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ORIGINAL RESEARCH

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Examining readmissions following outpatient microlaryngeal surgery

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Abstract

Objective: The objective of this study was to examine readmissions following microlaryngeal surgery. It was hypothesized that airway surgical procedures would have higher rates of readmission.

Design: Retrospective review.

Methods: Outpatient microlaryngeal surgeries from May 1, 2018 to November 27, 2022 were reviewed. Readmissions related to the original surgery within a 30-day postoperative period were examined. Patient demographics, body mass index, American Society of Anesthesiologist class, comorbidities, type of surgery, ventilation techniques, and operative times were examined and compared.

Results: Out of 480 procedures analyzed, 19 (4.0%) resulted in a readmission, 9 (1.9%) of which were for glottic stenosis management. Undergoing an airway procedure was significantly associated with a readmission ($p = .002$) and increased the odds of readmission by 5.99 (95% confidence interval [CI]: 2.22–16.16, $p < .001$). Current/former smoking status increased the odds of readmission by 4.50 (95% CI: 1.33–15.19, $p = .016$). Each additional minute of operating time increased the odds of readmission by 1.03 (95% CI: 1.00–1.05, $p = .04$).

Conclusion: Readmissions from microlaryngeal surgery are seldom reported but nonetheless occur. Identifying factors that may place a procedure at risk for readmission can help improve surgical quality of care.

Level of Evidence: 4.

KEYWORDS
microlaryngeal surgery, outpatient, readmissions, ventilation

1 | INTRODUCTION

Microlaryngeal surgery is generally considered ambulatory or "same day" surgery where serious complications in the postoperative period are rare.[1] However, as many as 66% report some complaints; mainly a sore throat and tongue-related complications following surgery for voice disorders.[2] When microlaryngeal surgeries encompass airway surgeries, the severity of postoperative concerns rise to include postoperative airway obstruction, reintubation, and postoperative mucosal hemorrhage and edema.[3,4] Cardiac complications must also be considered in 1.9%–6.8% of cases.[5]

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Yet, literature on readmissions following microlaryngeal surgery primarily focuses on children and those with neoplasms.[6–11] In a study examining the rates and causes of 30-day readmission and emergency room utilization following 1281 head and neck surgery cases, the authors report inpatient readmission and ED utilization rates of 3.20% and 8.43% respectively.[12] However, microlaryngeal surgeries were excluded. At the time of manuscript drafting, only three current studies were found directly examining adult outpatient laryngeal surgery readmissions utilizing several medical literature search engines (PubMed, Cochrane, Ovid MEDLINE, Google Scholar) only one of which examined microlaryngeal surgery.[13–15] As such, the purpose of this study was to examine readmissions within a 30-day period following outpatient adult microlaryngeal surgeries to contribute to the existing body of literature. Secondary outcomes of interest included whether patient characteristics or health history were predictors of readmission. It was hypothesized that airway surgical procedures would result in higher rates of readmission.

2 | METHODS

The Lehigh Valley Health Network's Institutional Review Board approved this study. Retrospective chart review of all patients undergoing surgery by a single fellowship-trained laryngologist between May 1, 2018, and November 27, 2022 were extracted (523 procedures). Four-hundred-eighty procedures met inclusion criteria. The population included only outpatient direct microlaryngoscopies. Outpatient surgery was defined as cases where the patient undergoes surgery and is discharged the same day within a few hours of completion of the procedure. This encompassed microflap excision of lesions, laryngeal injections (including steroid and injection augmentation), endoscopic resection of scar, endoscopic supraglottic procedures (arytenoidectomy and biopsy), endoscopic vocal cordotomies and endoscopic dilations of subglottic and tracheal stenoses. Patients under age 18 and those that underwent laryngeal framework surgeries were excluded. Patients who had tracheotomy performed at the same time as microlaryngeal surgery were excluded as well. Procedures that were lost to follow-up were also excluded. "Lost to follow-up" was defined as no patient care records both within the division or within the "Care Everywhere" function in EPIC® following surgery.

