http://dx.doi.org/10.5664/jcsm.6898

JCSM
Journal of Clinical Sleep Medicine

SCIENTIFIC INVESTIGATIONS

The Incidence and Characterization of Globus Sensation, Dysphagia, and Odynophagia Following Surgery for Obstructive Sleep Apnea

Masanari G. Kato, BS[1]; Mitchell J. Isaac, BS[1]; M. Boyd Gillespie, MD[2]; Ashli K. O'Rourke, MD[1]

[1]Department of Otolaryngology-Head and Neck Surgery, Medical University of South Carolina, Charleston, South Carolina; [2]Department of Otolaryngology-Head and Neck Surgery, University of Tennessee Health Science Center, Memphis, Tennessee

Study Objectives: To determine the incidence, duration, and predictors of swallowing-related symptoms following upper airway surgery for obstructive sleep apnea.

Methods: Adults (age 18 years or older) who underwent surgery for obstructive sleep apnea at a tertiary care institution from January 2012 to December 2015 were retrospectively reviewed. The incidence, duration, and associated factors of postoperative swallowing complaints were evaluated.

Results: A total of 130 patients (135 surgical encounters) met criteria for inclusion. There were 91 men (70.0%) and 39 women (30.0%) with a median age of 60 years (range: 19–79). Presurgical diagnosis of gastroesophageal reflux disease was present in 57 patients (43.8%). An average of 2.1 procedures (± 0.8) were conducted at each encounter. Uvulopalatopharyngoplasty (54.8%) was the most common followed by radiofrequency ablation of the soft palate (34.8%) and tongue base (29.6%). Postoperatively, 25 patients (19.8%) complained of dysphagia, 14 (10.9%) of globus, and 9 (6.7%) of odynophagia. Preoperative gastroesophageal reflux (odds ratio [OR] 4.09, 95% confidence interval [CI] 1.41–11.91) and hyoid myotomy with suspension (OR 4.88, 95% CI 1.34–17.77) were significant predictors for dysphagia. Radiofrequency ablation of the tongue base (OR 5.00, 95% CI 1.28–19.50) was a predictor for globus sensation. Median symptom durations, in months, were 4.0 for dysphagia, 7.3 for globus, and 3.0 for odynophagia.

Conclusions: Preoperative gastroesophageal reflux and hyoid myotomy with suspension procedure were associated with postoperative dysphagia whereas radiofrequency ablation of the tongue base was associated with globus. These findings can assist surgeons in providing preoperative counseling and postoperative supportive measures regarding dysphagic symptoms following sleep surgery.

Keywords: obstructive sleep apnea, surgical treatment of obstructive sleep apnea, reflux, swallowing/dysphagia

Citation: Kato MG, Isaac MJ, Gillespie MB, O'Rourke AK. The incidence and characterization of globus sensation, dysphagia, and odynophagia following surgery for obstructive sleep apnea. *J Clin Sleep Med.* 2018;14(1):127–132.

BRIEF SUMMARY

Current Knowledge/Study Rationale: Long-term swallowing complications following single-level surgery to treat obstructive sleep apnea are reported as frequent. Yet, studies have not investigated this topic in the context of multilevel surgery despite an increasing trend in this approach.

Study Impact: Subsequently, this study sought to characterize the incidence of and identify predictors for the development of subjective postoperative swallowing symptoms in patients with obstructive sleep apnea undergoing multilevel surgery. This initial investigation aims to gain further insight as a means to improve current preoperative and postoperative management of patients undergoing such surgeries.

INTRODUCTION

Obstructive sleep apnea (OSA) is a relatively common but frequently underdiagnosed condition, with prevalence among adults reported between 2% and 17%.[1–5] The condition is significantly higher in patients of older age, male sex, and increased body mass index (BMI).[2–4] As a result of accelerating rates of obesity and an aging population in the United States, the prevalence of OSA is expected to grow.[1,4] OSA has recently gathered widespread attention due to studies identifying its strong association with hypertension, cardiovascular disease, diabetes mellitus, depression, and other morbidities.[6–8]

