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Pharyngocutaneous fistula after total laryngectomy: A single-institution experience, 2001–2012★,☆☆

Eleni M. Benson, MD^{a,*}, Richard M. Hirata, MD, FACS^b, Carol B. Thompson, MS, MBA^c, Patrick K. Ha, MD, FACS^{a,b}, Carole Fakhry, MD, MPH^{a,b,d}, John R. Saunders, MD, FACS^b, Joseph A. Califano, MD, FACS^{a,b}, Demetri Arnaoutakis, MD^e, Marshall Levine, MD^b, Mei Tang, MD^b, Geoffrey Neuner, MD^b, Barbara P. Messing, MA, BRS-S, CCC-SLP^b, and Ray G.F. Blanco, MD, FACS^{a,b}

^a Department of Otolaryngology–Head and Neck Surgery, Johns Hopkins Medical Institutions, 601 N. Caroline Street, 6th floor, Baltimore, MD, United States

^b Milton J. Dance Jr. Head and Neck Cancer Center, Greater Baltimore Medical Center, 6569 N. Charles Street, Baltimore, MD, United States

^c Biostatistics Center, Johns Hopkins Bloomberg School of Public Health, 615 N. Wolfe St., Baltimore, MD, United States

^d Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, 615 N. Wolfe St., Baltimore, MD, United States

^e Department of Otolaryngology–Head and Neck Surgery, University of Texas Southwestern Medical Center, 5323 Harry Hines Blvd, Dallas, TX, United States

Abstract

Purpose—The purpose of this study was to determine the incidence of and risk factors for pharyngocutaneous fistula in patients undergoing total laryngectomy at a single institution.

Materials and methods—The records of 59 patients undergoing primary or salvage total laryngectomy at our institution from 2001 to 2012 were retrospectively reviewed. Data collected included patient, tumor and treatment characteristics, and surgical technique. Risk factors were analyzed for association with pharyngocutaneous fistula formation.

Results—Twenty patients (34%) developed fistulas. Preoperative tracheostomy (OR 4.1; 95% CI 1.3–13 [$p = 0.02$]) and low postoperative hemoglobin (OR 9.1; 95% CI 1.1–78 [$p = 0.04$]) were associated with fistula development. Regarding surgical technique, primary sutured closure of the total laryngectomy defect had the lowest fistula rate (11%). In comparison, primary stapled closure and pectoralis onlay flap over primary closure had nonsignificantly increased fistula rates

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* Corresponding author at: Department of Otolaryngology–Head and Neck Surgery, Johns Hopkins Medical Institutions, 601 N. Caroline Street, 6th floor, Baltimore, MD 21287, United States. Tel.: +1 410 955 1932; fax: +1 410 955 6526. ebenson6@jhmi.edu (E.M. Benson).

(43%, OR 6.0; 95% CI 1.0–37.3 [$p = 0.06$] and 25%, OR 2.7; 95% CI 0.4–23.9 [$p = 0.38$], respectively). Pectoralis flap incorporated into the suture line had a significantly increased fistula rate (50%, OR 7.1; 95% CI 1.4–46 [$p = 0.02$]). After stratification for salvage status, patient comorbidities were associated with fistula in non-salvage cases whereas disease-related characteristics were associated with fistula in salvage cases. Fistula development was associated with increased length of hospital stay ($p < 0.001$) and increased time before oral diet initiation ($p < 0.001$).

Conclusions—Pharyngocutaneous fistula is a common complication of total laryngectomy. Preoperative tracheostomy, postoperative hemoglobin, and surgical technique are important in determining the risk of fistula.

1. Introduction

Total laryngectomy (TL) carries with it significant morbidity, with 40%–92% reported complication rates [1–5]. Complications include wound infection and dehiscence, swallowing dysfunction, airway complications, chyle leak, and carotid artery rupture [1–6]. The most frequent postoperative complication is the development of a pharyngocutaneous fistula (PCF), which occurs with variable frequencies of 3% to 65% in reported series, most falling within 10%–40% [7]. PCF is an early complication [8,9] that causes increased length of hospital stay and delayed initiation of oral diet, and requires complex wound care, occasionally necessitating additional surgery for closure [8,10–12].