Demographic data (age and gender), body mass index (BMI), smoking status, respiratory disease (asthma, chronic obstructive pulmonary disease, emphysema, and lung disease), cardiac disease (hypertension, coronary artery disease, heart disease, aortic disease, and heart failure), American Society of Anesthesiologists (ASA) physical status classification, surgery type (airway or voice), method of surgical ventilation and total operative times were recorded. Type of surgery was determined based on the primary goal for undergoing surgery. Overarching patient concern or complaint was considered as well to categorize.

The primary outcome of interest was readmission within 30 days of the procedure. If a patient required unplanned admission following successful completion of surgery, this was captured as a "readmission." Procedures that resulted in an urgent care visit, inpatient admission, or emergency room assessment within a 30-day postoperative period were extracted and the associated charts reviewed in detail to examine the reason for readmission, relevant testing, work-up and treatment. The "Care Everywhere" function in EPIC® was utilized to capture out-of-network visits/admissions as well. Secondary outcomes included assessing whether type of surgery, past medical history, ASA class, or operative time increased risk for readmission.

2.1 | Biostatistical analysis

The data for this study was collected and managed using REDCap (Research Electronic Data Capture)[16,17] hosted at Lehigh Valley Health Network and data analysis was performed by a biostatistician. Descriptive statistics were generated to summarize the demographic and clinical characteristics of the sample. Categorical variables were summarized using frequency and percentage. Continuous variables were described using the mean and standard deviation (*SD*) when data were normally distributed and the median and interquartile range (IQR) when data were skewed. Skewness was assessed using the skewness statistic, standard error of skew, and visual inspection of histograms.

The entire sample was then split based on whether the patient experienced a related readmission within 30 days of surgery. Bivariate comparisons of categorical variables were made using the Chi-square test or the Fisher's exact test. Bivariate comparisons of continuous variables were made using the independent samples *t*-test or Mann–Whitney *U*-test. Simple and multivariable logistic regression models were used to determine the effects of any variables that were found to be associated at the $p \leq .25$ level with whether the procedure resulted in a related readmission. ASA class was omitted due to inadequate number of procedures in each individual class category resulting in quasi-complete separation of the model. Similarly, the type of procedure was analyzed as a binary variable due to the small sample size in each individual category. Additionally, to avoid multicollinearity, both versions of type of procedure (binary and categorical) were not included in the model. Smoking status had to be collapsed into a binary variable (never/passive vs. current/former) to avoid quasi-complete separation as well. All model assumptions were checked, and alpha was set to 0.05 for all analyses. SAS version 9.4 (Cary, NC, USA) was used to conduct statistical analysis.

3 | RESULTS

A total of 480 procedures met inclusion criteria. The average age was 55.5 years (*SD*: 16.6). The sample was majority female (55.6%), never-smokers (46.5%) with a history of cardiovascular disease (63.1%). Table 1 describes the sample characteristics as a whole and based on readmission status. The majority (75.4%) of the procedures were voice-based with the most common procedure being laryngeal

TABLE 1 Demographics and past medical history overall and by groups based on readmission related to procedure ($n = 480$).