The diagnosis of OSA is determined by polysomnography with its severity measured by the average number of apneas and hypopneas per hour of sleep (apnea-hypopnea index; AHI). Treatment is typically offered to symptomatic patients with AHI scores between 5 and 15 events/h, and to all patients with scores > 15 events/h. Continuous positive airway pressure (CPAP) is the recognized first-line treatment for moderate to severe OSA (AHI ≥ 15 events/h) with upper airway surgery reserved for failure of CPAP and other conservative therapies. A wide range of procedures are used to remodel the airway at points of collapse and obstruction, including uvulopalatopharyngoplasty (UPPP), hyoid myotomy with suspension (HMS), radiofrequency ablation (RFA) of the tongue and/or soft palate, and tonsillectomy.[8] Additional procedures may include tongue base suspension (TBS), septoplasty, rhinoplasty, turbinate reduction, hypoglossal nerve stimulator implantation, and pillar procedures. The increasing number of surgical procedures to treat OSA is a reflection of the heterogeneous nature of the disorder and the importance of addressing multiple levels of airway compromise. However, surgeons must balance the aggressiveness of the surgery with the severity of the disorder, as well as tailor treatments to individual patient preference. The general acceptance of this approach has led to increased reliance on multilevel procedures that target different anatomic levels of the upper airway.[9]

Although the effectiveness of surgery continues to be examined with rigor,[9] characterizing postoperative complications is of equal importance. The literature on this topic primarily focuses on the immediate postoperative course and examines rates of death, hemorrhage, and infection.[10,11] The incidence of long-term postoperative complications, such as dysphagia, have been cited as frequent, but studies are sparse and largely limited to single or set combinations of procedures.[12–24] For example, a systematic review by Franklin et al. in 2009 revealed that 58% of patients who underwent UPPP experienced persistent side effects, with dysphagia being most common at 31%.[25] Altman et al. reported a 60% dysphagia rate following UPPP with HMS.[12] These studies, however, may not be generalizable to the current heterogeneous nature of multilevel sleep surgery.

Therefore, as the first known study to consider a surgically heterogeneous cohort of OSA cases, the current study aims to address the aforementioned gaps in the literature, raise awareness of the effects of OSA surgery on swallowing, and serve as a starting point for future studies on this topic. To accomplish this, this investigation aims to characterize the long-term postoperative course of swallowing symptoms regarding incidence and duration, as well as to identify potential predictors for their occurrence in the setting of varied multilevel surgery. The study expects to provide insight on ways to improve preoperative counseling and postoperative management of swallowing dysfunction in patients undergoing upper airway surgery for OSA.

METHODS

This study was approved by the institutional review board at the Medical University of South Carolina (MUSC). Electronic medical records (Epic Systems Corporation, Verona, Wisconsin, United States) were retrospectively reviewed for individuals with OSA who had undergone OSA-related surgeries between January 1, 2012 and December 30, 2015. Patient demographics, surgical procedures, and postoperative symptoms were recorded.

Inclusion and Exclusion Criteria

The current study included all surgical encounters of adult patients (age 18 years or older) with ICD-9 and ICD-10 codes for sleep apnea as either primary and/or component diagnosis (327.23, 780.53, 780.57, and G47.33), in whom surgery was performed by an experienced sleep surgeon (MBG), with service codes for OSA-related procedures (21199, 21685, 30465, 30520, 30802, 31600, 41120, 41530, 41512, 42140, 42145, 42299, 42826, 42870, 64568, and 64999) over a period of 4 years. Patients of all BMIs were included. Patients with documented preoperative swallow disorders/diagnoses and encounters with incomplete surgical data were excluded. Of note, the former criteria for exclusion should be recognized as distinct from cases with only subjective complaints of globus, odynophagia, or dysphagia, which were included in the initial sample. Patients who underwent procedures limited to the nasal anatomy were excluded from the study.

Data Collection

In addition to collecting diagnosis and service codes, charts were reviewed for variables including patient age at surgery, sex, comorbidities, BMI, smoking status, types of surgeries, preoperative AHI, preoperative swallowing symptoms, postoperative swallowing symptoms, duration of postoperative swallow symptoms, and follow-up visits. Smoking status was categorized as current, former, or nonsmoker. Follow-up duration was calculated from the date of surgery to last visit with an otolaryngology provider at MUSC. Preoperative gastroesophageal reflux disease (GERD) was determined by documented diagnosis and/or use of antacid or antireflux medications.