Case series have identified many factors as significantly associated with PCF development, although consistency across studies is lacking. Preoperative radiation therapy increases both the frequency and severity of postoperative PCF [3,4,10,13–15], and chemotherapy augments this effect [3,16,17]. Other factors associated with increased rates of PCF include patient comorbidities [8,10,18], hypothyroidism [13], low perioperative hemoglobin [7,19,20] and albumin [10,19], more advanced primary tumor stage [21], prior tracheotomy [7,22,23] positive surgical margins [24,25], concurrent neck dissection [7,15,18], shorter elapsed time from completion of radiation to surgery [15], and surgical closure technique [10,12,26]. Although it is generally accepted that previous radiation and chemoradiation increase the risk of PCF [27], there is little consensus regarding the relative significance of these other various factors. In the era of organ preservation therapy with TL often reserved as a salvage measure after failed radiation with or without chemotherapy, recent efforts have largely focused on identifying surgical techniques to minimize PCF formation in tissue that is frequently irradiated and at high risk for poor wound healing [12,27].

The aims of this study were to review our single-center experience with PCF after TL and to determine risk factors associated with PCF in our patient population.

2. Material and methods

2.1. Patients

Approval for this study was obtained from the Greater Baltimore Medical Center (GBMC) Institutional Review Board. The records of 59 patients who underwent TL at GBMC in Baltimore, MD from 2001 to 2012 were retrospectively reviewed. Of note, 19 of these

patients (study ID numbers 3, 4, 11, 14–18, 20, 21, 24, 28–34, 36) were also included in a previously reported multicenter study of PCF after salvage total laryngectomy [12]. Patient, disease, and treatment data were collected. Patient data included age, gender, comorbidities, social history (tobacco and alcohol use) and laboratory data. Comorbidities were scored using the Washington University Head and Neck Cancer Comorbidity Index (WUHNC Index) [28].

2.2. Disease

The indication for surgery (primary versus salvage treatment, and cancer versus dysfunctional larynx), tumor site, and disease stage at the time of treatment were recorded.

2.3. Treatment

Pre- and postoperative radiation and chemotherapy were recorded. Salvage was defined as having received prior radiation therapy with or without chemotherapy. Surgical treatment data included any previous surgical treatment, surgical technique, any extent of pharyngectomy, concurrent neck dissection, preoperative tracheostomy, and margin status.

2.4. Outcomes

The primary outcome was PCF, defined as a frankly draining salivary tract from the neopharynx to the skin requiring either wound packing or surgical management. Additional outcomes included length of hospital stay, days before initiation of oral diet, and survival.

2.5. Statistical analysis

Descriptive statistics were reported as n (%) for categorical variables and as mean and standard deviation (SD) or median and range for continuous variables. Categorical variables as predictors of PCF occurrence were analyzed using the Fisher's exact test and logistic regression. Laboratory data were dichotomized based on our center's laboratory criteria and analyzed with logistic regression, and/or considered a continuous variable and analyzed using the Mann–Whitney U test. Differences in median length of stay and time before oral diet by PCF status were analyzed using a nonparametric equality-of-medians test. Multivariable analyses were performed using logistic regression with varying subsets of predictors based on the univariate analyses and/or previous literature. Analysis of PCF formation was performed for the entire cohort, after stratification for salvage, and with exclusion of pharyngectomy cases. Survival analysis was performed using the Kaplan–Meier method. Data analysis was performed using commercially-available software (STATA, version 11.2; StataCorp LP, College Station, TX, 2012). A p -value 0.05 was considered statistically significant.

3. Results

3.1. Patient characteristics

This study population included 59 patients with a mean age of 63 years (standard deviation, 10.6; range 38–89 years). The median follow-up time for all patients was 19.6 months (range, 1.2–124.1 months). For the 54 patients whose primary indication for TL was

malignancy, median overall survival was 33.3 months (standard error [SE] 3.7) and median disease-specific survival was 42.2 months (SE 9.0). Thirty-seven patients (63%) were considered salvage cases, and median time from completion of radiation to TL was 15 months (range, 2 to 112 months).