	Entire sample ($n = 480$)	Readmission related to procedure ($n = 19$)	No readmission related to procedure ($n = 461$)	p value
Age (years), mean ± *SD*	55.47 ± 16.62	59.89 ± 15.98	55.29 ± 16.64	.24[a]
Gender, *n* (%)				.84[b]
Male	213 (44.38)	8 (42.11)	205 (44.47)	
Female	267 (55.63)	11 (57.89)	256 (55.53)	
BMI, mean ± *SD*	30.21 ± 6.77	29.49 ± 5.55	30.24 ± 6.82	.63[a]
Smoking status, *n* (%)				**.003**[c]
No (never smoked)	223 (46.46)	4 (21.05)	219 (47.51)	
Yes (currently smokes)	71 (14.79)	0	71 (15.40)	
Former	182 (37.92)	15 (78.95)	167 (36.23)	
Passive	4 (0.83)	0	4 (0.87)	
PMH type, *n* (%)				
Resp disease	223 (46.46)	13 (68.42)	210 (45.55)	.05[b]
Cardio disease	303 (63.13)	17 (89.47)	286 (62.04)	**.015**[b]
ASA class, *n* (%)				**<.001**[c]
Normal (I)	6 (1.25)	0	6 (1.30)	
Mild systemic (II)	168 (35)	0	168 (36.44)	
Severe systemic (III)	251 (52.29)	13 (68.42)	238 (51.63)	
Constant life threat (IV)	55 (11.46)	6 (31.58)	49 (10.63)	
Type of procedure (binary), *n* (%)				**.002**[c]
Voice-based	362 (75.42)	8 (42.11)	354 (76.79)	
Airway stenosis	118 (24.58)	11 (57.89)	107 (23.21)	
Type of procedure, *n* (%)				**.006**[c]
DML explorative	4 (0.83)	1 (5.26)	3 (0.65)	
DML microflap/excision	292 (60.83)	10 (52.63)	282 (61.17)	
DML cordotomy	28 (5.83)	5 (26.32)	23 (4.99)	
DML vocal cord injection	106 (22.08)	3 (15.79)	103 (22.34)	
DML subglottic/tracheal stenosis	47 (9.79)	0	47 (10.20)	
DML fat injection	3 (0.63)	0	3 (0.65)	
Ventilation mode, *n (%)*				.30[c]
Endotracheal/tracheal	103 (21.46)	5 (26.32)	98 (21.26)	
AAIV	101 (21.04)	6 (31.58)	95 (20.61)	
Apnea	276 (57.50)	8 (42.11)	268 (58.13)	
OR time (min), median (IQR)	14 (7–21)	17 (10–27)	13 (7–21)	.12[d]

Note: Statistically significant *p*-values are in bold at the .25 level.

Abbreviations: AAIV, Apneic Anesthesia with Intermittent Ventilation; ASA Class, American Society of Anesthesiologists Classification; BMI, body mass index; Cardio, cardiovascular; DML, direct microlaryngoscopy; IQR, interquartile range; OR, operating room; PMH, past medical history; Resp, respiratory; *SD*, standard deviation.

[a]*p*-value generated using the independent sample *t*-test.

[b]*p*-value generated using the chi-square test of independence.

[c]*p*-value generated using the Fisher's exact test.

[d]*p*-value generated using the Mann–Whitney *U*-test.

microflap excisions (60.8%). More than half (57.5%) of the procedures were performed fully apneic (no endotracheal intubation).

Nineteen procedures (4.0%) resulted in a readmission due to a complaint related to the original surgery. Thirty procedures were readmitted for conditions deemed to not be related to the original surgery. There was one mortality following a voice procedure for a long-term tracheotomy dependent glottic stenosis patient related to the surgical condition. Table 2 examines the 19 readmitted cases with relevant case and historical details. It was found that 10 (52.6%) of procedures that required readmission carried a diagnosis of airway stenosis

TABLE 2 Details of cases that led to a readmission.