Procedure descriptions were reviewed to determine the frequencies and combinations of surgery types performed. This yielded the following procedure categories: UPPP, RFA of the tongue base, RFA of the soft palate, HMS, TBS, lingual tonsillectomy, partial glossectomy, hypoglossal nerve stimulator implantation, palatine tonsillectomy, epiglottectomy, and others. The "others" category included procedures that were performed fewer than five times: adenoidectomy, tracheostomy, uvulectomy, and pillar implantation. UPPP procedures were further categorized by level of uvula preservation and HMS procedures were categorized as either hyomandibular or hyothyroid suspension.

Any swallow-related complaints, including those raised from direct physician inquiry, were recorded preoperatively and postoperatively, and subsequently categorized as dysphagia, globus, or odynophagia. Symptoms of dysphagia included having sensation of food sticking in throat, regurgitating food from throat, difficulty initiating swallowing, and coughing and choking when eating. Globus was defined as feeling of a foreign body in the throat during or between swallows. Last, odynophagia was recorded if a patient had pain when swallowing longer than 2 weeks postoperatively to avoid including patients with expected postoperative pain. Symptom duration was determined from date of surgery to last encounter with an otolaryngology provider who either documented no swallowing-related complaints or resolution of symptoms. Patients with the complaint of a symptom preoperatively were excluded from the analyses.

Statistics

Data were imported into SPSS 24 (IBM Corp., Armonk, New York, United States) for analysis. Categorical variables are presented as frequencies and percentages whereas continuous variables are presented as medians with ranges or means with standard deviations. Univariate and multivariable analyses were conducted to determine associations between patient characteristics and procedure type to newly developed postoperative swallow symptoms. Univariate analysis was conducted by Pearson correlation for continuous variables including age, AHI, and BMI, and Spearman correlations for categorical variables including preoperative GERD and smoking status.

Multivariable binary logistical regression included all patient-related variables with significant correlations defined by $P > .10$ to any postoperative symptom development and all procedures with a frequency of more than 20 that were considered clinically relevant for developing postoperative swallow symptoms. Moreover, any symptom with fewer than 10 occurrences was not included in this analysis to preserve statistical integrity. Results of this analysis are presented as odds ratios (ORs) with 95% confidence intervals (CIs) to express the odds of developing postoperative swallow symptoms with the aforementioned variables as potential predictive factors.

RESULTS

A total of 130 patients (135 surgical encounters) met criteria for inclusion. There were 91 men (70.0%) and 39 women (30.0%) with a median age of 60 years (range: 19–79). The average BMI was 31.9 ± 7.0 kg/m^2 and almost half of patients had a preoperative GERD diagnosis (57; 43.8%). Nearly one-third of all patients (33.8%) were either current or former smokers. The average follow-up duration per encounter was 291.3 ± 269.6 days. Baseline data are detailed in **Table 1**.

Procedure Data

An average of 2.1 ± 0.8 nonnasal procedures were performed at each encounter, with the most common being UPPP (54.8%), followed by RFA of the soft palate (34.8%), RFA of the tongue base (29.6%), and HMS (20.7%). Procedure frequencies and number of procedures associated with the development of swallow symptoms are presented in **Table 2**. UPPP and HMS procedures were further examined for surgical technique. Most UPPP cases were uvula nonsparing (83.8%) and HMS cases were overwhelmingly hyomandibular (96.6%). Detailed rates are outlined in **Table 3**.

Stratifying encounters by number of nonnasal procedures produced cohorts of comparable sample sizes. Nearly one-fourth (22.2%) of encounters were single procedures, about half (46.7%) consisted of 2 procedures, and the remaining had 3 or more procedures (31%). Procedures most commonly conducted singly were UPPP (40.0%) followed by hypoglossal nerve stimulation implantation (33.3%). Procedures that were most frequently conducted in combination were UPPP (59.0%), followed by RFA of the soft palate (44.8%), TBS (37.1%), and lingual tonsillectomy (31.4%).