TL was performed using various surgical techniques including: Primary closure with suture (18 patients, 31%); primary closure with stapler (14 patients, 24%); PM myofascial onlay flap (PM onlay) over either sutured or stapled primary closure (eight patients or 14%, including one sutured closure and seven stapled closures); PM myocutaneous flap incorporated into the suture line (PM in suture line) (18 patients, 31%); and radial forearm free tissue transfer (one patient, 2%).

Patient characteristics were compared among the different closure groups. Statistically different characteristics are shown in Table 1. Compared with other techniques, a greater proportion of PM in suture line closures were used in cases with pharyngectomy defects (74% PM in suture line versus 0–17% of others, $p < 0.001$), and a greater proportion of PM in suture line and PM onlay closures were employed in salvage cases (89% PM in suture line and 88% PM onlay versus 43%–44% of others, $p = 0.004$).

3.2. Pharyngocutaneous fistula

Twenty patients (34%) developed PCF. With univariate analysis (Table 2), postoperative hemoglobin less than 12.5 g/dL was significantly associated with PCF (OR 9.1; 95% CI 1.1–78 [$p = 0.04$]). Preoperative hypothyroidism with TSH > 4.7 mIU/L perfectly predicted PCF formation, with 4 out of 4 patients developing PCF. Preoperative TSH was higher in patients who developed PCF compared to those who did not (median 5.0 mIU/L versus 0.7 mIU/L, $p = 0.0023$). Patients who underwent tracheostomy prior to TL had a significantly higher rate of PCF compared to patients who did not undergo preoperative tracheostomy (55% versus 23%, OR 4.1; 95% CI 1.3–13 [$p = 0.02$]).

With regard to surgical technique, primary sutured closure had the lowest PCF rate of 11%. PM onlay flap over sutured or stapled primary closure had a PCF rate of 25%, and primary stapled closure resulted in a PCF rate of 43%, both of which were not statistically greater than that for primary sutured closure (OR 2.7; 95% CI 0.4–23.9 [$p = 0.38$] and OR 6.0; 95% CI 1.0–37.3 [$p = 0.06$], respectively). Finally, PM in suture line resulted in a PCF rate of 50%, which was significantly greater than that of primary sutured closure (OR 7.1; 95% CI 1.4–46 [$p = 0.02$]). One patient underwent radial forearm free flap closure and developed PCF.

Seven of the eight PM onlay closures consisted of a PM flap over stapled primary closure. We compared the rate of PCF formation after primary stapled closure alone to the rate after primary stapled closure with PM onlay flap. The PCF rate was lower with a PM onlay flap, although this difference was not statistically significant (46% [6/13] with PM onlay flap compared to 29% [2/7] without onlay; OR = 0.46; 95% CI 0.06–3.5 [$p = 0.46$]). Because salvage status is often a consideration in the decision to use a PM onlay flap, we then restricted this analysis to salvage cases only, yielding similar results (50% [3/6] with PM onlay flap compared to 29% [2/7] without onlay; OR 0.4; 95% CI 0.04–4.3 [$p = 0.45$]).

The presence of a PCF was significantly associated with a greater median number of days before oral diet (44.5 versus 11 days [$p < 0.001$]) and longer median hospital stay (median 11.5 versus 8 days [$p = 0.001$]).

Of the 20 patients with PCFs, 19 closed successfully. PCF severity was approximated by the management required for resolution, with less severe PCFs resolving with wound packing and more severe PCFs requiring surgical repair. There was no statistical difference in PCF management by salvage status. Table 3 shows PCF management by closure category. PCF severity appeared to be lower with PM onlay and PM in suture line closures, with 0/2 (0%) and 2/7 (22%) requiring surgical repair, respectively, compared with 50% of primary closures with suture (1/2) or stapler (3/6), however these differences were not statistically significant (p overall = 0.30).

