ, Naughton MT. Obesity and the lung: 2. Obesity and sleep-disordered breathing. Thorax. 2008;63(8):738–46.
8. Chou KT, Huang CC, Chen YM, et al. Sleep apnea and risk of deep vein thrombosis: a non-randomized, pair-matched cohort study. Am J Med. 2012;125(4):374–80.
9. Gupta RM, Parvizi J, Hanssen AD, et al. Postoperative complications in patients with obstructive sleep apnea syndrome undergoing hip or knee replacement: a case-control study. Mayo Clin Proc. 2001;76(9):897–905.
10. Kaw R, Pasupuleti V, Walker E, et al. Postoperative complications in patients with obstructive sleep apnea. Chest. 2012;141(2):436–41.
11. Kaw R, Michota F, Jaffer A, et al. Unrecognized sleep apnea in the surgical patient: implication for the perioperative setting. Chest. 2006;129(1):198–205.
12. Jensen C, Tejirian T, Lewis C, et al. Postoperative CPAP and BiPAP use can be safely omitted after laparoscopic Roux-en-Y gastric bypass. Surg Obes Relat Dis. 2008;4(4):512–4.
13. Memtsoudis S, Liu SS, Ma T, et al. Perioperative pulmonary outcomes in patients with sleep apnea after noncardiac surgery. Anesth Analg. 2011;112(1):113–21.
14. Mador MJ, Goplani S, Gottumukkala VA, et al. Postoperative complications in obstructive sleep apnea. Sleep Breath. 2013;17(2):727–34.
15. Serafini FM, MacDowell AW, Rosemurgy AS, et al. Clinical predictors of sleep apnea in patients undergoing bariatric surgery. Obes Surg. 2001;11(1):28–31.
16. Frey WC, Pilcher J. Obstructive sleep-related breathing disorders in patients evaluated for bariatric surgery. Obes Surg. 2003;13(5):676–83.
17. Grover BT, Priem DM, Mathiason MA, et al. Intensive care unit stay not required for patients with obstructive sleep apnea after laparoscopic roux-en-y gastric bypass. Surg Obes Relat Dis. 2010;6(2):165–70.
18. Gross JB, Bachenberg KL, Benumof JL, et al. Practice guidelines for the perioperative management of patients with obstructive sleep apnea. Anesthesiology. 2006;104(5):1081–93.
19. Ramirez A, Lalor PF, Szomstein S, Rosenthal RJ. Continuous positive airway pressure in immediate postoperative period after laparoscopic Roux-en-Y gastric bypass: is it safe? Surg Obes Relat Dis. 2009;5(5):544–6.
20. Wong DT, Adly E, Ip HY, Thapar S, Maxted GR, Chung FF. A comparison between the Boussignac™ continuous positive airway pressure mask and the venturi mask in terms of improvement in the PaO2/FiO2 ratio in morbidly obese patients undergoing bariatric surgery: a randomized controlled trial. Can J Anaesth. 2011;58(6):532–9.
21. Huerta S, DeShields S, Shipiner R, Li Z, Liu C, Sawicki M, et al. Safety and efficacy of postoperative continuous positive airway

pressure to prevent pulmonary complications after Roux-en-Y gastric bypass. J Gastrointest Surg. 2002;6(3):354–8.
22. Theerakittikul T, Ricaurte B, Aboussouan LS. Noninvasive positive pressure ventilation for stable outpatients: CPAP and beyond. Cleve Clin J Med. 2010;77(10):705–14.
23. Weingarten TN, Flores AS, McKenzie JA, Nguyen LT, Robinson WB, Kinney TM, et al. Obstructive sleep apnea and perioperative complications in bariatric patients. Br J Anaesth. 2011;106(1):131–9.
24. Ahmad S, Nagle A, McCarthy RJ, Fitzgerald PC, Sullivan JT, Prystowsky J. Postoperative hypoxemia in morbidly obese patients with and without obstructive sleep apnea undergoing laparoscopic bariatric surgery. Anesth Analg. 2008;107(1):138–43.
25. Longitudinal Assessment of Bariatric Surgery [LABS] Consortium, Flum DR, Belle SH, King WC, Wahed AS, Berk P, et al. Perioperative safety in the longitudinal assessment of bariatric surgery. N Engl J Med. 2009;361(5):445–54.
26. Nguyen NT, Masoomi H, Laugenour K, Sanaiha Y, Reavis KM, Mills SD, et al. Predictive factors of mortalityin bariatric surgery: data from the Nationwide Inpatient Sample. Surgery. 2011;150(2):347–51.
27. Mokhlesi B, Hovda MD, Vekhter B, Arora VM, Chung F, Meltzer DO. Sleep-disordered breathing and postoperative outcomes after bariatric surgery: analysis of the nationwide inpatient sample. Obes Surg. 2013;23(11):1842–51.