Postoperative Swallowing Symptom Incidence and Duration

Preoperative symptoms were present in 9 encounters for dysphagia, 6 for globus, and 1 for odynophagia. Thus, these encounters were excluded from rate calculations of their respective symptoms. Among the remaining encounters, 25 (19.8%) reported the new onset of dysphagia, 14 (10.9%) with globus, and 9 (6.7%) with odynophagia. These symptomatic patients were represented by a total of 37 unique patients. All 3 symptoms developed in 2 patients, whereas 2 symptoms developed in 7 patients. Among newly developed dysphagia, detailed characteristics were available for 15 of 25 patients as

Table 1—Demographics and patient characteristics.

Age, years, median (range)	60 (19–79)
Sex, n (%)	
Male	91 (70.0)
Female	39 (30.0)
BMI, kg/m^2, mean ± SD	31.9 ± 7.0
AHI, events/h	37.0 ± 29.8
Preoperative GERD, n (%)	57 (43.8)
Smoking status, n (%)	
Current	9 (6.9)
Former	35 (26.9)
Nonsmoker	85 (65.4)
Follow-up per ENC, days, mean ± SD	291.3 ± 269.6

AHI = apnea-hypopnea index, BMI = body mass index, ENC = encounter, GERD = gastroesophageal reflux disease, SD = standard deviation.

Table 2—Nonnasal procedure frequencies and rates of new symptom development.

Surgery	Total Performed	ENCs Included, %	Procedures Associated With Symptoms, n (%)		
			Dysphagia	Globus	Odynophagia
Uvulopalatopharyngoplasty	74	54.8	17 (25.4)	7 (10.0)	5 (6.8)
Radiofrequency ablation of soft palate	47	34.8	4 (8.7)	6 (13.3)	4 (8.7)
Radiofrequency ablation of tongue base	40	29.6	7 (17.9)	9 (23.6)	4 (10.0)
Lingual tonsillectomy	34	25.2	5 (16.1)	4 (12.5)	1 (3.0)
Hyoid myotomy with suspension	29	21.5	11 (40.7)	1 (3.4)	1 (3.4)
Tongue base suspension	25	18.5	8 (34.8)	4 (16.0)	4 (16.0)
Glossectomy, partial	11	8.1	3 (30.0)	0 (0.0)	1 (9.1)
Hypoglossal nerve stimulator implantation	10	7.4	1 (10.0)	0 (0.0)	0 (0.0)
Palatine tonsillectomy	6	4.4	1 (16.7)	1 (16.7)	0 (0.0)
Epiglottectomy	5	3.7	1 (20.0)	0 (0.0)	0 (0.0)
Others	6	4.4	0 (0.0)	0 (0.0)	0 (0.0)
Total nonnasal procedures per ENC, mean ± SD	2.1 ± 0.8	–	–	–	–

ENC = encounter, SD = standard deviation.

follows, from most to least frequent: choking (6 of 15; 40.0%), coughing with eating (6 of 15; 40.0%), food sticking (4 of 15; 26.7%), nasal regurgitation (4 of 15; 26.7%), laryngopharyngeal reflux/regurgitation (2 of 15; 8.0%), and difficulty initiating swallow (1 of 15; 6.7%).

By absolute numbers, newly developed dysphagia was most commonly seen with encounters that included UPPP (17 of 71; 25.4%), globus with RFA of the tongue base (9 of 38; 23.6%), and odynophagia with UPPP (5 of 71; 6.8%). When examining symptomatic patients, dysphagic patients most commonly had undergone UPPP (68.0%) or HMS (44.0%) whereas globus most frequently presented following RFA of the tongue base (64.2%) or UPPP (50.0%) and odynophagia after UPPP (55.6%), RFA of the soft palate (44.4%), RFA of the tongue base (44.4%), or TBS (44.4%).

The influence of the number of nonnasal procedures on swallow symptoms was evaluated by Spearman correlations. Although the rates of dysphagia were higher in cases with more than 1 procedure (11.1% versus 22.2%), correlation by increasing number of nonnasal procedures proved to be nonsignificant ($P > .05$). Similarly, globus (3.4% versus 13.0%) and odynophagia (6.7% versus 9.6%) were increased in cases with more than 1 procedure, yet correlations were nonsignificant.

