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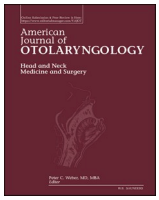

Risk factors for dysphagia following total laryngectomy

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ABSTRACT

Background: Dysphagia is a common and challenging long-term sequela following total laryngectomy (TL) that can negatively impact patient quality of life. Following TL, many patients require repeat esophageal dilations to maintain swallowing function. This study aimed to identify surgical and non-surgical risk factors associated with dysphagia following TL, defined as clinically diagnosed postoperative dysphagia based on patient-reported symptoms and dysphagia requiring dilation.

Methods: We conducted a retrospective single-institution cohort study of patients who underwent total laryngectomy from 1999 to 2024. Outcomes included clinically diagnosed dysphagia and dysphagia requiring esophageal dilations, with covariates including age, BMI, preoperative PEG tube, cricomyotomy, flap reconstruction type, pharyngectomy, glossectomy, base of tongue resection, postoperative complication, neoadjuvant radiation, and adjuvant radiation. Associations between dysphagia and covariates were assessed using univariable and multivariable logistic regressions.

Results: A total of 787 patients underwent total laryngectomy. Median follow-up was 28.5 months (Interquartile range [IQR]: 10.3–68.2 months). During the follow-up period, 212 patients (26.9 %) reported dysphagia, and 131 patients underwent dilation (16.6 %). Prior radiation (adjusted odds ratio [aOR]: 2.51, 95 % CI: 1.56–4.05, $p < 0.001$), adjuvant radiation (aOR: 1.86; 95 % CI 1.10 to 3.17; $p = 0.021$), and tongue base resection (aOR: 2.14, 95 % CI: 1.24–3.70, $p = 0.006$) were independently associated with postoperative clinical dysphagia. Total pharyngectomy (odds ratio [OR]: 1.83, 95 % CI 1.17–2.83, $p = 0.008$) was associated with dysphagia on univariable analysis. Pedicled reconstruction (OR: 1.38, 95 % CI 1.00–1.90, $p = 0.053$) showed a trend towards increased odds of clinical dysphagia. Only prior radiation was independently associated with dysphagia requiring esophageal dilation (aOR: 2.92, 95 % CI: 1.62–5.26, $p < 0.001$).

Conclusions: Dysphagia is common following total laryngectomy. Prior radiation, adjuvant radiation, total pharyngectomy, tongue base resection, and pedicled reconstruction were factors influencing swallowing outcomes following TL. Salvage TL patients should be counseled on the possible need for post-laryngectomy esophageal dilations.

1. Introduction

Total laryngectomy (TL) is a surgical procedure used to treat advanced laryngeal and hypopharyngeal cancer, as well as to manage afunctional larynxes and chronic aspiration [1]. Dysphagia, a common and challenging long-term sequelae of TL, may result from pharyngeal weakness and pharyngoesophageal restriction [1–3]. TL patients experiencing dysphagia commonly report regurgitation, globus sensation, and prolonged mealtime, symptoms which significantly impact quality of life [1]. Dysphagia is also associated with higher rates of distress, perceived disability, and impaired social activity [4,5]. Among head and neck cancer patients, swallowing ability has consistently ranked as a top priority in recovery [5].

Reported rates of postoperative dysphagia after TL vary widely, ranging from 10 % to 87 %, reflecting inconsistent definitions of dysphagia and swallowing [1,4,6]. While some studies have assessed dysphagia based on oral intake or diet consistencies, others focus on structural outcomes such as pharyngeal stricture formation [4,7–9].

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Stricture formation is influenced by multiple factors, including smoking status, female sex, weight loss, hypopharynx tumor site, tubed flap reconstruction, and fistula formation [6–13]. Both prior and adjuvant radiation have been associated with an increased rate of postoperative dysphagia [1,9–11]. Although pharyngeal stricture formation is a key contributor to dysphagia, other swallowing mechanisms contribute, including impaired swallowing biomechanics and esophageal dysmotility [3]. Few studies have comprehensively evaluated these factors and their impact on long-term swallowing outcomes.

While risk factors for stricture formation following TL have been studied, there remains a need for larger database studies that evaluate clinically diagnosed dysphagia symptoms. This retrospective study, utilizing the largest single-institution database of TL patients to date ($n = 787$), evaluates surgical and nonsurgical risk factors of both clinically diagnosed postoperative dysphagia and dysphagia requiring esophageal dilation following TL.