Obs	Description	PMHx	Reason/Dx	Procedure and readmission details
15	68 y/o F Former smoker	BMI = 22.5 +Cardiac	Voice change Dx: SCCa supraglottis	DML microflap biopsy, intubated, 23 min POD#20 returned for scheduled cancer treatment: supraglottectomy
39	80 y/o F Former smoker	BMI = 32.4 +Cardiac +Resp	Airway Obstruction Dx: SCCa larynx	DML biopsy with debulking of tumor, AAIV, 17 min POD#8 POD#10 and #23 Returned to ER for cough, progression of laryngeal SCCa
47	97 y/o F Never smoker	BMI = 28.0 +Cardiac	Airway obstruction Dx: Laryngeal schwannoma	DML coblator excision, AAIV, 73 min POD#5 ER with bleeding, +Eliquis
59	63 y/o M Never smoker	BMI = 33.5 +Cardiac	Airway Dx: Glottic stenosis	DML COBLATOR CORDotomy, apnea, 25 min PACU bleeding and SOB (trach placed)
90	56 y/o M Former smoker	BMI = 35.5 +Cardiac	Airway Dx: Glottic stenosis	DML lysis of posterior glottic scar and removal of granuloma, AAIV, 21 min POD#14 Returned for planned tracheotomy (after office discussion) for persistent SOB
108	64 y/o F Former smoker	BMI = 21.6 +Cardiac +Resp	Airway Dx: Glottic stenosis	DML removal of posterior glottic granuloma, apnea, 5 min POD#20 ER for SOB, progression of glottic stenosis
202	52 y/o F Former smoker	BMI = 31.4 +Cardiac +Resp	Voice Dx: Vocal fold leukoplakia	DML microflap excision, intubated, 12 min POD#1 ER pain, nausea/vomiting, tasting blood but not seeing any blood
207	51 y/o F Former smoker	BMI = 32.7 +Cardiac +Resp	Voice Dx: Left vocal fold paresis	DML vocal fold injection (hyaluronic acid), apnea, 4 min POD#7 ER Sublingual neck swelling
267	67 y/o M Former smoker	BMI = 34.3 +Cardiac +Resp	Voice Dx: Vocal Fold Atrophy	DML bilateral vocal fold injection (hyaluronic acid), Apnea, 10 min POD#3 Throat discomfort, SOB, sensitivity to injectable
277	54 y/o F Former smoker	BMI = 40.6 +Resp +Small cell lung cancer +Langerhans Histiocytosis	Airway Dx: Subglottic Granuloma	DML excision of subglottic granuloma, apnea, 5 min POD#19 hemoptysis, admitted for observation, no significant bleeding
289	47 y/o F Former smoker	BMI = 21.4 +Cardiac +Resp	Airway Dx: Glottic stenosis	DML B/L coblator cordotomies, AAIV, 14 min POD#3 ER SOB (adamantly against tracheotomy)
290	47 y/o F Former smoker	BMI = 22.0 +Cardiac +Resp	Airway Dx: Glottic stenosis	DML repeat right coblator cordotomy, AAIV, 13 min POD#5 and POD#8 and POD#26 ER SOB (adamantly against tracheotomy)
294	61 y/o M Never smoker	BMI = 31.4 +Cardiac +Resp +Tracheotomy +33.75% TBSA Burn	Voice Dx: Aphonia, Tracheotomy Dependent Complete Glottic Stenosis	DML partial cordotomy, patient had fused glottis due to high-riding tracheotomy; procedure was done to regain some glottic patency for voice, Intubated, 56 min POD#0 Enroute home Sudden SOB, trach dislodgement witnessed PEA, STEMI, Anoxic brain injury, death
299	36 y/o F Former smoker	BMI = 25.0 +Cardiac +Resp	Voice Dx: Right vocal fold paralysis	DML vocal fold injection, apnea, 2 min POD#17 ER Dyspnea, laryngospasm
324	77 y/o M Former smoker	BMI = 25.0 +Cardiac +Resp	Voice Dx: Leukoplakia of epiglottis and arytenoid	DML biopsy of leukoplakic lesions, apnea, 15 min ER POD#0 coughed up two small clots of blood, scope revealed no active bleeding

(Continues)

TABLE 2 (Continued)

Obs	Description	PMHx	Reason/Dx	Procedure and readmission details
336	25 y/o M Former smoker	BMI = 29.0 +Tracheotomy +Traumatic Brain Injury	Voice Dx: Aphonia, tracheotomy dependent complete glottic stenosis	DML Excision of subglottic granulation tissue, intubated, 42 min POD#1 Ambulance to ER due to bloody mucous plug blocking the distal lumen of tracheostomy tube
342	64 y/o M Former smoker	BMI = 33.5 +Cardiac +Resp +Tracheotomy + chronic variceal bleeding	Airway Dx: Tracheotomy dependent glottic stenosis	DML exploration for tracheal bleeding, intubated, 47 min POD#24 ER St Luke's w/cough, and occasional blood clots in trach
345	63 y/o M Former smoker	BMI = 34.5 +Cardiac	Airway Dx: Glottic stenosis	DML coblator cordotomy, apnea, 27 min POD#0 ER shortness of breath, edema
446	66 y/o F Never smoker	BMI = 26.0 +Cardiac +Resp	Airway Dx: supraglottic stenosis, sarcoidosis	DML right supraglottoplasty, right arytenoidectomy, AAIV, 24 min POD#8 ER visit for pain