Regarding symptom duration, 4 patients with dysphagia (22.2%) were symptomatic beyond 6 months and none beyond 12 months. Globus persisted in 6 patients (66.7%) at 6 months and 3 patients (33.3%) at 12 months. Finally, odynophagia resolved in all patients by 6 months. Detailed postoperative courses of symptom resolution are presented in **Table 4**. Of note, 7 patients with dysphagia, 5 with globus, and 3 with odynophagia were lost to follow-up, and therefore excluded from calculations outlining symptom duration.

Predictors of Postoperative Swallowing Symptoms

BMI, GERD, and procedures including UPPP, RFA of the soft palate, RFA of the tongue base, HMS, TBS, and lingual tonsillectomy were included in multivariable binary logistical regression (**Table 5**). Significant predictors for dysphagia were GERD (OR 4.09, 95% CI 1.41–11.91) and HMS (OR 4.88, 95% CI 1.34–17.77), whereas RFA of the tongue base (OR 5.00, 95% CI 1.28–19.50) was significant for globus development. UPPP was not an independent predictor of either dysphagia (OR 1.73, 95% CI 0.55–5.41) or globus (OR 0.89, 95% CI 0.24–3.33).

Postoperative Modified Barium Swallow Evaluation

Postoperative modified barium swallows were conducted in 14 patients following a median duration of 46 days (range: 3–1,030 days). The most common reason to obtain a modified barium swallow was for persistence of dysphagia (9 of 14; 64.3%), nearly one-fourth (2 of 9) of whom had significant, associated weight loss. Of the remaining 4 cases, 1 patient was recognized to have clinically overt aspiration and the remaining 3

Table 3—Surgical techniques: uvulopalatopharyngoplasty and hyoid myotomy with suspension.

Surgery	Technique	n (%)
UPPP (n = 74)	Uvula nonsparing	62 (83.8)
	Uvula flap	10 (13.5)
	Uvula sparing	2 (2.7)
HMS (n = 29)	Hyomandibular	28 (96.6)
	Hyothyroid	1 (3.4)

HMS = hyoid myotomy with suspension, UPPP = uvulopalatopharyngoplasty.

Table 4—Incidence of symptom development and rate of resolution.

Symptom	Associated ENCs, n (%)	Lost to FU, n (%)	No. Symptomatic at Time Point (months, postoperatively) 1	3	6	12	18	Duration, months, median (range)
Dysphagia	25 (19.8)	7 (28.0)	17/18	11/18	4/18	0/18	0/18	4.1 (1.0–10.8)
Globus	14 (10.9)	5 (35.7)	9/9	8/9	6/9	3/9	1/9	7.3 (2.3–32.5)
Odynophagia	9 (6.7)	3 (33.3)	5/6	2/6	0/6	0/6	0/6	3.0 (0.5–4.8)

ENC = encounter, FU = follow-up.

Table 5—Multivariable regression: predictors of postoperative swallow symptoms.

Variable	Dysphagia, OR (95% CI)	Globus, OR (95% CI)
Body mass index	1.05 (0.97–1.13)	1.03 (0.95–1.12)
Preoperative gastroesophageal reflux	4.09 (1.41–11.91)*	1.02 (0.28–3.64)
Uvulopalatopharyngoplasty	1.73 (0.55–5.41)	0.89 (0.24–3.33)
Radiofrequency ablation of soft palate	0.48 (0.12–2.01)	0.74 (0.17–3.13)
Radiofrequency ablation of tongue base	2.35 (0.64–8.61)	5.00 (1.28–19.50)*
Hyoid myotomy with suspension	4.88 (1.34–17.77)*	0.42 (0.04–4.19)
Tongue base suspension	2.24 (0.66–7.55)	2.09 (0.52–8.35)
Lingual tonsillectomy	0.52 (0.15–1.83)	1.72 (0.43–6.94)

* = statistically significant. CI = confidence interval, OR = odds ratio.

with undocumented/unknown reasons. Most procedures were completed for patients with newly developed symptoms, although fewer than half of such patients were evaluated overall (13 of 37, 32.4%). Of this evaluated cohort, most studies showed some degree of impairment in swallowing function (10 of 13, 76.9%). Aspiration was observed in 6 patients whereas the remaining displayed other impairments in oropharyngeal swallowing function.