2. Methods

2.1. Patient selection

This retrospective cohort study was approved by Vanderbilt University's Institutional Review Board (IRB #211379). Patients who underwent TL at Vanderbilt University Medical Center, a quaternary care center, from June 1999 to September 2024 ($n = 787$) were included. Electronic medical records were reviewed, and data related to demographics, medical comorbidities, preoperative feeding tubes, tumor staging based on 8th edition American Joint Committee on Cancer (AJCC) guidelines, operative details including extent of resection and type of reconstruction, postoperative fistula formation, and radiation therapy were all recorded [14]. Patients with no documented follow-up data, including those immediately lost to follow-up or deceased without any postoperative evaluations were excluded. Patients were also excluded if they never attempted oral intake postoperatively and remained indefinitely on enteral feeds. Patients were considered to have clinical dysphagia based on consistent clinical documentation, with at least 2 office visits reporting symptoms of dysphagia, including difficulty swallowing solids or liquids, globus sensation, and other patient-reported swallowing difficulty. Patients were also assessed to see if any interventions were required to treat their dysphagia, including esophageal dilation, botulinum toxin injections, and the insertion of a feeding tube.

2.2. Statistical analysis

Univariable and multivariable logistic regression analyses were conducted to assess the association between clinical dysphagia and predictors, including age, body mass index (BMI), preoperative percutaneous endoscopic gastrostomy (PEG) feeding tubes, cricopharyngeal myotomy, type of reconstruction, pharyngectomy, base of tongue resection, fistula formation, neoadjuvant radiation, and adjuvant radiation. Univariable logistic regression was initially conducted for each predictor individually to assess crude associations with postoperative dysphagia. For categorical variables with multiple levels, comparisons were made between each category and a reference group, with odds ratios reported for each comparison. Separate univariable and multivariable analyses were performed for dysphagia requiring esophageal dilation using the same covariates. A p-value of <0.05 was considered statistically significant. All statistical analysis was performed using RStudio Version 2024.12.0 (RStudio Inc).

3. Results

A total of 787 patients met inclusion criteria (Table 1). The median age was 63 (interquartile range [IQR]: 56–69), and the majority of this cohort was male ($n = 640$, 81 %). Of this cohort, 735 patients (93 %) underwent TL for malignancy, including 261 primary TLs (36 %) and 474 salvage TLs (64 %). Fifty-eight patients (7 %) were treated for dysfunctional larynx. The cohort had a median follow-up time of 28.5 months (IQR: 10.3–68.2). Clinical dysphagia was documented in 212 patients (27 %). One hundred thirty-one patients required an esophageal dilation (7 %), performed on average 12 months postoperatively. Forty-eight patients required a feeding tube (6 %), and 96 patients were unable to achieve postoperative oral intake (12 %).

On univariable analysis, total pharyngectomy (odds ratio [OR]: 1.83; 95 % confidence interval [CI] 1.17 to 2.83; $p = 0.008$), base of tongue resection (OR: 1.69; 95 % CI 1.05 to 2.73; $p = 0.031$), and prior radiation (OR: 2.02; 95 % CI 1.41 to 2.89; $p < 0.001$) were significantly associated

Table 1
Cohort characteristics.

Patient characteristic	Total patients, $n = 787$ (%)
Median age at TL (IQR)	63 (56–69)
Gender	
Female	147 (18.7 %)
Male	640 (81.3 %)
Race	
Non-Hispanic White	707 (89.9 %)
Black or African American	69 (8.8 %)
Hispanic or Latino	5 (0.6 %)
Asian (including East/South Asian and Pacific Islanders)	2 (0.3 %)
American Indian (including Alaska or Native Hawaiians)	2 (0.3 %)
Other or unknown	2 (0.3 %)
Mean BMI (kg/m^2) (SD)	24.4 (6.1)
TL indication	
Tumor	735 (93.4 %)
Afunctional	58 (7.4 %)
Primary T (tumor) stage	
T1	33 (4.5 %)
T2	105 (14.3 %)
T3	209 (28.4 %)
T4	318 (43.3 %)
Primary N (node) stage	
N0	400 (54.4 %)
N1	61 (8.3 %)
N2	105 (14.3 %)
N3	77 (10.5 %)
Tumor subsite	
Supraglottis	443 (60.3 %)
Glottis	467 (63.5 %)
Subglottis	161 (21.9 %)
Hypopharynx	74 (10.1 %)
Base of tongue	10 (1.4 %)
Prior radiation therapy	515 (65.4 %)
Preoperative gastrostomy tube	281 (35.7 %)
Pharyngectomy	
None	413 (52.5 %)
Partial	267 (33.9 %)
Total	107 (13.6 %)
Glossectomy	
None	750 (95.3 %)
Partial	22 (2.8 %)
Total	15 (1.9 %)
Base of tongue resection	88 (11.2 %)
Cricopharyngeal myotomy	333 (42.3 %)
Neopharyngeal reconstruction	
Primary closure	304 (38.6 %)
Local/pedicled	310 (39.4 %)
Free flap	172 (21.8 %)
Postoperative complications	
Hematoma	36 (4.6 %)
Flap failure	8 (1.0 %)
Surgical site infection	147 (18.7 %)
Fistula formation	238 (30.2 %)
Wound dehiscence	120 (15.2 %)
Adjuvant radiation	143 (18.2 %)

Abbreviations – TL: total laryngectomy; IQR: interquartile range; BMI: body mass index; SD: standard deviation.

with clinical dysphagia (Table 2). Pedicled reconstruction demonstrated a trend towards an increased odds of clinical dysphagia (OR: 1.38; 95 % CI 1.00 to 1.90; $p = 0.053$). On multivariable analysis, both base of tongue resection (adjusted odds ratio [aOR]: 2.14; 95 % CI 1.24 to 3.70; $p = 0.006$) and prior radiation (aOR: 2.51; 95 % CI 1.56 to 4.05; $p < 0.001$) remained independently associated with clinical dysphagia. Adjuvant radiation was also an independent risk factor for dysphagia (aOR: 1.86; 95 % CI 1.10 to 3.17; $p = 0.021$). Pedicled reconstruction was not associated with clinical dysphagia on multivariable analysis (aOR: 1.23; 95 % CI 0.76 to 1.99; $p = 0.402$).

On univariable analysis, prior radiation was associated with dysphagia requiring esophageal dilation (aOR: 2.56; 95 % CI 1.61 to 4.07; $p < 0.001$; Table 3). Similarly, on multivariable analysis, prior radiation was associated with dysphagia requiring esophageal dysphagia (aOR: 2.92; 95 % CI 1.62 to 5.26; p < 0.001).

4. Discussion

This largest single-institution TL study to date ($n = 787$) evaluates surgical and nonsurgical risk factors of clinically diagnosed post-operative dysphagia and dysphagia requiring esophageal dilation following TL. Our findings demonstrate that clinical dysphagia occurred in 27 % of patients after TL ($n = 212$), and 17 % of patients required esophageal dilations after TL ($n = 131$). Prior radiation, adjuvant radiation, and base of tongue resection were independent risk factors associated with clinical dysphagia. Total pharyngectomy was also associated with a higher likelihood of clinical dysphagia. Pedicled reconstruction demonstrated a trend towards an increased odds of clinical dysphagia. Prior radiation was an independent risk factor associated with post-TL esophageal dilation.

Our findings regarding prior radiation as a risk factor for dysphagia and the need for esophageal dilation following TL are consistent with prior studies [15,16]. Clinical dysphagia has been shown to commonly present as difficulty tolerating solid foods and significant dietary restrictions, occurring in 60 % of patients with prior radiation compared with 33 % of those who did not receive radiotherapy [15,16]. Studies also demonstrated that prior radiation independently increased the likelihood of requiring multiple esophageal dilations, indicating that radiation-induced strictures are commonly refractory to routine treatment [10,11]. Adjuvant radiation was associated with clinical dysphagia in our cohort, mirroring previous findings [17,18]. Jiang et al. (2016) and Charters et al. (2022) established a dose-dependent relationship between the dose of adjuvant radiation received and the severity of dysphagia [17,18]. The majority of patients from our cohort received their radiation therapy from outside institutions, and therefore, radiation dosage could not be effectively quantified in this study. Adjuvant radiation was not found to be a risk factor for esophageal dilations, which differs from prior reports by Petersen et al. (2019) and Green et al. (2018), which demonstrated adjuvant radiation increases risk of multiple esophageal dilations, with some patients experiencing delayed-onset strictures [11,19].