Abbreviations: AAIV, apneic anesthesia with intermittent (endotracheal) ventilation; B/L, bilateral; BMI, body mass index; DML, direct microlaryngoscopy; Dx, diagnosis; ER, emergency room; F, female; M, male; min, minutes; PMHx, past medical history; POD, postoperative day; Resp, respiratory; SCCa, squamous cell carcinoma; SOB, shortness of breath; PEA, pulseless electrical activity; STEMI, ST-elevation myocardial infarction.

TABLE 3 Crude and adjusted odds ratios for the occurrence of readmission related to surgery ($n = 480$).

	Crude OR	95% CI	*p*-value	Adjusted OR	95% CI	*p*-value
Type of procedure (binary) (ref = voice-based)						
Airway stenosis	4.55	1.78–11.60	***.002***	5.99	2.22–16.16	***<.001***
Smoking status (ref = never/passive)						
Current/former	3.51	1.15–10.74	***.03***	4.50	1.33–15.19	***.016***
PMH cardio (ref = no)						
Yes	5.20	1.19–22.78	***.03***	4.18	0.87–20.12	*.07*
PMH resp (ref = no)						
Yes	2.59	0.97–6.93	*.06*	1.76	0.61–5.04	*.29*
Age (years)	1.02	0.99–1.05	*.24*	1.00	0.96–1.04	*.98*
OR time (min)	1.02	1.00–1.05	***.04***	1.03	1.00–1.05	***.04***

Note: *p*-values in bold are statistically significant at the .05 level.
Abbreviations: Cardio, cardiovascular; CI, confidence interval; OR, odds ratio; PMH, past medical history; ref, reference; Resp, respiratory.

(9 glottic stenosis, 1 supraglottic stenosis). Five of these were cordotomy procedures in patients who were determined to avoid tracheotomy or to try to become tracheotomy-free. It should be noted that steroid injections, dilations, mucosal flaps, and microflap excisions were also performed for some glottic stenosis cases but the majority that led to readmission were cordotomies.

Table 3 displays the calculated crude and adjusted odds ratios (OR) for variables associated with a related readmission at the $p < .25$ level from Table 1. Type of procedure (binary), smoking status, a past medical history of cardiovascular disease, and operating time were found to be significant in the crude models. Recall, ASA classes and specific procedures could not be included in odds analysis due to small numbers in each individual class or procedure type. In the adjusted model, type of procedure, smoking status, and operating time were statistically significant but a past medical history of cardiovascular disease was not ($p = 0.07$). The adjusted odds of a readmission following an airway procedure were 5.99 times that of a voice procedure (95% CI: 2.22–16.16, $p < .001$) while controlling for other potential covariates. Similarly, the odds of a readmission in a current/former smoker were 4.50 times that of a never/passive smoker (95% CI: 1.33–15.19, $p = .016$). Operating room time (OR time) analysis revealed that each additional minute increased the odds of a readmission by 1.03 (95% CI: 1.00–1.05, $p = .04$).