DISCUSSION

The growing prevalence of OSA, along with recent advancements in multilevel surgical approaches, will likely increase the number of sleep surgeries performed.[9] Most previous studies have focused on the immediate postoperative complications of such procedures[10,11] and reports on long-term postprocedure morbidities have been limited.[12–24] The current study noted postoperative swallowing symptoms of dysphagia (18.5%), globus (10.3%), and odynophagia (6.7%). Interestingly, in the context of multivariable analysis of multilevel surgery, UPPP was not statistically predictive of any of these symptoms. Moreover, patients with preoperative GERD (OR 4.09, 95% CI 1.41–11.91) and individuals who had undergone HMS (OR 4.88, 95% CI 1.34–17.77) were significantly more likely to present with dysphagia, whereas patients who had received RFA of the tongue base (OR 5.00, 95% CI 1.28–19.50) were more likely to complain of globus. When observing time to resolution of these symptoms, postoperative dysphagia and globus persisted for longer durations (4.1 and 7.3 months, respectively) compared to odynophagia (3.0 months).

In the literature, dysphagia is the most frequently cited long-term complication following surgery for snoring and sleep apnea. Largely due to variable time frame of symptom assessment, its incidence has been reported between zero and 60%, with broad inconsistencies even within studies of isolated techniques.[12,15,16,20–22,24] The diversity in reported results may also reflect differences in surgical practice and patient selection. Among these studies, UPPP is the most commonly cited procedure to cause dysphagia, likely due to its prevalence in the management of OSA and lack of literature on other modalities. In the current cohort, the presence of dysphagia was less likely to be associated with UPPP compared to HMS (17 of 67, 25.4% versus 11 of 27, 40.7%). This difference was likewise observed on multivariable analysis that demonstrated the odds of dysphagia following HMS was nearly five times greater (OR 4.88) as compared to encounters without it, whereas UPPP remained nonsignificant. A similarly high incidence of 60% was reported by Altman et al. in 1999 in patients who underwent UPPP with staged or concurrent hyoid suspension without descriptions about the time-point of evaluation.[12] Whether this higher rate is due to an additive or synergistic effect with UPPP is uncertain. On the contrary, Neruntarat in 2003 noted transient dysphagia in only 3% of patients following genioglossus advancement with HMS.[20] Similarly, time points and methods of evaluation were not described. The mechanism of dysphagia following HMS is thought to result from restrictions in the anterior and superior displacement of the hyoid, altering swallowing function.[26] Thus, although preoperative counseling on dysphagia is warranted for all patients, there may be a stronger emphasis on patients who will undergo HMS.

Furthermore, the relationship between preoperative GERD and postoperative dysphagia is a novel concept that has not been explored. On multivariable analysis, in patients with preoperative GERD the development of postoperative dysphagia symptoms was four times more likely (OR 4.09). The authors hypothesize that such patients are prone to the exacerbation of reflux postoperatively, subsequently causing secondary dysphagia. However, further studies are necessary to define this relationship. These data suggest that attempts should be made to maximally manage GERD using diet and lifestyle modifications and/or medications prior to and following sleep surgery.

Globus is a common complaint in general, though less frequently reported as sequelae of sleep surgery. Its benign, yet often persistent nature, is a concern to many patients. A study by Rombaux et al. in 2003 compared globus rates at 6 weeks postoperatively revealing UPPP having a substantially higher incidence compared to laser-assisted uvulopalatoplasty (UPP) (23.5% and 13.3%, respectively) and RFA of the tongue base and/or soft palate (5.9%).[22] A later study by Lim et al. in 2007 reported globus rates 6 months postoperatively, showing laser-assisted UPP to have higher rates of globus compared to radiofrequency-assisted UPP (35% and 8.3%, respectively).[18] It is interesting to see that the occurrence was substantially higher in the latter study even though patients were assessed much later in their postoperative course. In our study, overall rates of globus were generally low at 10.9% compared to 23.6% of patients who underwent RFA of the tongue base. On multivariable analysis, undergoing RFA treatment of the tongue base increased the odds of the development of globus by fivefold (OR, 5.00) relative to other encounters. Studies have tied the development of globus to increased formation of postoperative scar tissue, which is the very mechanism of the procedure.[18] In addition, globus may be exacerbated by dry mucosal patches that are created by submucosal fibrosis. This would account for the magnitude of increase in odds seen in RFA that is absent in other procedures.

