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Original article

## Self-reported remission of obstructive sleep apnea following bariatric surgery: cohort study

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### Abstract

**Background:** Evidence on remission of obstructive sleep apnea (OSA) after bariatric surgery and its relation to weight loss is conflicting. We sought to identify factors associated with successful self-reported OSA remission in a large cohort of bariatric surgery patients.

**Methods:** We analyzed data from the statewide, prospective clinical registry of the Michigan Bariatric Surgery Collaborative and identified 3,550 patients with OSA who underwent a primary bariatric procedure between June 2006 and October 2011 and had at least 1 year of follow-up data. We used multivariate logistic regression to identify preoperative factors associated with successful self-reported OSA remission, defined as discontinuation of continuous positive airway pressure or bilevel positive airway pressure at 1 year. Our regression model also included procedure type and weight loss at 1 year, divided into equal quintiles, as covariates.

**Results:** The overall 1-year self-reported OSA remission rate was 60%. Significant predictors of remission included age category (per 10 yr) (OR .73, CI .69–.78), body mass index category (per 10 units) (OR .57, CI .54–.62), male gender (OR .58, CI .52–.69), hypertension (OR .83, CI .74–.99), depression (OR .78, CI .69–.88), pulmonary disease (OR .88, CI .78–.98), and baseline Health and Activities Limitations Index score (OR 1.70, CI 1.32–2.23). Relative to gastric banding, the adjusted odds of OSA remission were greater with gastric bypass (OR 2.38, CI 1.89–3.08), sleeve gastrectomy (OR 2.01, CI 1.44–2.55), and duodenal switch (OR 2.57, CI 1.02–7.26). The odds ratio of OSA remission increased stepwise through quintiles of 1-year weight loss. Relative to the lowest quintile, the odds ratios of remission in the 2<sup>nd</sup> through 5<sup>th</sup> quintiles were 1.44 (CI 1.11–1.84), 2.03 (CI 1.48–2.57), 2.47 (1.85–3.40), and 3.53 (CI 2.56–4.85).

**Conclusions:** Weight loss is an important predictor of self-reported OSA remission after bariatric surgery. However, independent of weight loss, there remain significant differences in the likelihood of remission between gastric banding and other bariatric procedures. This suggests that there may be metabolic, weight-independent effects of procedure type on self-reported OSA remission. (Surg Obes Relat Dis 2014;■:00–00.) © 2014 American Society for Metabolic and Bariatric Surgery. All rights reserved.

### Keywords:

Sleep apnea; Obesity; Bariatric surgery; Co-morbidity remission; Weight loss

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Bariatric surgery has emerged as the dominant treatment modality for long-term and sustainable weight loss in morbidly obese patients [1]. Obstructive sleep apnea (OSA), a co-morbidity for which obesity is a major risk factor [2], is underdiagnosed in the bariatric population with data suggesting prevalence is >75% [3–6]. It has also been reported as an independent prognostic marker for all-cause mortality in obese patients [7]. Existing OSA treatments include oral appliances, continuous positive airway pressure (CPAP), and upper airway surgery [8,9]. Although these can improve OSA symptoms, they do not address other obesity associated co-morbidities, such as cardiovascular disease and diabetes, which likely contribute to higher mortality rates in these patients. Meta-analyses have suggested that bariatric surgery is effective in resolving OSA although questions remain regarding long-term remission and the degree to which weight loss alone is responsible for these improvements [1,10].

A recent randomized controlled trial (RCT) assessed remission of OSA in morbidly obese patients assigned to either conventional nonsurgical weight loss therapy or to adjustable gastric banding [11]. Although the surgical group lost more weight, they did not have significantly greater OSA remission. Furthermore, the majority of benefit in OSA remission appeared to plateau at the level of mild-to-moderate weight loss. The findings from this study and other work suggest that there may be metabolic, weight-independent effects that exert a greater influence on OSA remission than previously appreciated [12,13].

The aim of this study was to identify predictors of self-reported OSA remission after bariatric surgery, using a prospective statewide clinical outcomes registry. In addition to identifying predictive patient characteristics, we sought to assess the degree to which procedure type and weight loss contribute to self-reported remission of OSA.

## Methods

### *Study setting*

For this study, we analyzed data from the Michigan Bariatric Surgery Collaborative (MBSC), a payor-funded quality improvement program that administers a prospective, externally audited clinical outcomes registry. As described in greater detail elsewhere [14,15], the MBSC is a regional consortium of 39 hospitals and 85 surgeons performing bariatric surgery in Michigan. The MBSC currently enrolls about 6,000 patients annually into its registry and captures data on nearly all patients undergoing bariatric surgery in Michigan. Participating hospitals submit data on all patients who undergo primary and revisional bariatric procedures, including gastric bypass, adjustable gastric banding, sleeve gastrectomy, and biliopancreatic diversion with duodenal switch.

Patient data for the clinical registry are obtained from chart abstraction at the end of the perioperative period

(in-hospital and up to 30 d after surgery) and include information on preoperative clinical characteristics and co-morbid conditions, as well as perioperative clinical care and outcomes. The medical records are reviewed by centrally trained data abstractors using a standardized and validated instrument. Each hospital within the MBSC is audited annually by nurses from the coordinating center to verify the accuracy and completeness of its registry data.

Patients who consent to longitudinal follow-up are surveyed at baseline and annually thereafter. These surveys request information on weight loss, medication use, quality of life, and satisfaction with surgery and serve as the primary means by which data on long-term outcomes of care are obtained. The study protocol was approved by the institutional review boards of the University of Michigan and all participating hospitals. The requirement for informed consent was waived.

### *Study population*

We identified all patients with OSA, defined as being treated with CPAP or bilevel positive airway pressure (BiPAP) at baseline, who underwent a primary bariatric procedure between June 2006 and October 2011 and had at least 1 year of follow-up data.

### *Data collected and outcomes*

Patient characteristics collected include patient demographic characteristics (height, weight, age, gender, race, and insurance type); smoking status; mobility; and weight-related and other co-morbidities (lung disease, cardiovascular disease, hypertension, hyperlipidemia, gastroesophageal reflux, peptic ulcer, cholelithiasis, urinary incontinence, renal failure, diabetes, liver disease, history of venous thromboembolism [VTE], musculoskeletal disorders, history of hernia repair, and depression). Co-morbidity status is defined by the documentation in the medical record of that co-morbidity and its treatment. Information collected on OSA included method of treatment (CPAP/BiPAP versus other) and the presence of cor pulmonale.

Outcomes obtained at each follow-up included weight, quality of life, co-morbidity remission, and patient satisfaction. Co-morbidity remission is defined by discontinuation of treatment for that condition. Generic health-related quality of life is measured using the Health and Activities Limitations Index (HALex), which includes items derived from the National Health Interview Survey and incorporates information about perceived health and activity limitation into a single composite score, scaled like a utility, where 0 is equivalent to death and 1 is equivalent to life in perfect health [16].

Bariatric health-related quality of life was measured using the bariatric quality of life (BQL) questionnaire, a 19-item tool that includes the domains of psychological well-being,

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