3.3. Stratification by salvage status and pharyngectomy

Patients were stratified by salvage status and univariate analysis was performed (data not shown). For non-salvage cases, only pulmonary disease (OR 8.7; 95% CI 1.0–75 [$p = 0.05$]) and WUHC Index score of 1 (OR 15; 95% CI 1.3–180 [$p = 0.03$]) were significantly associated with increased risk of PCF. Forty-three percent of patients with hypertension (6/14) developed PCF compared with none of those without hypertension (0/8). For salvage cases, high T stage (OR 10 for T4 versus T2; 95% CI 1.0–104 [$p = 0.05$]) and overall stage (OR 5.7 for stage IV versus stages II/III; 95% CI 1.1–29 [$p = 0.04$]) were significantly associated with PCF formation, as was preoperative tracheostomy (OR 8.9; 95% CI 1.7–45 [$p = 0.009$]). Surgical closure technique was not significantly associated with PCF in either stratum. The interaction terms for each of these variables with salvage status were not statistically significant. Elapsed time from completion of radiation to TL was not significantly associated with PCF for salvage cases (OR 1.0; 95% CI 0.3–3.6 [$p = 0.96$] for 12 months compared with < 12 months).

Further analysis of all cases was then performed after excluding patients with pharyngectomy defects ($n = 17$). Risk factors significantly associated with PCF in non-pharyngectomy cases were preoperative tracheostomy (OR 4.5; 95% CI 1.1–18 [$p = 0.03$]) and surgical closure with PM in suture line (OR 26; 95% CI 1.8–380 [$p = 0.02$]).

3.4. Multivariate analysis of PCF formation

Multiple logistic regression analysis was performed for factors associated with PCF formation (Table 4). Surgical closure technique was not significantly associated with PCF development after adjustment for preoperative tracheostomy, postoperative hemoglobin and salvage status. However, preoperative tracheostomy was significantly associated with PCF (adjusted OR 4.6; 95% CI 1.2–18 [$p = 0.03$]).

4. Discussion

Pharyngocutaneous fistula development is a common complication of total laryngectomy resulting in increased length of hospital stay [8,10–12], delayed oral intake [12,29], delay of adjuvant therapy [26] and often the need for complex wound care and additional procedures

for fistula closure [11,12]. Given the frequency of PCF and its significant morbidity, it is important to identify salient risk factors and potential measures for improving outcomes.

Our study identified preoperative tracheostomy as significantly associated with PCF both with univariate analysis and after adjustment for other factors. This has been reported in other studies [22,23] and also in a meta-analysis [7], and there is speculation that it may be secondary to tissue contamination and/or larger tumor size [22]. We also identified hypothyroidism and low postoperative hemoglobin as risk factors for PCF, which have consistently been reported in other studies [7,13,14,19,23].

It is widely accepted that a history of radiation therapy increases the risk of PCF after TL [7,30], an effect augmented by the addition of chemotherapy [3,4,31]. We did not detect a significant association of PCF with salvage status in our study. However it is interesting that after stratification for salvage status a pattern emerged suggesting a potential interaction of preoperative radiation with other commonly identified risk factors for PCF. For primary TL cases, comorbidities (hypertension, pulmonary disease and WUHNC index) significantly increased the risk of PCF. In salvage cases, disease-related and anatomical characteristics – T stage, overall stage and preoperative tracheostomy – were associated with PCF, but comorbidities were not. Although interaction terms were not statistically significant in this small study, this contrast highlights the fact that radiation-treated tissues, subject to acute toxicity and long-term microvascular injury [7], should be considered as fundamentally distinct both in practice and in further studies. Further, this may explain some of the heterogeneity in reported risk factors for PCF.

Surgical technique has emerged as one of the more important factors in the development of PCF, although the optimal method of closure for reducing PCF incidence is still unclear. In our study, primary closure with suture yielded the lowest rate of PCF (11%). PM in the suture line had the highest rate (50%, OR 7.1; 95% CI 1.4–46 [$p = 0.02$]), which may relate to the effectively doubled length of the surgical closure; however, this increase was not statistically significant after adjustment for other factors (OR 6.2; 95% CI 0.9–44 [$p = 0.07$]). While PM onlay flap closures have had excellent outcomes in other studies (discussed below), our less favorable results (25% developed PCF) may be skewed as seven out of eight of these flaps were used to reinforce stapled primary closures. In our hands stapled closures seem to have higher rates of PCF (43%) despite reports of decreased PCF incidence with mechanical staples [32–34].