The primary limitation of this study is associated with its retrospective design. Subjective preoperative and postoperative symptoms were abstracted from electronic documentation without the aid of validated symptom metrics (eg, Eating Assessment Tool-10[27], Dysphagia Handicap Index[28]), and therefore the incidence of patient symptoms may be underreported. In addition, several patients were lost to follow-up, and thus were excluded from evaluations related to symptom duration. This may result in overestimation or underestimation of the resolution of symptoms. Furthermore, nonspecific data on GERD regimens limit quality insight on methods to improve its management and whether changes in management would indeed lower risks of developing postoperative swallowing complications. Furthermore, the current study was conducted at a single institution with cases performed by a single surgeon. The external validity of the results is not certain without comparative studies in the literature. Moreover, the heterogeneity of the procedures conducted may make generalizability of these data difficult.

CONCLUSIONS

This study identified patients with preoperative GERD and those who had undergone hyoid myotomy with suspension as having significantly increased odds of the development of dysphagia. Furthermore, patients receiving RFA of the tongue base were significantly more likely to complain of globus. In the modern era of multilevel, concurrent procedures to treat OSA, the characterization of swallowing-related outcomes can assist in proper preoperative counseling of patients as well as prompt clinicians to provide the adequate level of supportive measures in the postoperative period.

ABBREVIATIONS

AHI, apnea-hypopnea index
BMI, body mass index
CI, confidence interval
CPAP, continuous positive airway pressure
GERD, gastroesophageal reflux disease
HMS, hyoid myotomy suspension
OSA, obstructive sleep apnea
OR, odds ratio
RFA, radiofrequency ablation
TBS, tongue base suspension
UPP, uvulopharyngoplasty
UPPP, uvulopalatopharyngoplasty