4 | DISCUSSION

Our study found a readmission rate of 4.0% following adult outpatient microlaryngeal surgery. This is akin to rates found in the literature. In a retrospective study of 104 adult patients undergoing outpatient transoral laser CO_2 microsurgery of the larynx, Chiesa-Estomba and colleagues found that 3.8% of patients required readmission following

surgery.[14] Similarly, in an early 1998 study of both inpatient and outpatient laryngeal surgeries, 4.5% (4/88) required readmission, however most cases were performed as inpatient procedures which introduces some selection bias.[18]

As hypothesized, airway procedures, particularly airway stenosis procedures, had increased odds of readmission. This is certainly commensurate with the disease process and pathophysiology of airway stenosis which often requires multiple procedures for management with extensive discussion on morbidity and quality of life.[19,20] The majority of the airway procedures that resulted in readmission were procedures for the management of glottic stenosis with a cordotomy. These procedures were done to mitigate, postpone, or obviate tracheotomy in patients with severe systemic disease. Twenty-eight cordotomies were performed in our study, five of which resulted in readmission (18%). This rate is comparable to a study by Qazi et al. where 5 out of 20 patients (25%) undergoing transverse posterior cordotomy required readmission for dyspnea.[21]

Our study found current/former smoking status to be a risk factor for readmission. Similarly, in their cordotomy study, Qazi et al. also found that patients with a history of smoking were found to have a higher likelihood of experiencing complications after cordotomy procedures.[18] While the link between risk of microlaryngeal surgery readmission and smoking status is not surprising, the lack of associated risk with pulmonary or respiratory disease was slightly confounding. Graboyes et al. examined 30-day readmission risk factors following inpatient otolaryngology surgery revealing that "comorbidities associated with an increased rate of readmission were chronic anemia, chronic lung disease, and chronic renal failure."[22] Our study found no association between presence of pulmonary disease and risk of readmission, but this may be due to our sample size.

Lastly, each additional minute of operating time was associated with risk of readmission. Interestingly, median operative time findings were not (statistically) significantly higher in procedures that resulted in a readmission (median 17 min vs. 13 min) however, for every one-minute increase in operating room time, the odds of readmission were 1.03 (95% CI: 1.00–1.05). To exemplify this as a probability, the probability of readmission is 50.7% for a 1-min increase in OR time (nearly the same as a coin flip). To calculate a larger increase in OR time one would exponentiate the parameter estimate by the OR time of interest. Thus, the increase in odds of readmission related to operating room time is very small yet statistically significant. The correlation of longer operative times and risk bears consideration for any laryngeal surgeon especially when airway surgery is being performed and apneic techniques are utilized. Operatives time considerations are balanced with concern for oxygenation depletion and carbon dioxide accumulation in apneic techniques.[23] However, previous work by the author and others have shown safe apnea times (i.e., those without adverse events or carbon dioxide retention) ranging from 24 to 30 min.[20,24] Median operative times for both readmitted and nonreadmitted cases fell below 24 min. Moreover, the method of ventilation was not found to be associated with risk of readmission in this study where 57% of procedures were performed fully apneic.

The authors acknowledge the limitations of this single-surgeon retrospective study as it is the results of only one surgeon and the retrospective nature introduces misclassification bias. Consideration for adding surgeons from outside institutions however introduces more variability and bias. The authors acknowledge that some readmissions could have been missed or not reported. As only the presence of cardiovascular and respiratory/pulmonary diseases was studied, future studies will encompass a wider array of patient comorbidities such as the presence of endocrine, renal, and neurologic diseases. Additionally, comorbidities were grouped broadly, and severity of diseases was not detailed. Studies including patient socioeconomic factors such as health and medical literacy, insurance status, and housing status would also lend further insight into readmission risks. Also, studies with adequate numbers of patients in each ASA classification would be beneficial as this may be another indicator of readmission. Lastly, the authors acknowledge that the findings of the study support what is likely intuitive to most laryngeal surgeons. However, institutions and insurance companies are increasingly relying on "benchmark data" for quality measures and this study is the first to provide such a "benchmark" for laryngologists.

5 | CONCLUSIONS

This is the first dedicated study examining adult 30-day readmissions following outpatient microlaryngeal surgeries. Undergoing an airway procedure or being a current/former smoker were both found to increase the odds of readmission. Each additional minute of operating time was also found to slightly increase the odds of a readmission.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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