Base of tongue resection and total pharyngectomy were also found to be risk factors for clinical dysphagia. Base of tongue resections have also been associated with poor swallow outcomes, which many attribute to the inability to trigger a pharyngeal swallow [20,21]. Prior studies have demonstrated that tongue base resection is associated with delayed swallow initiation and increased oral and pharyngeal residue [20,21]. More extensive pharynx resections have also been shown to negatively impact swallowing outcomes [5,22–24]. Layton et al. showed that cohorts with total pharyngectomy experienced the worst swallowing outcomes, with only 23.7 % achieving a normal diet, compared to 34.45 % after partial pharyngectomy and 43.5 % in patients with no pharyngeal resection [22]. Many studies also note that partial pharyngectomies are more likely to use pedicled flaps for reconstruction while total pharyngectomies more commonly require free flaps for reconstruction [22–25]. Reconstruction modality has also been shown to influence

Table 2
Logistic regression analysis identifying variables associated with clinically diagnosed dysphagia.

Variable	Univariable logistic regression, OR (CI 95 %)	P-value	Multivariable logistic regression, aOR (CI 95 %)	P-value
Age	0.98 (0.96, 1.00)	0.014	0.98 (0.96, 1.00)	0.447
BMI	0.99 (0.97, 1.01)	0.634	1.00 (0.98, 1.03)	0.993
Preoperative gastrostomy tube	1.16 (0.83, 1.61)	0.385	0.97 (0.67, 1.39)	0.860
Cricopharyngeal myotomy	0.88 (0.64, 1.21)	0.427	0.85 (0.60, 1.20)	0.353
Pharyngectomy				
None	0.96 (0.70, 1.32)	0.814		
Partial	0.75 (0.53, 1.06)	0.101	0.73 (0.46, 1.16)	0.183
Total	**1.83 (1.17, 2.85)**	**0.008**	1.55 (0.88, 2.72)	0.128
Glossectomy				
None	1.65 (0.71, 3.82)	0.244		
Partial	0.80 (0.29, 2.20)	0.662	0.63 (0.21, 1.86)	0.406
Total	0.39 (0.09, 1.74)	0.216	0.21 (0.04, 1.05)	0.057
Base of tongue resection	**1.69 (1.05, 2.73)**	**0.031**	**2.14 (1.24, 3.70)**	**0.006**
Neopharyngeal reconstruction				
Local/pedicled	1.38 (1.00, 1.90)	0.053	1.23 (0.76, 1.99)	0.402
Free flap	0.85 (0.57, 1.25)	0.403	0.80 (0.46, 1.39)	0.436
Fistula formation	0.99 (0.57, 1.69)	0.958	0.91 (0.47, 1.76)	0.779
Prior radiation	**2.02 (1.41, 2.89)**	**0.0001**	**2.51 (1.56, 4.05)**	**0.0002**
Adjuvant radiation	1.03 (0.68, 1.54)	0.894	**1.86 (1.10, 3.17)**	**0.021**

Abbreviations – OR: odds ratio; aOR: adjusted odds ratio; CI: confidence interval; BMI: body mass index.
Bolded variables and values indicate variables that demonstrated a statistically significant association with clinical dysphagia (p < 0.05).

Table 3
Logistic regression analysis identifying variables associated with dysphagia required esophageal dilation.

Variable	Univariable logistic regression, OR (CI 95 %)	P-value	Multivariable logistic regression, aOR (CI 95 %)	P-value
Age	0.972 (0.95, 0.99)	0.004	0.97 (0.95, 0.99)	0.007
BMI	1.00 (0.98, 1.03)	0.988	1.01 (0.98, 1.04)	0.545
Preoperative gastrostomy tube	1.28 (0.87, 1.87)	0.214	1.10 (0.72, 1.68)	0.657
Cricopharyngeal myotomy	1.14 (0.78, 1.67)	0.489	1.18 (0.78, 1.77)	0.430
Pharyngectomy				
None	1.17 (0.80, 1.71)	0.415		
Partial	0.64 (0.42, 0.97)	0.036	0.62 (0.36, 1.07)	0.088
Total	1.55 (0.94, 2.55)	0.086	1.09 (0.57, 2.06)	0.796
Glossectomy				
None	3.64 (0.86, 15.31)	0.078		
Partial	0.23 (0.03, 1.74)	0.156	0.21 (0.03, 1.58)	0.128
Total	0.35 (0.77, 2.32)	0.316	0.25 (0.03, 2.07)	0.199
Base of tongue resection	1.33 (0.77, 2.71)	0.316	1.52 (0.81, 2.83)	0.191
Neopharyngeal reconstruction				
Local/pedicled	1.09 (0.75 1.60)	0.648	1.10 (0.64, 1.92)	0.724
Free flap	1.07 (0.68, 1.68)	0.758	1.05 (0.56, 1.94)	0.883
Fistula formation	0.70 (90.35, 1.40)	0.318	0.57 (0.25, 1.29)	0.177
Prior radiation	**2.56 (1.61, 4.07)**	**0.0001**	**2.92 (1.62, 5.26)**	**0.0004**
Adjuvant radiation	0.78 (0.46, 1.30)	0.335	1.47 (0.77, 2.79)	0.241