REFERENCES

1. Peppard PE, Young T, Barnet JH, Palta M, Hagen EW, Hla KM. Increased prevalence of sleep-disordered breathing in adults. *Am J Epidemiol*. 2013;177(9):1006–1014.
2. Bixler EO, Vgontzas AN, Lin HM, et al. Prevalence of sleep-disordered breathing in women: effects of gender. *Am J Respir Crit Care Med*. 2001;163(3 Pt 1):608–613.
3. Bixler EO, Vgontzas AN, Ten Have T, Tyson K, Kales A. Effects of age on sleep apnea in men: I. Prevalence and severity. *Am J Respir Crit Care Med*. 1998;157(1):144–148.
4. Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. *N Engl J Med*. 1993;328(17):1230–1235.
5. Kapur V, Strohl KP, Redline S, Iber C, O'Connor G, Nieto J. Underdiagnosis of sleep apnea syndrome in U.S. communities. *Sleep Breath*. 2002;6(2):49–54.
6. Reichmuth KJ, Austin D, Skatrud JB, Young T. Association of sleep apnea and type II diabetes: a population-based study. *Am J Respir Crit Care Med*. 2005;172(12):1590–1595.
7. Peppard PE, Young T, Palta M, Skatrud J. Prospective study of the association between sleep-disordered breathing and hypertension. *N Engl J Med*. 2000;342(19):1378–1384.
8. Sharafkhaneh A, Giray N, Richardson P, Young T, Hirshkowitz M. Association of psychiatric disorders and sleep apnea in a large cohort. *Sleep*. 2005;28(11):1405–1411.
9. Lin HC, Friedman M, Chang HW, Gurpinar B. The efficacy of multilevel surgery of the upper airway in adults with obstructive sleep apnea/hypopnea syndrome. *Laryngoscope*. 2008;118(5):902–908.
10. Harmon JD, Morgan W, Chaudhary B. Sleep apnea: morbidity and mortality of surgical treatment. *South Med J*. 1989;82(2):161–164.
11. Kezirian EJ, Weaver EM, Yueh B, et al. Incidence of serious complications after uvulopalatopharyngoplasty. *Laryngoscope*. 2004;114(3):450–453.
12. Altman JS, Halpert RD, Mickelson SA, Senior BA. Effect of uvulopalatopharyngoplasty and genial and hyoid advancement on swallowing in patients with obstructive sleep apnea syndrome. *Otolaryngol Head Neck Surg*. 1999;120(4):454–457.
13. den Herder C, Kox D, van Tinteren H, de Vries N. Bipolar radiofrequency induced thermotherapy of the tongue base: Its complications, acceptance and effectiveness under local anesthesia. *Eur Arch Otorhinolaryngol*. 2006;263(11):1031–1040.
14. Friedman M, Ibrahim H, Lowenthal S, Ramakrishnan V, Joseph NJ. Uvulopalatoplasty (UP2): a modified technique for selected patients. *Laryngoscope*. 2004;114(3):441–449.
15. Jaghagen EL, Berggren D, Dahlqvist A, Isberg A. Prediction and risk of dysphagia after uvulopalatopharyngoplasty and uvulopalatoplasty. *Acta Otolaryngol*. 2004;124(10):1197–1203.
16. Levring-Jaghagen E, Nilsson ME, Isberg A. Persisting dysphagia after uvulopalatoplasty performed with steel scalpel. *Laryngoscope*. 1999;109(1):86–90.
17. Li KK, Powell NB, Riley RW, Guilleminault C. Temperature-controlled radiofrequency tongue base reduction for sleep-disordered breathing: long-term outcomes. *Otolaryngol Head Neck Surg*. 2002;127(3):230–234.
18. Lim DJ, Kang SH, Kim BH, Kim HG. Treatment of primary snoring using radiofrequency-assisted uvulopalatoplasty. *Eur Arch Otorhinolaryngol*. 2007;264(7):761–767.
19. Lundkvist K, Friberg D. Pharyngeal disturbances in OSAS patients before and 1 year after UPPP. *Acta Otolaryngol*. 2010;130(12):1399–1405.
20. Neruntarat C. Genioglossus advancement and hyoid myotomy under local anesthesia. *Otolaryngol. Head Neck Surg*. 2003;129(1):85–91.
21. Rohrer JW, Eller R, Santillan PG, Barrera JE. Geniotubercle advancement with a uvulopalatal flap and its effect on swallow function in obstructive sleep apnea. *Laryngoscope*. 2015;125(3):758–761.
22. Rombaux P, Hamoir M, Bertrand B, Aubert G, Liistro G, Rodenstein D. Postoperative pain and side effects after uvulopalatopharyngoplasty, laser-assisted uvulopalatoplasty, and radiofrequency tissue volume reduction in primary snoring. *Laryngoscope*. 2003;113(12):2169–2173.
23. Sorrenti G, Piccin O, Mondini S, Ceroni AR. One-phase management of severe obstructive sleep apnea: tongue base reduction with hyoepiglottoplasty plus uvulopalatopharyngoplasty. *Otolaryngol Head Neck Surg*. 2006;135(6):906–910.
24. Stuck BA, Starzak K, Verse T, Hormann K, Maurer JT. Complications of temperature-controlled radiofrequency volumetric tissue reduction for sleep-disordered breathing. *Acta Otolaryngol*. 2003;123(4):532–535.
25. Franklin KA, Anttila H, Axelsson S, et al. Effects and side-effects of surgery for snoring and obstructive sleep apnea--a systematic review. *Sleep*. 2009;32(1):27–36.
26. Steele CM, Bailey GL, Chau T, et al. The relationship between hyoid and laryngeal displacement and swallowing impairment. *Clin Otolaryngol*. 2011;36(1):30–36.
27. Belafsky PC, Mouadeb DA, Rees CJ, et al. Validity and reliability of the Eating Assessment Tool (EAT-10). *Ann Otol Rhinol Laryngol*. 2008;117(12):919–924.
28. Silbergleit AK, Schultz L, Jacobson BH, Beardsley T, Johnson AF. The Dysphagia handicap index: development and validation. *Dysphagia*. 2012;27(1):46–52.

SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication May 11, 2017
Submitted in final revised form August 16, 2017
Accepted for publication October 11, 2017
Address correspondence to: Ashli K. O'Rourke, MD, Medical University of South Carolina, Department of Otolaryngology-Head and Neck Surgery, 135 Rutledge Ave, MSC 550, Charleston, SC 29425; Email: aorourke@musc.edu

DISCLOSURE STATEMENT

The authors report no conflicts of interest.