The introduction of well-vascularized, non-irradiated tissue into complex pharyngeal closures is an attractive option for the improvement of wound healing in salvage patients. PM flaps have been used both as myofascial onlay flaps to reinforce suture lines [35,36] and as myocutaneous flaps inset into the pharyngeal reconstruction, with generally promising results among salvage patients [12,16,36,37]. In a recent multi-institutional retrospective review of 359 patients undergoing salvage laryngectomy, which included 19 patients from our study, the PCF rate was highest with primary closure (34%; reference category), intermediate with interposed free tissue (25%, $p = 0.07$) and lowest with PM onlay flap (15%, $p = 0.02$) [12]. An analysis of 591 patients from 7 studies found a relative risk for PCF of 0.64 (95% CI 0.47 to 0.85) in salvage TL patients with flap reconstruction or

reinforcement compared to those without vascularized tissue, noting that a decrease in both PCF incidence and severity were consistent findings [27]. In our study, relatively fewer of the PCFs developing after PM onlay (0%) or PM in suture line (22%) closures required surgical closure compared with non-flap closures (50%), supporting the utility of vascularized flaps in reducing PCF severity.

Limitations of our study include its retrospective nature with a small and heterogeneous cohort, making it difficult to draw more precise conclusions with regard to the relative significance of risk factors for PCF and the optimal surgical closure techniques.

5. Conclusion

PCF remains a common complication of TL. Risk factors for PCF are poorly defined, making it challenging to decrease their incidence and severity. We identified preoperative tracheostomy, low postoperative hemoglobin and hypothyroidism as factors associated with PCF. Although preoperative radiotherapy was not associated with PCF, a distinct pattern of risk factors was noted for PCF in salvage compared with non-salvage patients. Surgical closure technique also emerged as an important consideration in PCF development. The use of mechanical staples and PM flaps was associated with increased incidence of PCF compared to primary closure with suture in univariate analysis; however, the incorporation of PM flaps – either as onlay reinforcement or in the suture line – may have decreased PCF severity. Further research is required to identify the critical risk factors for PCF after TL and most favorable surgical techniques for prevention.

Abbreviations

TL	total laryngectomy
PCF	pharyngocutaneous fistula
WUHN Index	Washington University Head and Neck Cancer Comorbidity Index
PM	pectoralis major
OR	odds ratio
CI	confidence interval

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Table 1 Patient characteristics by surgical closure category ^a.

Closure ^b	N	Primary with suture, N (%)	Primary with stapler, N (%)	PM onlay, N (%)	PM in suture line, N (%)	p-Value ^c
Total N	59	18	14	8	19	
Characteristic						
HTN						0.025
No	28	6 (33)	4 (29)	7 (88)	11 (58)	
Yes	31	12 (67)	10 (71)	1 (12)	8 (42)	
Pulmonary disease						0.025
No	42	14 (78)	6 (43)	5 (63)	17 (89)	
Yes	17	4 (22)	8 (57)	3 (38)	2 (11)	
Obesity						0.024
No	52	15 (83)	13 (93)	5 (63)	19 (100)	
Yes	7	3 (17)	1 (7)	3 (38)	0 (0)	
Disease						
Salvage						0.004
No	21	10 (56)	8 (57)	1 (13)	2 (11)	
Yes	38	8 (44)	6 (43)	7 (88)	17 (89)	
Site						<0.001
Glottic	28	9 (50)	12 (86)	4 (50)	3 (16)	
Supraglottic	14	8 (44)	1 (7)	3 (38)	2 (11)	
Hypopharyngeal	10	0 (0)	0 (0)	0 (0)	10 (53)	
Oropharyngeal	5	0 (0)	0 (0)	1 (12)	4 (21)	
Other ^d	2	1 (6)	1 (7)	0 (0)	0 (0)	
Pharyngectomy						<0.001
No	42	15 (83)	14 (100)	8 (100)	5 (26)	
Yes	17	3 (17)	0 (0)	0 (0)	14 (74)	
Positive margins						0.037
No	39	13 (72)	13 (93)	4 (50)	9 (50)	
Yes	20	5 (28)	1 (7)	4 (50)	9 (50)	

Abbreviation: HTN, hypertension.

^aThis table includes variables that showed significant differences across the closure categories. Other variables examined that did not show significant associations include: age, gender, tobacco use, alcohol use, diabetes, coronary artery disease, Washington University Head and Neck Comorbidity Index, preoperative hypothyroidism, preoperative hypoalbuminemia, preoperative hemoglobin < 12.5, postoperative hemoglobin < 12.5, indication for total laryngectomy (cancer versus dysfunctional larynx), preoperative tracheostomy, and neck dissection.

^bThe single patient undergoing free flap closure was excluded from these analyses.

^cSignificance calculated using Fisher's exact t-test.

^d"Other" includes patients with unknown primary and no malignancy (dysfunctional larynx).

Table 2

Univariate analysis of risk factors for pharyngocutaneous fistula formation.

Characteristic	N	No. patients (% of total patients)	No. patients with PCF (% of patients in category)	OR; 95% CI (<i>p</i>) ^a
<i>Patient</i>				
Age: (range 38–89, mean 63)	59			
<6		18 (31)	6 (33)	REF
60		41 (69)	14 (34)	0.9; 0.3–3.4 (0.95)
Gender:	59			
Female		11 (19)	3 (27)	REF
Male		48 (81)	17 (35)	1.5; 0.3–6.3 (0.61)
Social history:	59			
Tobacco use				
No		10 (17)	1 (10)	REF
Yes		49 (83)	19 (39)	5.7; 0.7–50 (0.12)
Alcohol use				
No		31 (53)	12 (39)	REF
Yes		28 (47)	8 (29)	0.63; 0.2–1.9 (0.41)
Medical history:	59			
DM				
No		45 (76)	14 (31)	REF
Yes		14 (24)	6 (43)	1.7; 0.5–5.8 (0.42)
HTN				
No		27 (46)	6 (22)	REF
Yes		32 (54)	14 (44)	2.7; 0.9–8.6 (0.09)
Pulmonary disease ^b				
No		41 (69)	12 (29)	REF
Yes		18 (31)	8 (44)	1.9; 0.6–6.1 (0.26)
CAD				
No		45 (76)	13 (29)	REF
Yes		14 (24)	7 (50)	2.5; 0.7–8.5 (0.16)
Obesity				
No		51 (86)	17 (33)	REF
Yes		8 (14)	3 (38)	1.2; 0.3–5.7 (0.81)
WUHN index	59			
0		34 (58)	9 (26)	REF
1+		25 (42)	11 (44)	2.2; 0.7–6.6 (0.17)
<i>Laboratory data</i>				
Preop hypothyroidism (TSH >4.7 mIU/L)	16			N/A ^c
No		12 (75)	4 (33)	
Yes		4 (25)	4 (100)	

Characteristic	N	No. patients (% of total patients)	No. patients with PCF (% of patients in category)	OR; 95% CI (<i>p</i>) ^a
Preop albumin 3.2 g/dL	42			
No		39 (93)	15 (38)	REF
Yes		3 (7)	2 (67)	3.2; 0.3–40 (0.37)
Preop Hgb <12.5 g/dL	57			
No		34 (60)	10 (29)	REF
Yes		23 (40)	10 (43)	1.8; 0.6–5.6 (0.28)
Postop Hgb <12.5 g/dL	57			
No		13 (23)	1 (8)	REF
Yes		44 (77)	19 (43)	9.1; 1.1–78 (0.04)
<i>Disease</i>				
Indication for surgery	59			
Cancer		54 (92)	17 (32)	REF
Dysfunctional larynx		5 (8)	3 (60)	3.3; 0.5–21.7 (0.22)
Site	57			
Glottic		27 (46)	9 (33)	REF
Hypopharyngeal		11 (19)	5 (45)	1.7; 0.4–7.1 (0.49)
Supraglottic		14 (24)	3 (21)	0.5; 0.1–2.5 (0.43)
Oropharyngeal		5 (8)	2 (40)	1.3; 0.2–9.6 (0.78)
Staging				
T stage	54			
T2		13 (24)	2 (15)	REF
T3		14 (26)	4 (29)	2.2; 0.3–15 (0.42)
T4		27 (50)	11 (41)	3.8; 0.7–21 (0.13)
Overall stage	54			
II–III		25 (46)	5 (20)	REF
III–IV		29 (54)	12 (41)	2.8; 0.8–9.7 (0.10)
<i>Treatment</i>				
Salvage	59			
No		22 (37)	6 (27)	REF
Yes		37 (63)	14 (38)	1.6; 0.5–5.2 (0.41)
Previous surgical treatment	58			
No		44 (76)	13 (30)	REF
Yes		14 (24)	7 (50)	2.4; 0.7–8.3 (0.17)
Closure	59			
Primary with suture		18 (31)	2 (11)	REF
Primary with stapler		14 (24)	6 (43)	6.0; 1.0–37.3 (0.06)
PM onlay		8 (14)	2 (25)	2.7; 0.4–23.9 (0.38)
PM in suture line		18 (31)	9 (50)	7.1; 1.4–46 (0.02)
Free flap ^d		1 (5)	1 (100)	
Pharyngectomy ^e	59			

Characteristic	N	No. patients (% of total patients)	No. patients with PCF (% of patients in category)	OR; 95% CI (<i>p</i>) ^a
No		42 (71)	14 (33)	REF
Yes		17 (29)	6 (35)	1.1; 0.3–3.6 (0.89)
Neck dissection ^f	59			
No		20 (34)	8 (40)	REF
Yes		39 (66)	12 (31)	0.67; 0.2–2.1 (0.48)
Preop tracheostomy	59			
No		39 (66)	9 (23)	REF
Yes		20 (34)	11 (55)	4.1; 1.3–13 (0.02)
Positive margins	59			
No		39 (66)	13 (33)	REF
Yes		20 (34)	7 (35)	1.1; 0.3–3.4 (0.90)

Abbreviations: PCF, pharyngocutaneous fistula; No., number; OR, odds ratio; CI, confidence interval; DM, diabetes mellitus; HTN, hypertension; CAD, coronary artery disease; WUHC Index, Washington University Head and Neck Comorbidity Index; Preop, preoperative; TSH, thyroid stimulating hormone; Hgb, hemoglobin; Postop, postoperative; PM, pectoralis major.

^aFor binary characteristics, odds ratios and *p*-values are included with the non-reference category; for characteristics with more than 2 categories, the *p*-value is associated with the non-reference category compares that category to the reference category. Reference category is indicated by "REF". Statistically significant associations are in bold font.

^bPulmonary disease was defined as asthma or chronic obstructive pulmonary disease.

^cN/A: perfect prediction, i.e. all patients with risk factor have outcome.

^dFree flap not included in analysis.

^eIncludes any extent of pharyngectomy.

^fIncludes bilateral and unilateral neck dissection.

Table 3

Comparison of surgical closure technique and pharyngocutaneous fistula management.

Surgical closure type^a	Total N (%)	Wound packing N (%)	Surgical closure N (%)^b
Primary with suture	2 (10)	1 (50)	1 (50)
Primary with stapler	6 (30)	3 (50)	3 (50)
PM onlay	2 (10)	2 (100)	0 (0)
PM in suture line	9 (45)	7 (78)	2 (22)
Free flap ^c	1 (5)	0 (0)	1 (100)
Total	20	13 (65)	7 (35)

Abbreviation: PM, pectoralis major.

^a Overall $p = 0.304$.

^b Types of surgical closure: primary closure (2), local flaps (1), debridement (1), pec flap (1) and latissimus dorsi then pec flap (1), unknown (1).

^c Single free flap closure not included in analysis of overall statistical significance.

Table 4

Multivariable analysis of risk factors associated with pharyngocutaneous fistula.

Risk factor	OR for PCF; 95% CI	p-Value
Closure		
Primary with suture	REF	
Primary with staples	6.0; 0.8–3	0.08
PM onlay	2.2; 0.3–24	0.53
PM in suture line	6.2; 0.9–44	0.07
Preop tracheostomy	4.6; 1.2–18	0.03
Postop Hgb ^a	0.8; 0.5–1.2	0.26
Salvage	1.6; 0.3–7.7	0.58

Abbreviations: PCF, pharyngocutaneous fistula; PM, pectoralis major; Preop, preoperative; Postop, postoperative; hgb, hemoglobin; OR, odds ratio; CI, confidence interval.

^a Postoperative hemoglobin considered as a continuous variable.