Abbreviations – OR: odds ratio; aOR: adjusted odds ratio; CI: confidence interval; BMI: body mass index.
Bolded variables and values indicate variables that demonstrated a statistically significant association with dysphagia requiring esophageal dilation (p < 0.05).

swallowing outcomes and may mask additional differences attributable to pharyngeal resection [22–28].

On univariable analysis, pedicled reconstruction trended towards an increased risk of clinical dysphagia. This is consistent with other studies that show inferior swallowing outcomes for pedicle flap reconstruction compared to free flap reconstruction following TL [19,25–28]. This has been attributed to the greater bulk of the pedicled flap in comparison to a thinner, versatile free flap [25]. Although we did not observe an association between pedicled flap reconstruction and esophageal dilation, Nguyen and Thuot reported a significant relationship [26]. Other studies noted that pedicled flap reconstruction was associated with higher rates of pharyngoesophageal stenosis, which can lead to dysphagia and esophageal dilations [27].

Limitations of this study include its single-institution retrospective design. While this study sought to address the development of post-operative clinical dysphagia, an additional limitation is the lack of formal, objective assessment beyond clinical documentation. The absence of standardized clinical assessment is a limitation across the literature, potentially contributing to underdiagnosis and negatively impacting patient quality of life. Furthermore, dysphagia outcomes in this study relied on patient-reported symptoms at post-operative clinical visits, which may underestimate the true prevalence of dysphagia following TL. In other studies, dysphagia following TL was evaluated as the presence of strictures, findings from objective swallow studies, diet tolerated, or self-reported symptoms documented within the electronic medical record [1,7,10,29]. Patients did not routinely undergo objective swallow analysis, such as barium swallows or video fluoroscopic swallow study, and they did not complete a standardized survey, which could be implemented in future studies. Additionally, patients were not stratified based on the severity of their dysphagia, so mild and severe dysphagia were considered equally in our analysis. Patients who were unable to achieve oral intake were not included in this study, and therefore, patients with severe dysphagia may be under-documented, as mentioned above. While this study included the largest TL patient cohort to date, the 25-year time span from 1999 to 2024 may be a limitation because surgical resection, reconstructive techniques, and adjuvant therapy modalities evolved over the study period [30].

5. Future directions and implications

Future studies should evaluate patient-reported outcomes through standardized clinical surveys in addition to objective assessments, such as barium swallows or video fluoroscopic swallow studies, to improve detection and diagnosis of postoperative dysphagia following TL. Given the negative impact of dysphagia on patient quality of life, timely diagnosis and early intervention may mitigate functional limitations and support overall well-being. Our findings may aid clinicians in preoperative counseling of long-term outcomes, especially among salvage TL patients receiving prior radiation. This knowledge may also facilitate early involvement of speech-language pathologists and provide patients with targeted preoperative and postoperative swallow resources to optimize patient rehabilitation.

6. Conclusion

In this retrospective TL database study, we report that prior radiation, adjuvant radiation, base of tongue resection, total pharyngectomy, and pedicled reconstruction were factors influencing swallowing outcomes following TL. Understanding these risk factors for clinical dysphagia and esophageal dilations can aid clinicians in preoperative counseling and facilitate early involvement of resources to support swallow function and recovery.

CRediT authorship contribution statement

Brooke Swain: Data curation, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. **Clara D. Si:** Data curation, Investigation, Writing - review & editing. **Daniel R.S. Habib:** Data curation, Formal analysis, Investigation, Writing – review & editing. **Whitney Jin:** Data curation, Investigation, Methodology, Writing – review & editing. **Pamela Duvall:** Resources, Visualization. **Robert J. Sinard:** Supervision, Writing – review & editing. **Kyle Mannion:** Supervision, Writing – review & editing. **Sarah L. Rohde:** Supervision, Writing – review & editing. **Alexander J. Langerman:** Supervision, Writing – review & editing. **Eben L. Rosenthal:** Supervision, Writing – review & editing. **Melanie D. Hicks:** Supervision, Writing – review & editing. **Michael C. Topf:** Conceptualization, Methodology, Supervision, Writing – review & editing.

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Declaration of competing interest

None.

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