The Journal of Laryngology & Otology

cambridge.org/jlo

Clinical outcomes following pharyngolaryngectomy reconstruction: a 20-year single-centre study

T Layton[1,2], R Thomas[2], C Harris[2], S Holmes[2], L Fraser[2], P Silva[2] and S C Winter[2,3]

[1]Kennedy Institute of Rheumatology, Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, University of Oxford, Oxford, England, [2]Bleinheim Head and Neck Unit, Churchill Hospital, Oxford University Hospitals NHS Foundation Trust, Oxford, England and [3]Nuffield Department of Surgical Sciences, University of Oxford, Oxford, UK

Abstract

Background. Advanced malignant neoplasms of the larynx and hypopharynx pose many therapeutic challenges. Total pharyngolaryngectomy and total laryngectomy provide an opportunity to cure these tumours but are associated with significant morbidity. Reconstruction of the pharyngeal defect following total pharyngolaryngectomy demands careful consideration and remains an area of debate within surgical discussions.

Methods. This paper describes a systemic analysis of pharyngeal reconstruction following total pharyngolaryngectomy and total laryngectomy, leveraging data collected over a 20-year period at a large tertiary referral centre.

Results. Analysing 155 patients, the results show that circumferential pharyngeal defects and prior radiotherapy have a significant impact on surgical complications. In addition, free tissue transfer in larger pharyngeal defects showed lower rates of post-operative anastomosis leak and stricture.

Conclusion. Pharyngeal resection carries a substantial risk of post-operative complications, and free tissue transfer appears to be an effective means of reconstruction for circumferential defects.

Main Article

Mr T Layton takes responsibility for the integrity of the content of the paper

Cite this article: Layton T, Thomas R, Harris C, Holmes S, Fraser L, Silva P, Winter SC. Clinical outcomes following pharyngolaryngectomy reconstruction: a 20-year single-centre study. *J Laryngol Otol* 2022;**136**:1105–1112. https://doi.org/10.1017/S0022215122000019

Accepted: 4 August 2021
First published online: 10 January 2022

Key words:
Otolaryngology; Head And Neck Cancer; Outcomes Research

Author for correspondence:
Mr Thomas Layton, Kennedy Institute of Rheumatology, NDORMS, University of Oxford, Oxford OX3 7FY, UK
E-mail: Thomas.layton@kennedy.ox.ac.uk

Introduction

Advanced malignant neoplasms of the larynx and hypopharynx pose many therapeutic challenges.[1–3] The efficacy of radiotherapy (RT) and chemoradiotherapy has increased the indications for organ preservation treatments, explaining the declining role of total laryngectomy and pharyngolaryngectomy.[4,5] The precise surgical management of these cancers is influenced by diverse clinical and pathological factors.[6] Current indications for primary total laryngectomy or total pharyngolaryngectomy include locally advanced disease (including transcartilage involvement or extralaryngeal extension), a non-functioning larynx with a fixed cord, and contraindications to neoadjuvant chemotherapy.[7,8] In contrast, salvage total laryngectomy and total pharyngolaryngectomy may be favoured, even in cases of small recurrent tumours, if the field has previously been exposed to RT.[9,10] The extent of the surgical resection is influenced by the site of the primary tumour. For advanced hypopharyngeal primary tumours, pharyngolaryngectomy is an appropriate treatment modality. It comprises a total laryngectomy combined with removal of a portion (partial pharyngolaryngectomy) or circumferential segment of the pharynx (total pharyngolaryngectomy).[11,12]

The larynx and pharynx represent complex structures positioned at the junction of the respiratory and digestive tracts, and are vital in maintaining and protecting the airway during swallowing and speech.[8,13,14] Removing these organs therefore carries significant morbidity.[14] Key surgical outcomes following resection include pharyngocutaneous fistula, anastomosis leak and pharyngeal stricture, with each having a profound influence on subsequent quality of life, in particular speech and swallowing.[15–17] Pharyngocutaneous fistula is potentially associated with increased morbidity and mortality, an elongated length of hospital stay, and delayed enteral feeding.[13,18,19] Furthermore, the development of a pharyngeal stricture, most commonly at the level of the anastomosis, often heralds recalcitrant dysphagia and an ultimately poor nutritional status.[6] Accordingly, post-surgical outcomes are an important metric to evaluate and compare the success of surgery and facilitate comparisons between techniques.

Reconstruction of the pharyngeal defect following total pharyngolaryngectomy demands careful consideration[20] and remains an area of debate within surgical discussions.[7,9,21–23] While its primary aim is to seal the neopharynx and prevent a salivary fistula, a secondary aim is to maximise the long-term function of speech and swallowing.[15] Currently, a wide array of reconstructive techniques are available.[14,23–25] These can be stratified into primary closure, visceral interposition, regional flaps (e.g. pectoralis

major) and free tissue transfer, encompassing musculocutaneous, fascio-cutaneous or gastro-intestinal flaps.[21] Free tissue transfer has been proposed by some as providing better outcomes, which is attributed to the recruitment of a vascularised tissue composite to the anastomosis site, with examples including the anterolateral thigh flap and radial forearm free flap.[15,16,22,26] However, others have supported regional flaps and have demonstrated a reduced risk of several post-operative complications with these techniques. Further research is required on post-operative outcomes and their association with distinct reconstructive techniques, to help guide surgical management strategies.

High-level evidence is limited for the optimal reconstruction method for the hypopharynx, and there remains no consensus. Contributing factors are the rarity of these tumours, ethical barriers to randomised, controlled trials, and the evolution of surgical practice. Indeed, the growing repertoire of reconstructive options underlines the reliance on small retrospective case series to compare techniques. We performed a systemic analysis of patients undergoing total laryngectomy, partial pharyngolaryngectomy and total pharyngolaryngectomy across a 20-year period in a single institute. Leveraging the evolution of surgical practice at this institute, we highlight strengths of distinct reconstructive methods. Our results support established factors associated with poorer surgical outcomes, such as previous RT and more extensive pharyngeal resections, as well as suggesting that free tissue transfer may have an important role in the reconstruction of larger pharyngeal defects.

Materials and methods

In this retrospective study, electronic clinical records of all patients undergoing laryngeal and hypopharyngeal resection with or without reconstruction, for carcinoma of the hypopharynx, larynx or upper oesophagus, between 1999 and 2020, at a single institute, were identified. Inclusion criteria included all patients free of distant or metastatic disease at the time of surgery and at six months post-operatively. Exclusion criteria were: patients with synchronous or metachronous tumours, those with incomplete documentation, and patients lost to follow up.

Patients were stratified into primary versus salvage surgical intervention. Salvage procedures were defined as including any patient who had received RT with a curative intent. The tumour–node–metastasis (TNM) classification was defined at the time of initial histological diagnosis using the contemporary American Joint Committee on Cancer edition. Surgical procedures were classified as total laryngectomy, total pharyngolaryngectomy or partial pharyngolaryngectomy. Partial pharyngolaryngectomy was defined as a subtotal pharyngeal resection with a remaining section of native mucosa between resection margins. Total pharyngolaryngectomy was defined as a complete circumferential pharyngeal defect between resection margins. Reconstruction methods were classified as direct closure, pedicled flap, free tissue transfer (free flaps) and intestinal pull up. Pedicled flaps were the pectoralis major, supraclavicular, facial artery musculomucosal and temporalis flaps. Free flaps were the anterolateral thigh flap, free latissimus dorsi and radial forearm free flap.

Clinicopathological data were collected, including patient age, gender, World Health Organization (WHO) performance status, tumour laterality and location. For primary tumours invading multiple subsites, the nidus was determined by the operating surgeon and used for subsite classification. Histology examination was carried out by a specialist head and neck pathologist. Post-operative complications were assessed; these included: the need for revision and repeat procedures, fistula, anastomosis leak, and other post-operative complications such as flap necrosis and failure. In our institute, it is standard of care for all patients to undergo a water-soluble contrast study 7–14 days post-operatively. We used a strict criterion to define post-operative leaks, which included any leak demonstrated on a contrast swallow study regardless of the size or presence of symptoms. In contrast, a fistula was defined as any fistula tract between the pharynx and skin (pharyngocutaneous fistula), the majority of which evolved from a previously demonstrated anastomosis leak. The rate of stricture was defined as any stricture requiring balloon dilatation. Finally, we recorded the time to the first oral intake, for all patients.

Ethical approval

Ethical approval for this study was obtained from the local audit authority committee (clinical improvement module number: 6748).

Statistics

All statistical analysis was performed using R software (RStudio, version 3.5). For comparisons of statistical significance between two variables, a paired *t*-test was used, and for multiple groups a one-way analysis of variance test was used, with an alpha of 0.05. For binary comparisons of categorical variables, a chi-square test was used. An F test was applied to each sample to compare the variance implemented in the 'var.test' R function. In order to test normality assumptions, we analysed the residuals of covariate linear models, in addition to applying a Shapiro–Wilk test of normality. When normality assumptions were not met, a Kruskal–Wallis test or Mann–Whitney U test was used. All tests were two-tailed, and a value of $p < 0.05$ was considered statistically significant.

Results

Patient demographics and treatment overview

A total of 155 patients met the inclusion criteria. During the study, 85 patients underwent total laryngectomy, 32 patients underwent partial pharyngolaryngectomy and 38 patients underwent total pharyngolaryngectomy. One patient with locally advanced chondrosarcoma was included, but all other tumours were squamous cell carcinomas. Patient characteristics and reconstruction data are shown in Table 1. The study included 91 (58 per cent) males and 64 (42 per cent) females, with a mean age of 64.3 years (range, 42–86 years). Stratifying patients based on WHO performance status score demonstrated a mean score of 1; 38 patients had a score of 0, 54 had a score of 1, 40 had a score of 2 and 23 patients had a score of 3.

The overall complication rate was 46.4 per cent (72 out of 155 patients), and all patients were alive six months post-operatively as per the inclusion criteria. Using the Clavien–Dindo classification,[27] post-operative complications were categorised as grade 1 in 7 cases, grade 2 in 20 cases, grade 3 in 41 cases and grade 4 in 4 cases. In all patients, 8.3 per cent (13 out

https://doi.org/10.1017/S0022215122000019 Published online by Cambridge University Press

Table 1. Demographic characteristics and reconstruction data

Characteristic	Total*	Total laryngectomy†	Partial pharyngolaryngectomy‡	Total pharyngolaryngectomy**
Age (mean (range); years)	67.3 (42–86)	63.9 (47–86)	69.8 (42–78)	64.4 (44–80)
Sex (*n*)				
– Male	91	50	20	21
– Female	64	35	12	17
Performance status score (mean (range))	1 (0–3)	1 (0–3)	1 (0–2)	1 (0–3)
Location (*n*)				
– Supraglottis	27	15	6	6
– Glottis	86	65	9	12
– Subglottis	7	5	0	2
– Pyriform	30	0	17	13
– Oesophagus	4	0	0	4
Grade (*n*)				
– Well	21	10	2	6
– Moderate	117	63	22	27
– Poor	27	12	8	5
Tumour (T) stage (*n*)				
– T_0	1	1	0	0
– T_1	9	6	1	2
– T_2	15	8	5	2
– T_3	49	29	14	6
– T_4	81	41	12	28
Nodal (N) stage (*n*)				
– N_X	1	1	0	0
– N_0	60	24	6	12
– N_1	15	27	5	13
– N_2	36	19	20	9
– N_3	3	14	1	1
Post-operative medical prescription? (*n*)				
– Yes	56	33	22	15
– No	59	52	10	23
Procedure (*n*)				
– Primary	104	56	25	23
– Salvage	51	29	7	15
Flap (*n*)				
– None	72	68	0	4§
– Pectoralis major	20	5	14	1
– Anterolateral thigh flap	34	0	6	28
– Supraclavicular	13	3	7	3
– Facial artery musculomucosal	7	0	5	2
– Radial forearm	2	0	2	0
– Temporalis	1	0	1	0
– Latissimus dorsi	3	0	2	1

*$n = 155$; †$n = 85$; ‡$n = 32$; **$n = 38$. §Pull-up surgery only.

of 155) developed a fistula, 9.6 per cent (15 out of 155) suffered a salivary leak and 11.6 per cent (18 out of 155) developed a stricture requiring dilatation. Eight of the 10 patients (80 per cent) who developed a fistula had a previously demonstrated anastomosis leak on a contrast swallow study. In addition, 9.0 per cent of patients (14 out of 155) required a

https://doi.org/10.1017/S0022215122000019 Published online by Cambridge University Press

revision procedure following the tumour resection. The indications for these revision procedures were: haematoma evacuation, fistula repair, incision and drainage of a neck collection, and debridement of the flap. There was one loss of flap (1 out of 155, 0.64 per cent), which was an anterolateral thigh flap; this was excised and revised with a supraclavicular flap that survived. The mean time to first oral intake was 13.2 days (range, 6–59 days).

Tumour subsite analysis

Localisation of the primary tumour was as follows: supraglottis ($n = 27$), glottis ($n = 86$), subglottis ($n = 7$), pyriform fossa ($n = 30$) and oesophagus ($n = 4$). Analysis of histological grade of lesions identified 21 (13.4 per cent) well-differentiated, 117 (75.5 per cent) moderately differentiated and 27 (17.4 per cent) poorly differentiated tumours.

The TNM classifications of tumours based on post-operative histology are listed in Table 1. The most common T stage was T_4 ($n = 81$), followed by T_3 ($n = 49$), T_2 ($n = 15$), T_1 ($n = 9$) and T_0 ($n = 1$). Together, 83.9 per cent of patients (130 out of 155) had advanced tumours (T_3–T_4). With regard to nodal status, N_0 ($n = 60$) was the most common N stage, followed by N_2 ($n = 36$), N_1 ($n = 15$) N_3 ($n = 3$) and N_x ($n = 1$). For primary tumours, 1 was T_1, 3 were T_2, 36 were T_3 and 64 were T_4. Prior to surgery, an initial tumour stage was determined based on endoscopy findings and imaging. Of note, all primary T_1–T_2 tumours were down-staged following surgery and represented historically old cases (1999–2004), suggesting improved accuracy of contemporary staging imaging. For salvage resections, 1 was T_x, 8 were T_1, 12 were T_2, 13 were T_3 and 17 were T_4. No patient had distant metastasis at the time of surgery (M_0, $n = 155$), and all patients were alive six months after their surgery.

Outcomes and type of resection

Tables 2 and 3 illustrate post-operative complications. Post-operative complications occurred in 41.1 per cent (35 out of 85) of total laryngectomies, 46.8 per cent (15 out of 32) of partial pharyngectomies and 65.7 per cent (25 out of 38) of total pharyngolaryngectomies. The overall fistula formation rate was highest after total pharyngolaryngectomy, at 18.4 per cent (7 out of 38), followed by 12.5 per cent (4 out of 32) for partial pharyngolaryngectomy, and 2.4 per cent (2 out of 85) for total laryngectomy ($p = 0.09$) (Figure 1b). Post-operative leaks occurred in 21.4 per cent (8 out of 38) of total pharyngolaryngectomy patients, 15.6 per cent (5 out of 32) of partial pharyngolaryngectomy patients and 2.3 per cent (2 out of 85) of total laryngectomy patients ($p = 0.47$) (Figure 1a). Return to the operating theatre was necessary in 15.3 per cent (13 out of 85) of total laryngectomy patients, 15.6 per cent (5 out of 32) of partial pharyngolaryngectomy patients and 7.9 per cent (3 out of 38) of total pharyngolaryngectomy patients. The percentage of strictures was 1.2 per cent (1 out of 85) for total laryngectomy, 15.6 per cent (5 out of 32) for partial pharyngolaryngectomy and 31.6 per cent (12 out of 38) for total pharyngolaryngectomy ($p = 0.01$) (Figure 1c). Finally, there was a significant difference ($p = 0.02$) between the resection groups in terms of the time to first oral intake, at 11.7 days (range, 6–58 days) for total laryngectomy, 13.9 days (range, 7–54 days) for partial pharyngolaryngectomy and 19.0 days (range, 9–59 days) for total pharyngolaryngectomy (Figure 1d).

Complications after surgery

Tumour resection was performed as a primary procedure in 68.4 per cent of patients (106 out of 155) and as a salvage procedure in 31.6 per cent of patients (49 out of 155). All patients who underwent salvage procedures had received prior RT or chemoradiotherapy with curative intent. Post-operative RT was given to all patients, 44.2 per cent of whom (70 out of 155) were RT naïve. There was a higher rate of fistula in patients undergoing salvage procedures as compared with primary procedures (8.1 per cent *vs* 5.7 per cent, $p = 0.33$; Figure 2b). Patients undergoing surgical salvage were at an increased risk of an anastomosis leak compared with those undergoing primary surgical procedures (16.3 per cent and 13.3 per cent, $p = 0.24$; Figure 2a). Patients undergoing salvage procedures did not exhibit differences in terms of post-operative complications (14.3 per cent and 15.0 per cent, $p = 0.22$) or rate of return to the operating theatre (14.1 per cent *vs* 12.3 per cent, $p = 0.21$). There was a longer time to first oral intake in salvage compared with primary procedures (mean 14.8 *vs* 13.1 days, $p = 0.32$; Figure 2d). Finally, there was a difference in stricture rate between salvage and primary procedures (14.8 per cent *vs* 12.2 per cent, respectively, $p = 0.24$; Figure 2c).

Outcomes by reconstructive method

Seventy-eight patients (48.5 per cent) received no form of reconstruction primarily involving closure of the defect. Of the 155 patients, a pectoralis major flap was used for 20 (12.9 per cent), an anterolateral thigh flap was used for 34 (21.9 per cent), a supraclavicular flap was used for 13 (8.39 per cent) and a facial artery musculomucosal flap was used for 7 (4.5 per cent). In addition, two patients received a radial forearm free flap (1.29 per cent), three received a latissimus dorsi flap (0.65 per cent), one received a temporalis flap (0.65 per cent) and one underwent synchronous facial artery musculomucosal and supraclavicular flaps (0.65 per cent). Four patients (2.58 per cent) underwent gastric pull-up surgery.

The percentages of all post-operative complications varied across reconstruction groups, with 33 per cent (24 out of 72) for direct closure, 52.5 per cent (21 out of 40) for regional flaps, 61 per cent (24 out of 39) for free flaps and 75 per cent (3 out of 4) for gastric pull ups. Table 4 depicts the post-operative complications by reconstructive method and nature of resection. The overall rate of fistula formation was 1.4 per cent (1 out of 72) for direct closure, 17.5 per cent (7 out of 40) for regional flaps, 5.1 per cent (2 out of 39) for free tissue transfer and 0 per cent (1 out of 4) for gastric pull up ($p = 0.08$). Anastomosis leak rates were 9.7 per cent (7 out of 72) for direct closure, 12.5 per cent (5 out of 40) for regional flaps, 23 per cent (9 out of 39) for free flaps and 25 per cent (1 out of 4) for gastric pull ups ($p = 0.4$). The rate of stricture formation was 4.2 per cent (3 out of 72) for direct closure, 10 per cent (4 out of 40) for regional flaps, 30.8 per cent (12 out of 39) for free flaps and 25 per cent (1 out of 4) for gastric pull-up flaps ($p = 0.02$). Furthermore, the rates for return to the operating theatre were 12.5 per cent (9 out of 72) for direct closure, 20 per cent (8 out of 40) for regional flaps, 10.3 per cent (4 out of 39) for free flaps and 0 per cent (0 out of 4) for gastric pull ups. Finally, the mean time for oral first intake was 10.9 days (range, 6–58 days) for direct closure, 15.8 days (range, 7–59 days) for regional flaps, 16.5 days (range, 7–56

https://doi.org/10.1017/S0022215122000019 Published online by Cambridge University Press

Table 2. Post-operative complications

Complication	Total*	Total laryngectomy†	Partial pharyngolaryngectomy‡	Total pharyngolaryngectomy**
Loss of flap? (*n*)				
– Yes	1	0	0	1
– No	154	85	32	37
Leak? (*n*)				
– Yes	15	2	5	8
– No	140	83	27	30
Fistula? (*n*)				
– Yes	13	2	4	7
– No	142	83	28	31
Stricture? (*n*)				
– Yes	18	1	5	12
– No	137	84	27	26
Complications (excl. leak, fistula, stricture, flap loss)? (*n*)				
– Yes	17	1	5	11
– No	138	84	27	27
Return to operating theatre? (*n*)				
– Yes	14	13	5	3
– No	141	72	27	35
Time to 1st oral intake (mean (range); days)	13.2 (6–59)	11.7 (6–58)	13.9 (7–54)	19.0 (9–59)

*$n = 155$; †$n = 85$; ‡$n = 32$; **$n = 38$. Excl. = excluding

Table 3. Post-operative complications by salvage status and nature of resection

Parameter	Leak (%)	Fistula (%)	Stricture (%)
Salvage surgery			
– Total laryngectomy	10.3	10.3	3.5
– Partial pharyngolaryngectomy	14.3	0	14.3
– Total pharyngolaryngectomy	26.7	6.7	40
Primary surgery			
– Total laryngectomy	7.2	3.6	3.6
– Partial pharyngolaryngectomy	20	8.0	12
– Total pharyngolaryngectomy	21.7	8.7	30.4

days) for free flaps and 13.8 days (range, 9–21 days) for gastric pull ups ($p = 0.7$).

Discussion

While total laryngectomy and primary closure is an operation that has been performed since 1873,[28] there remains no consensus on the surgical management of advanced laryngeal and hypopharyngeal tumours that require reconstruction. This study involved a systemic analysis of covariates associated with post-operative outcomes, including the extent of pharyngeal resection, salvage status and method of reconstruction. Overall, our data correspond to the lower end of reported rates for these complications, despite broad inclusion criteria for each. In the literature, the incidence of complications varies from 4.6 per cent to 48.8 per cent[29] for fistula, and from 11 per cent to 60 per cent for strictures.[30,31] In addition, pharyngeal resection is associated with a variety of complications and significant overall morbidity. Previous research has demonstrated that circumferential defects have worse outcomes and more frequent complications when compared with partial defects.[30] The results presented here align with these observations and show that the rates of post-operative fistula (18.4 per cent *vs* 12.5 per cent), anastomosis leak (21.4 per cent *vs* 15.6 per cent) and stricture (31.6 per cent *vs* 15.6 per cent) were higher in total pharyngolaryngectomy than in partial pharyngolaryngectomy.

Prior RT to the operative field is proposed as a key determinant in head and neck surgery outcomes,[32–34] but few studies have directly examined its impact following pharyngolaryngeal resection.[35] One example demonstrated that salvage total laryngectomy, total pharyngolaryngectomy or partial pharyngolaryngectomy were associated with delayed onset of oral intake as compared with primary procedures.[35] In another study, previous RT was shown to have a negative impact on swallowing function but not speech outcomes.[36] Distinct surgical complications such as pharyngocutaneous fistula have also been reported as being increased in patients undergoing salvage partial pharyngolaryngectomy or total pharyngolaryngectomy, but others have found no difference when these were compared with primary procedures.[37] Collectively, our data showed an increased rate of surgical complications following salvage procedures, with higher rates of anastomosis leak, pharyngocutaneous fistula and stricture. Despite this clear trend, we lacked the resolution to show statistical significance between rates of complications. One factor driving this non-significance may be the relatively small number of salvage procedures and post-operative complications compared across subgroups. Future comparisons should

https://doi.org/10.1017/S0022215122000019 Published online by Cambridge University Press

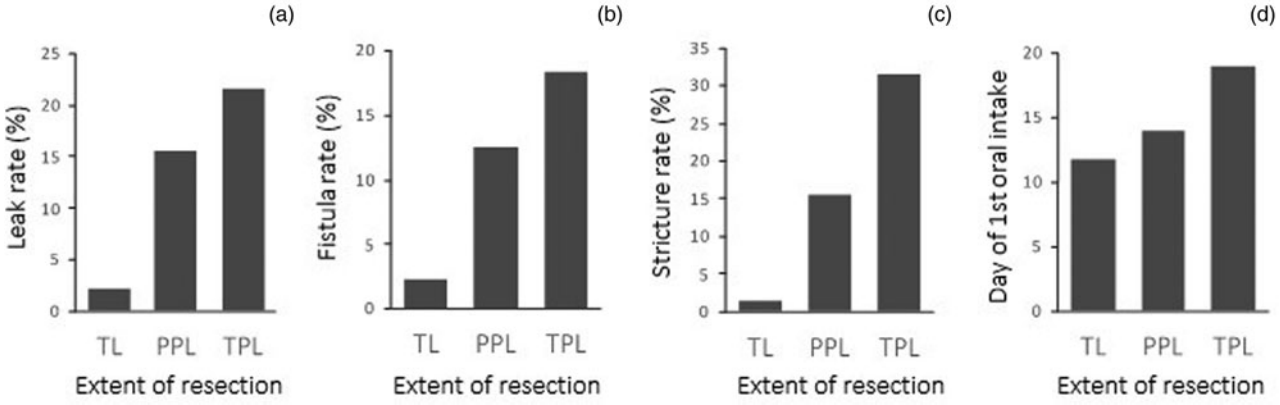

Fig. 1. Bar plots showing the complications by extent of resection, namely: (a) anastomosis leak rate; (b) fistula rate; (c) stricture rate; and (d) day of first oral intake. TL = total laryngectomy; PPL = partial pharyngolaryngectomy; TPL = total pharyngolaryngectomy

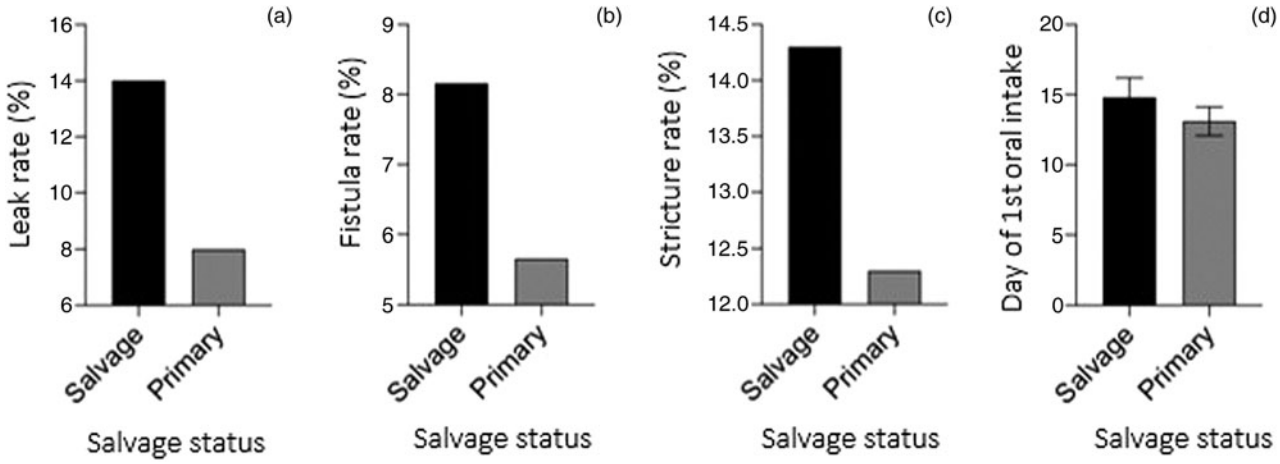

Fig. 2. Bar plots showing the complications by salvage status (primary or salvage), namely: (a) anastomosis leak rate; (b) fistula rate; (c) stricture rate; and (d) day of first oral intake.

Table 4. Post-operative complications by resection status and method of reconstruction

Parameter	Cases (*n*)	Fistula (%)	Leak (%)	Stricture (%)	Time to 1st oral intake (days)
Total laryngectomy					
– None	67	1.5	8.9	6	11
– Regional	17	23.5	5.8	8	14
– Free	1	0	0	13	13
– Pull up	0	N/A	N/A	N/A	N/A
Partial pharyngolaryngectomy					
– None	3	0	33.3	0	11
– Regional	21	9.5	19*	14.3*	14
– Free	8	0	12.5	12.5	19
– Pull up	0	N/A	N/A	N/A	N/A
Total pharyngolaryngectomy					
– None	2	50	0	0	12
– Regional	2	47	0	50	47
– Free	30	6.7	26.7	36.7	16
– Pull up	4	0	25	25	13

*$p < 0.05$. N/A = not applicable

https://doi.org/10.1017/S0022215122000019 Published online by Cambridge University Press

build on our findings and include functional outcomes across primary and salvage procedures, to help delineate differences in longer-term complications.

Defect characteristics have a profound influence on the success of reconstruction[25] in addition to helping to inform which method will be used. For example, cases of circumferential pharyngeal defects requiring a tubed flap have been shown to be at a higher risk of stricture formation.[8,15,37] Given this, we performed a subgroup analysis of post-operative complications by method of reconstruction stratified by the extent of pharyngeal defect (Table 4). Interestingly, this revealed that free tissue transfer had lower rates of anastomosis leak, fistula and strictures for partial pharyngeal defects. In addition, free tissue transfer showed lower rates of fistula and stricture, but a higher rate of anastomosis leak, for total pharyngolaryngectomy. These findings support the use of free tissue transfer for partial pharyngeal defects and possibly for circumferential defects too. Moreover, as our results demonstrated that circumferential defects were associated with worse surgical outcomes, including increased rates of anastomosis leak and fistula, the benefit of free tissue transfer may be more important than previously indicated, and may act to reduce the incidence of complications in higher-risk patients.

Several limitations must be considered when interpreting the findings of this study. Firstly, as is common in large clinical studies, the data are subject to omissions and collection bias. One value of our data is that it represents a single-institute cohort over a 20-year period, but this may introduce a selection bias into those patients entered in the study. Second, the exact nature of the pharyngeal resection exhibits great variability, and our data points are limited to the primary defect site, size and grade, without much detail on the types of resection performed. Third, we used the American Society of Anesthesiologists grade as a crude metric to determine preoperative healthy status, but there are numerous factors that may affect the success of the reconstruction, including smoking status, diabetes and peripheral vascular disease, which are not present in our dataset. The retrospective nature of this study also imposes limits on the interpretation of the results. Finally, there is a surgeon and case selection bias, in that larger tumours are more likely to be selected for more aggressive surgical resection and therefore reconstruction.

- This study investigated clinical outcomes following pharyngolaryngectomy reconstruction
- Salvage procedure is associated with more post-operative complications
- Circumferential pharyngeal defects lead to increased post-operative complications
- This study describes varied reconstructive methods and discusses how these relate to post-operative outcomes
- It provides further evidence suggesting free tissue transfer may be more appropriate to reconstruct larger circumferential pharyngeal defects

Conclusion

Pharyngeal resection carries a substantial risk of post-operative complications. Our results show that circumferential pharyngeal defects and prior RT have a significant impact on complications. Crucially, across a spectrum of reconstructive methods, and leveraging data collected along an evolution of surgical practice, we provide valuable information to support the use of free tissue transfer for larger pharyngeal defects. Building on these retrospective findings, moving forward, prospective data will be valuable to further our understanding of patient and surgical factors that influence outcomes in advanced head and neck malignancies. In addition, including longer-term functional outcomes will provide a complete perspective of outcomes that complements our findings on complications.

Competing interests. None declared

References

1 Sharaf B, Xue A, Solari MG, Boa O, Liu J, Hanasono MM *et al.* Optimizing outcomes in pharyngoesophageal reconstruction and neck resurfacing: 10-year experience of 294 cases. *Plast Reconstr Surg* 2017;**139**:105–19
2 Nagel TH, Hayden RE. Advantages and limitations of free and pedicled flaps in reconstruction of pharyngoesophageal defects. *Curr Opin Otolaryngol Head Neck Surg* 2014;**22**:407–13
3 Yu P, Lewin JS, Reece GP, Robb GL. Comparison of clinical and functional outcomes and hospital costs following pharyngoesophageal reconstruction with the anterolateral thigh free flap versus the jejunal flap. *Plast Reconstr Surg* 2006;**117**:968–74
4 Bonomi MR, Blakaj A, Blakaj D. Organ preservation for advanced larynx cancer: a review of chemotherapy and radiation combination strategies. *Oral Oncol* 2018;**86**:301–6
5 Patel SA, Qureshi MM, Dyer MA, Jalisi S, Grillone G, Truong MT. Comparing surgical and nonsurgical larynx-preserving treatments with total laryngectomy for locally advanced laryngeal cancer. *Cancer* 2019;**125**:3367–77
6 Clark JR, Gilbert R, Irish J, Brown D, Neligan P, Gullane PJ. Morbidity after flap reconstruction of hypopharyngeal defects. *Laryngoscope* 2006;**116**:173–81
7 Nouraei SA, Dias A, Kanona H, Vokes D, O'Flynn P, Clarke PM *et al.* Impact of the method and success of pharyngeal reconstruction on the outcome of treating laryngeal and hypopharyngeal cancers with pharyngolaryngectomy: a national analysis. *J Plast Reconstr Aesthet Surg* 2017;**70**:628–38
8 Moradi P, Glass GE, Atherton DD, Eccles S, Coffey M, Majithia A *et al.* Reconstruction of pharyngolaryngectomy defects using the jejunal free flap: a 10-year experience from a single reconstructive center. *Plast Reconstr Surg* 2010;**126**:1960–6
9 Karri V, Yang M-C, Chung K-P, Chen S-H, Mardini S, Chen H-C. Total pharyngolaryngectomy and voice reconstruction with ileocolon free flap: functional outcome and quality of life. *J Plast Reconstr Aesthet Surg* 2011;**64**:911–20
10 Microvascular Committee of the American Academy of Otolaryngology – Head & Neck Surgery. Salvage laryngectomy and laryngopharyngectomy: multicenter review of outcomes associated with a reconstructive approach. *Head Neck* 2019;**41**:16–29
11 Deleyiannis FW, Weymuller EA Jr, Coltrera MD, Futran N. Quality of life after laryngectomy: are functional disabilities important? *Head Neck* 1999;**21**:319–24
12 Clark JR, de Almeida J, Gilbert R, Irish J, Brown D, Neligan P *et al.* Primary and salvage (hypo)pharyngectomy: analysis and outcome. *Head Neck* 2006;**28**:671–7
13 Denewer A, Khater A, Hafez MT, Hussein O, Roshdy S, Shahatto F *et al.* Pharyngoesophageal reconstruction after resection of hypopharyngeal carcinoma: a new algorithm after analysis of 142 cases. *World J Surg Oncol* 2014;**12**:182
14 Broome M, Juilland N, Litzistorf Y, Monnier Y, Sandu K, Pasche P *et al.* Factors influencing the incidence of severe complications in head and neck free flap reconstructions. *Plast Reconstr Surg Glob Open* 2016;**4**:e1013
15 Lewin JS, Barringer DA, May AH, Gillenwater AM, Arnold KA, Roberts DB *et al.* Functional outcomes after laryngopharyngectomy with anterolateral thigh flap reconstruction. *Head Neck* 2006;**28**:142–9
16 Murray DJ, Gilbert RW, Vesely MJ, Novak CB, Zaitlin-Gencher S, Clark JR *et al.* Functional outcomes and donor site morbidity following circumferential pharyngoesophageal reconstruction using an anterolateral thigh flap and salivary bypass tube. *Head Neck* 2007;**29**:147–54
17 Ward EC, Bishop B, Frisby J, Stevens M. Swallowing outcomes following laryngectomy and pharyngolaryngectomy. *Arch Otolaryngol Head Neck Surg* 2002;**128**:181–6
18 Siddiq S, Paleri V. Outcomes of tumour control from primary treatment of hypopharyngeal cancer. *Adv Otorhinolaryngol* 2019;**83**:90–108

https://doi.org/10.1017/S0022215122000019 Published online by Cambridge University Press

19 van Brederode TD, Halmos GB, Stenekes MW. Functional outcome after one-stage flap reconstruction of the hypopharynx following tumor ablation. *Eur Arch Otorhinolaryngol* 2017;**274**:969–76
20 Zelken JA, Kang CJ, Huang SF, Liao CT, Tsao CK. Refinements in flap design and inset for pharyngoesophageal reconstruction with free thigh flaps. *Microsurgery* 2017;**37**:112–18
21 Sagar B, Marres HA, Hartman EH. Hypopharyngeal reconstruction with an anterolateral thigh flap after laryngopharyngeal resection: results of a retrospective study on 20 patients. *J Plast Reconstr Aesthet Surg* 2010;**63**:970–5
22 Murray DJ, Novak CB, Neligan PC. Fasciocutaneous free flaps in pharyngolaryngo-oesophageal reconstruction: a critical review of the literature. *J Plast Reconstr Aesthet Surg* 2008;**61**:1148–56
23 Hanasono MM. Reconstructive surgery for head and neck cancer patients. *Adv Med* 2014;**2014**:7954–83
24 Kubo T, Seike S, Kiya K, Tomita K, Hosokawa K. Salvage treatment of failed free jejunal flap transfer: our experiences and literature review. *Plast Reconstr Surg Glob Open* 2018;**6**:e1889
25 Kao H-K, Abdelrahman M, Chang K-P, Wu C-M, Hung S-Y, Shyu VB-H. Choice of flap affects fistula rate after salvage laryngopharyngectomy. *Sci Rep* 2015;**5**:9180–90
26 Scharpf J, Esclamado RM. Reconstruction with radial forearm flaps after ablative surgery for hypopharyngeal cancer. *Head Neck* 2003;**25**:261–6
27 Dindo D, Demartines N, Clavien P-A. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004;**240**:261–6
28 Schwartz AW. Dr. Theodor Billroth and the first laryngectomy. *Ann Plast Surg* 1978;**1**:513–16
29 Carsuzaa F, Capitaine A-L, Ferrié J-C, Apert V, Tonnerre D, Frasca D *et al.* Pharyngocutaneous fistulas after total laryngectomy or pharyngolaryngectomy: place of video-fluoroscopic swallowing study. *Head Neck* 2020;**42**:3638–46
30 Mahalingam S, Srinivasan R, Spielmann P. Quality-of-life and functional outcomes following pharyngolaryngectomy: a systematic review of literature. *Clin Otolaryngol* 2016;**41**:25–43
31 Terlingen LT, Pilz W, Kuijer M, Kremer B, Baijens LW. Diagnosis and treatment of oropharyngeal dysphagia after total laryngectomy with or without pharyngoesophageal reconstruction: systematic review. *Head Neck* 2018;**40**:2733–48
32 Esteller E, Vega MC, López M, Quer M, León X. Salvage surgery after locoregional failure in head and neck carcinoma patients treated with chemoradiotherapy. *Eur Arch Otorhinolaryngol* 2011;**268**:295–301
33 Bossi P, Alfieri S, Strojan P, Takes RP, López F, