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Predictors of Gastrostomy Tube Dependence in Surgically Managed Oropharyngeal Squamous Cell Carcinoma

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Abstract

Objectives: To elucidate predictive factors in the perioperative period resulting in gastrostomy tube (G-tube) dependence for patients undergoing primary surgical treatment of oropharyngeal squamous cell carcinoma (OPSCC) in the modern era.

Methods: Two hundred and thirty patients with known OPSCC treated with primary surgery were screened and selected from a retrospective database spanning from 2002 to 2012 at The Ohio State University Wexner Medical Center (Columbus, Ohio), with univariable and multivariable logistic regression modeling used to determine independent predictive factors resulting in G-tube dependence (defined as tube persistence/presence 1 year after surgery).

Results: Surgical approach, baseline characteristics, tumor (T)-nodal-metastasis stage, human papillomavirus status, extent of tissue resected, surgical complications, reconstructive technique, preoperative G-tube presence, and adjuvant treatment were recorded. Patients undergoing open surgery for OPSCC without adjuvant treatment had 42.9% G-tube dependence (44.6% with adjuvant chemoradiation [CRT]) compared to 0% for those undergoing transoral nonrobotic surgery (8.1% with adjuvant CRT) and 0% for those undergoing transoral robotic surgery (10.3% with adjuvant CRT). In multivariable analysis, greater than 25% of the oral tongue resected (odds ratio [OR] 12.29; $P = 0.03$), an open surgical approach (OR 5.72; $P < 0.01$) and T3/T4 tumor stage (OR 2.84; $P = 0.02$) were independent and significant predictors of G-tube dependence.

Conclusion: Surgical approach, advanced tumor stage, and oral tongue resection may influence the development of nutritional dependence for surgically treated patients with OPSCC.

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Keywords

Oropharynx; oropharyngeal squamous cell carcinoma (OPSCC); gastrostomy tube dependence; outcomes; quality of life

INTRODUCTION

Oropharyngeal squamous cell carcinoma (OPSCC) is the most common malignancy encountered by the head and neck oncologist today.^{1,2} There is strong evidence that the rise in OPSCC incidence is due to several cancer-causing strains of human papillomavirus (HPV) that drive neoplasia after prior infection.^{3,4} In addition, HPV positivity is one of the most important prognostic markers for patients with OPSCC.⁵

The historic treatment for OPSCC includes open surgical intervention, reconstruction, and postoperative chemoradiotherapy (CRT).^{6,7} Open surgery of the oropharynx traditionally required extensive postoperative rehabilitation given the extensive nature of the resections performed, usually via mandibulotomy, interfering with the natural process of swallowing, chewing, and speaking. In part due to these consequences, open surgery for OPSCC causes discomfort and impairment to the nutritional status of patients postoperatively, and in some cases for many years following treatment.

As clinicians searched for ways to minimize the morbidity of open surgery, organ-preserving CRT emerged in the early 1990s as an alternative and equally effective treatment for head and neck cancer. Parsons et al. were among the first to publish data showing comparable oncologic outcomes and potentially superior functional outcomes using CRT versus open surgery for OPSCC.⁶ Thus begun a pendulum shift in clinical management toward CRT for OPSCC.

However, despite its comparatively lower short-term treatment morbidity compared to open surgery, CRT itself can profoundly impair a patient's nutritional ability secondary to side effects including mucositis, dysphagia, xerostomia, and fibrosis.⁸ As a result, patients undergoing primary CRT will commonly receive prophylactic placement of a gastrostomy tube (G-tube) because it has been shown to prevent weight loss, maintain a patient's nutritional status, and reduce the risk of aspiration.⁹⁻¹⁵

Despite the G-tube's effectiveness in providing an alternate source of nutrition, G-tube dependence (i.e., depending on G-tube as the primary source of nutrition for an extended period) is an issue that profoundly impacts the quality of life of OPSCC patients. Patient-reported quality-of-life surveys consistently demonstrate that patients perceive long-term G-tube dependence as one of the worst burdens of treatment.¹⁶ The primary goal of this study is to assess G-tube rate by surgical approach (open vs. transoral, nonrobotic vs. transoral robotic surgery [TORS]) in patients treated with primary surgery for OPSCC. Our secondary objective is to determine predictors of G-tube dependence in this population.

MATERIALS AND METHODS

Study Sample

After institutional review board approval, a retrospectively database of head and neck cancer patients treated with primary surgery was queried and assembled by the Division of Head and Neck Surgery at The Ohio State University Comprehensive Cancer Center–Arthur G. James Cancer Hospital and Richard J. Solove Research Institute. The database was then retrospectively searched for patients who underwent primary surgical management of oropharyngeal squamous cell carcinoma (OPSCC) from January 1, 2002, to August 31, 2012. Patients who had received a G-tube preoperatively were excluded. Also excluded were patients who underwent surgical management of their regional disease without management of the local disease and those who were being treated for second primary lesions. Patients for whom 1 year follow-up data after surgery was not available were also excluded.

Regarding the rehabilitation of swallowing function, our speech-language pathologists (SLPs) see patients throughout the perioperative period. Preoperatively, patients are evaluated by our SLPs and see them frequently in the inpatient and out-patient setting after their surgery. This strategy has been present for decades at our institution and has not appreciably changed with time. In addition, institutional policy concerning placement of G-tubes is reactive, not prophylactic. A G-tube is placed after concomitant assessment by the SLP, a clinical nutrition expert (dietician), and the head and neck team when a patient is having significant weight loss, has signs of aspiration that result in being at risk to swallow, or has anatomical alterations due to the surgery that make it difficult or impossible to swallow.

Covariates

Data was collected on patient age at time of surgical treatment, sex, smoking status in pack-years, tumor (T) stage, nodal (N) stage, AJCC (American Joint Committee on Cancer) 7th edition overall stage,¹⁷ and HPV status.⁵

Surgical management of the primary site was classified as: 1) open, 2) transoral nonrobotic, and 3) TORS. For each type of surgical intervention, the amount of resected tissue within each of the following subsites was documented: tonsil, base of tongue (BOT), soft palate, pharynx, mandible, and oral tongue. Over the study, case volume by technique was assessed for trends at our institution.

All patients underwent a neck dissection to manage the regional basin at the time of their primary resection based on NCCN (National Comprehensive Cancer Network) guidelines.¹⁸ Surgical reconstruction following tumor resection was assessed and categorized as: 1) no reconstruction, 2) split-thickness skin graft or full-thickness skin graft/local mucosal flap, 3) pectoralis major flap or other regional flaps, or 4) free flap.

Adjuvant treatment was categorized as radiation (RT) or CRT, according to NCCN guidelines.¹⁹

Outcome Assessment

G-tube dependence was the primary outcome assessed and was defined as tube presence at the 12 month follow-up appointment after surgery regardless of how reliant the patient was on the tube. Of note, at our institution, patients receiving RT or CRT for OPSCC routinely undergo prophylactic G-tube placement prior to initiation of these adjuvant treatments. Tube dependency rates are reported by surgical approach and adjuvant treatment modality used.

Statistical Analysis

Descriptive statistics were applied to characterize the study population using means and standard deviation for continuous variables and frequencies and proportions for categorical variables. These characteristics were also summarized by surgical approach and adjuvant treatment status. Fisher exact tests were used to compare G-tube rates between primary treatment groups with and without stratification by adjuvant treatment.

Multivariable logistic regression was used to determine predictors of 1 year postsurgery G-tube dependency, starting with all the statistically significant variables ($P < 0.05$) from univariate analysis. Variables with $P > 0.05$ were removed sequentially from the logistic regression with the backward selection strategy. All analyses were conducted in SAS version 9.3 (SAS Institute, Inc., Cary, NC). Demographic, clinical, and treatment variables were assessed using univariable and multivariable analyses to determine predictors of 1 year postsurgery G-tube dependency, reporting odds ratios (OR) with 95% confidence intervals. Fisher's exact tests with Bonferroni corrections were used to compare G-tube rates between primary treatment groups with and without stratification by adjuvant treatment.

A multivariable logistic regression model was developed using a backward selection algorithm from univariable predictors with a P value of less than 0.05. All analyses were conducted in SAS version 9.3 (SAS Institute, Inc.).

RESULTS

Patient Characteristics

Our cohort consists of 230 previously untreated patients with OPSCC who underwent surgical resection with curative intent. Patient demographic and clinical characteristics are summarized in Table I. Of note, most patients had advanced AJCC staged cancer (92.1% were stage III/IV) as well as advanced nodal disease (67.5% were N2/N3).

Institutional Trends From 2002 to 2012

To document the evolution of surgical therapy for OPSCC at the James Cancer Hospital during the study years, an analysis was done concerning the number of cases performed from 2002 to 2012, as documented in the divisional database, using three different surgical approaches (open, transoral nonrobotic, and TORS). From 2002 to 2006, open primary oropharyngectomy and transoral nonrobotic approaches were the primary methods of surgical therapy. In 2008, TORS was first utilized for OPSCC at our institution, and by 2009 it was the primary approach (88.9% of cases) for surgery compared to open and transoral nonrobotic surgery (0.0 and 11.1%, respectively). Although our database did not capture all

surgically managed OPSCC cases at our institution because some cases were not entered, the trends in surgical management reported in our dataset are in keeping with the overall surgical approach trends at our institution during the study years.

G-Tube Rates Stratified by Surgical Approach and Adjuvant Treatment Status

Table II reports G-tube dependency at 12 month postsurgical management stratified by surgical approach and adjuvant treatment status. The number of patients included in this analysis is 213 rather than 230 because adjuvant treatment data was missing for 17 patients. For open, transoral nonrobotic, and TORS approaches, 90.3%, 95.4%, and 89.5% received adjuvant treatment, respectively (CRT/RT rates were 46.2%/53.8% for open, 66.1%/33.9% for transoral nonrobotic, and 67.6%/32.4% for TORS, respectively). Pairwise comparisons revealed that patients receiving an open approach had higher G-tube dependence than those in the transoral nonrobotic and TORS groups (44.6%, 8.1%, and 10.3%, respectively; both P values < 0.01). However, the transoral nonrobotic and TORS groups did not have statistically significant differences in G-tube rates (P value = 0.78).

Among patients receiving an open resection, there was no statistical difference in G-tube dependence between patients who received adjuvant therapy (44.6%, $n = 29$ of 65) and patients who did not receive adjuvant therapy (42.9%, $n = 3$ of 7, P value = 0.99). Of those patients receiving transoral nonrobotic surgery with adjuvant therapy, 8.1% ($n = 5$ of 62) were G-tube dependent versus 0.0% ($n = 0$ of 3) for those who did not receive adjuvant therapy (P value = 1.00). Finally, for patients receiving TORS with adjuvant therapy, 10.3% ($n = 7$ of 68) were G-tube dependent compared to 0.0% ($n = 0$ of 8) for those not receiving adjuvant therapy (P value = 1.00) (Table II).

G-Tube Dependence: Univariate Analysis

In univariate analysis, the factors that were significant ($P < 0.05$) for G-tube dependency include: advanced T-stage (T3/T4), greater than 25% of the BOT resected, greater than 25% of the soft palate resected, resection of the pharynx up to or past the midline, greater than 25% of the oral tongue resected, supraglottic laryngectomy performed, surgical defect requiring reconstruction with a split-/full-thickness skin graft, pectoral flap or free flap, negative HPV status, open surgical approach, and advanced age (Table III).

G-tube dependence: Multivariable Analysis

The multivariate analysis, significant ($P < 0.05$) factors for G-tube dependence included open surgical approach (OR 5.72; $P < 0.01$), greater than 25% of the oral tongue resected (OR 12.29; $P = 0.03$), and advanced T-stage (T3/T4) (OR 2.84; $P = 0.02$) (Table IV).

DISCUSSION

The primary treatment approach for OPSCC has undergone major paradigm shifts over the past 3 decades, although to this day uncertainty persists regarding the ideal treatment modality.^{20–22} In the 1990s, primary open surgery was the standard of care for malignancy in the head and neck. However, with the advent of organ preservation trials such as the Veterans Affairs trial in 1991, organ-preservation strategies such as CRT were presented

and proved to be of equal oncologic efficacy as well as a potentially less morbid primary treatment for OPSCC and for OPSS proved to be of equal oncologic efficacy as well as a potentially less morbid primary treatment.^{6,23,24} Nonetheless, CRT is not without risks such as dysphagia, xerostomia, mucositis, pharyngoesophageal muscle stenosis and fibrosis, and osteoradionecrosis, which interfere with swallowing and increase nutritional dependence after therapy.⁸ After the Food and Drug Administration-approved TORS for treatment of head and neck cancer in 2009, there has been an increase in the use of this treatment modality and primary surgery in the management of select OPSCC, with improved visualization and the ability to perform less morbid surgery driving ongoing adjuvant treatment de-escalation trials.^{20,25,26}

Multicenter studies assessing feasibility, safety, and margin control of TORS have found incidence of positive tumor margins as low as 4.3%, with minimal postoperative adverse events as well as high 2 year disease-free survival and recurrence-free survival (95.1% and 92.4%, respectively).²⁷ In addition, transoral laser microsurgery (TLM) has been studied for stage III/IV tonsil and tongue base cancer (early T-stage, advanced nodal disease), with 93% negative margins along with a 82% 3 year disease-free survival.²⁸

Because surgical therapy has made oropharyngeal cancer survivorship soar, the focus now must shift toward optimizing the quality of life for patients overcoming their disease and living with the sequelae of treatment. Open surgical approaches for OPSCC continue to demonstrate G-tube dependency rates as high as 20% to 50%, which is consistent with our findings in the modern era.^{29,30} In contrast, transoral surgical approaches have been shown to result in much lower long-term feeding dependence, with studies by Canis et. al. (OPSCC stages I–IV) citing rates of 6% and those focused only on patients with advanced stage disease showing rates of 18.8%.^{28,31}

Specifically for patients undergoing TORS approaches for oropharyngeal cancer, several studies and reviews have quoted a 4.5% to 5% average 1-year postoperative G-tube dependence.^{24,27,32} In Sinclair et al.'s study of 42 patients with advanced stage OPSCC (76% AJCC stage III, early T-stage advanced with advanced nodal disease) undergoing TORS, even with a significant proportion of patients getting adjuvant therapy (76% received adjuvant RT), no patients developed long-term G-tube dependence 1 year after surgery.³³

Our results provide a unique perspective on survivor treatment morbidity because they include patients receiving open and minimally invasive approaches with and without the use of robotic surgery while demonstrating the impact of each approach on G-tube dependency. In addition, our institution has historically treated patients travelling long distances who often favored primary surgery treatment over CRT for OPSCC. This translated into a high rate of primary open oropharyngectomy, comprising a unique dataset that has allowed us to provide these rates in the modern era. In our study, patients undergoing open surgery had greater than 40% G-tube dependence regardless of adjuvant treatment status. However, for patients undergoing transoral approaches without need for adjuvant therapy, neither cohort had any patients with long-term G-tube dependence. Expectedly, the presence of adjuvant therapy had a negative impact on overall swallowing function, with transoral nonrobotic patients averaging 8.1% and TORS averaging 10.3% G-tube dependence. Due to small

sample size, however, this was not statistically different than the rates for those not receiving adjuvant treatment.

Our univariate predictors of G-tube dependence included surgical approach, HPV status, smoking status, TNM/AJCC stage, oropharyngeal subsite resections, and reconstructive approach. Our multivariable analysis showed that open surgical approach, advanced T-stage, and > 25% of oral tongue resection were independent predictors of G-tube dependence.

Regarding open surgery's (OR 5.72, $P < 0.01$) impact on G-tube dependence, our results mirror prior knowledge concerning the treatment morbidity of open surgery. Open surgery, by splitting the mandible and dividing the floor of mouth and pharyngeal musculature, impacts swallowing more significantly than a minimally invasive approach that does not disrupt these muscular attachments. Regarding advanced T-stage disease (OR 2.84, $P = 0.02$), this result likely reflects the increased percentage of patients with advanced T-stage tumors that required larger resections of key oropharyngeal subsites and adjuvant RT or CRT. Our multivariate model therefore reflects the added functional treatment morbidity of adjuvant CRT on long-term swallowing function. Finally, resection of > 25% of the oral tongue had the most profound impact on G-tube dependence (OR 12.29, $P = 0.03$). Given knowledge of oropharyngeal anatomy/function and the importance of the oral tongue on the coordination of swallowing, this also reflects the impact that surgical resection of this region has on long-term swallowing dysfunction.

There are many limitations that arise when studying functional outcomes in OPSCC because it is a multifactorial endpoint caused by many components inherent to the disease and each treatment modality. One limitation of our study is the equating of G-tube dependence with the presence of a G-tube at a 1 year follow-up appointment after primary surgery. Although many have debated whether this should be a multifactorial assessment of a patient's postoperative swallowing dysfunction, we kept our endpoint in line with prior published literature. Furthermore, some patients have a G-tube at 1 year with minimal use. It is a long-integrated treatment paradigm at our institution for SLPs to work with our patients throughout the perioperative period to minimize G-tube dependence. In addition, patients undergoing surgery receive reactive G-tube placement, not prophylactic. There is no strict abided criteria placement other than if the patient has significant weight loss or is at high risk for aspiration. In the postoperative period, our patients receive aggressive swallowing rehabilitation during recovery to wean them off tube feeding.

Another issue that arises with any single institutional study of this sort is an element of selection bias based on the case load/treatment strategies that are performed for OPSCC. It is not surprising that T-stage is correlated with G-tube dependence; larger tumors with more involvement of muscles that assist in coordination of swallowing function, when resected, are more likely to result in supplemental nutritional dependence. Indeed, our univariate and multivariate results echo these sentiments (Tables III and IV). Prior to constructing our multivariate models for G-tube dependence, we ensured that variables entered into the model were not colinear (including T-stage, tumor site, and surgical intervention). As such, we were able to report them as independent predictors of G-tube dependence. However, G-tube dependence and open surgical approach are strongly correlated given treatment

morbidity. As such, we have moved away from doing open surgical resection for OPSCC and transitioned toward TORS on a select group of patients with early stage disease.

In addition, our data does not capture patients who may not be G-tube dependent but still have significant swallowing dysfunction that negatively impacts their life. Our future work will aim to capture health-related quality-of-life metrics beyond G-tube dependency to further characterize our outcomes and give more granularity for strategies to avoid this unfortunate consequence of treatment. However, our study has several strengths. Our cohort is one of the largest in the modern era comparing open and minimally invasive primary surgical G-tube dependency rates in the OPSCC population. Our study also reflects the evolution of therapy over the past decade at a high-volume institution, as well as the resultant positive effects that adoption of minimally invasive treatment approaches have on functional outcomes in this population. Although open approaches at our institution are now reserved for salvage oropharyngectomy after recurrence/persistent disease, our historic cohort provides a unique dataset with a single institution comparison that quantifies the functional consequences of different surgical treatment approaches for OPSCC.

CONCLUSION

OPSCC is the most common form of head and neck malignancy encountered by head and neck oncologists today. The treatment modalities for this type of cancer have changed rapidly throughout the past 3 decades from open surgery to organ-preserving strategies such as CRT, and to the current era of incorporating minimally invasive approaches such as TLM and TORS for select lesions. Our study has shown G-tube dependence in patients treated with a primary surgical approach to be significantly impacted by surgical approach, T-stage, and percentage of oral tongue resected. As such, transoral approaches may offer an opportunity for patients to receive therapeutic efficacy with potentially less detriment to their quality of life in the long term.

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TABLE I.

Patient Baseline Characteristics

Characteristic (n = 230)	
Age, mean (SD)	57.24 ± 8.94
Female sex, N (%)	51 (22.2)
Smoking status (pack-years), N (%) [*]	
10	74 (33.6)
> 10	146 (66.4)
Tumor stage, N (%)	
T1/T2	170 (73.9)
T3/T4	60 (26.1)
Nodal stage, N (%) [†]	
N0/N1	74 (32.5)
N2/N3	154 (67.5)
AJCC 7th Overall Stage, N (%) [‡]	
I/II	18 (7.9)
III/IV	210 (92.1)
HPV status, N (%) [‡]	
Positive	147 (65.6)
Negative	77 (34.4)

Patient baseline characteristics were assessed (as available) from medical records, pathology reports, and follow-up clinical data.

^{*}n = 220.

[†]n = 228.

[‡]n = 224.

AJCC = American Joint Committee on Cancer; HPV = human papillomavirus; N = nodal; T = tumor; SD = standard deviation.

TABLE II. OPSCC G-tube Rates by Surgical Approach and Adjuvant Treatment Status (n = 213)

	Open			Transoral Nonrobotic			Transoral Robotic		
	Yes	No		Yes	No		Yes	No	
Adjuvant treatment, N (%)[*]	65 (90.3)	7 (9.7)		62 (95.4)	3 (4.6)		68 (89.5)	8 (10.5)	
Age, mean (SD)	58 (8.3)	59 (5.7)		55.4 (10.7)	61 (10.5)		58.4 (8.0)	57.8 (8.4)	
HPV+, N (%)	33 (51.6)	2 (28.6)		50 (80.7)	2 (66.7)		48 (75.0)	3 (42.9)	
Smoking status (pack-years), N (%)									
10	20 (31.8)	1 (14.3)		20 (33.9)	1 (50.0)		27 (40.9)	2 (33.3)	
> 10	43 (68.2)	6 (85.7)		39 (66.1)	1 (50.0)		39 (59.1)	4 (66.7)	
Tumor stage, N (%)									
T1/T2	29 (44.6)	6 (85.7)		54 (87.1)	3 (100.0)		61 (89.7)	8 (100.0)	
T3/T4	36 (55.4)	1 (14.3)		8 (12.9)	0 (0.0)		7 (10.3)	0 (0.0)	
Nodal stage, N (%)									
N0/N1	23 (35.4)	5 (71.4)		19 (30.7)	2 (66.7)		11 (16.7)	6 (75.0)	
N2/N3	42 (64.6)	2 (28.6)		43 (69.3)	1 (33.3)		55 (83.3)	2 (25.0)	
AJCC 7th stage, N (%)									
I/II	0 (0.0)	4 (57.1)		3 (4.8)	2 (66.7)		2 (3.0)	4 (50.0)	
III/IV	65 (100.0)	3 (42.9)		59 (95.2)	1 (33.3)		64 (97.0)	4 (50.0)	
G-tube dependence, N (%) [‡]	29 (44.6)	3 (42.9)		5 (8.1)	0 (0.0)		7 (10.3)	0 (0.0)	

Available patient surgical approach and adjuvant treatment status data (n = 213) used to stratify baseline characteristics and G-tube dependence

^{*} Adjuvant treatment is defined as postoperative radiotherapy or chemoradiotherapy (in accordance with National Comprehensive Cancer Network guidelines).

[‡] G-tube dependence defined as presence of a G-tube 1 year after primary surgical intervention.

AJCC = American Joint Committee on Cancer; G = gastrostomy; HPV = human papillomavirus; N = nodal; OPSCC = oropharyngeal squamous cell carcinoma; SD = standard deviation; T = tumor.

TABLE III.

Univariable Predictors of G-tube Dependence

Predictor	N	Odds Ratio	95% Confidence Interval	P Value
Age	230	1.04	1.01–1.08	0.02
HPV status	224			
Negative		Ref		
Positive		0.34	0.18–0.66	< 0.01
Smoking status (pack-years)	220			
10		Ref		
> 10		1.88	0.92–3.86	0.08
Tumor stage	230			
T1/T2		Ref		
T3/T4		4.24	2.19–8.19	< 0.01
Nodal stage	228			
N0/N1		Ref		
N2/N3		1.54	0.76–3.10	0.23
AJCC 7th stage	228			
I/II		Ref		
III/IV		1.01	0.32–3.21	0.99
Amount of base of tongue resected	230			
0–25%		Ref		
> 25%		2.59	1.37–4.89	< 0.01
Amount of soft palate resected	230			
0–25%		Ref		
> 25%		5.53	2.83–10.8	< 0.01
Amount of pharynx resected	229			
0%		Ref		
Part of lateral pharyngeal wall		1.72	0.81–3.67	0.16
Up to or past midline		7.22	2.43–21.44	< 0.01
Amount of oral tongue resected	230			
0–25%		Ref		

Predictor	N	Odds Ratio	95% Confidence Interval	P Value
> 25%		27.53	3.30–229.54	< 0.01
Amount of larynx resected	229			
None		Ref		
Supraglottic laryngectomy		5.18	1.71–15.71	< 0.01
Reconstruction of oropharyngeal defect	230			
None		Ref		
STSG or FTSG/local mucosal flap		4.04	1.59–10.31	< 0.01
PMF/other regional flap		20.15	8.22–49.43	< 0.01
Free flap		9.36	2.71–32.35	< 0.01
Surgical approach	230			
Transoral approach*		Ref		
Open approach		8.27	4.10–16.66	< 0.01

Univariate logistic regression used for determining the association between predictive variables and G-tube dependence. Significant predictors displayed.

* Transoral approach includes both transoral nonrobotic and transoral robotic surgical approaches.

AJCC = American Joint Committee on Cancer; FTSG = full-thickness skin graft; G = gastrostomy; HPV = human papillomavirus; N = nodal; PMF = pectoralis major flap; STSG = split-thickness skin graft, T = tumor.

TABLE IV.

Multivariate Predictors of G-tube Dependence

Predictor	Odds Ratio	95% Confidence Interval	P Value
Surgical approach			
Transoral approach	Ref		
Open approach	5.72	2.34–13.98	< 0.01
Tumor stage			
T1/T2	Ref		
T3/T4	2.84	1.19–6.78	0.02
Amount of oral tongue resected			
0–25%	Ref		
> 25%	12.29	1.32–114.4	0.03

The following variables were considered in the multivariable model: amount of base of tongue resected, amount of soft palate resected, amount of pharynx resected, amount of oral tongue resected, amount of larynx resected, type of reconstruction, tumor stage, HPV status, surgical approach, surgery/adjuvant treatment, and age.

G = gastrostomy; HPV = human papillomavirus; T = tumor.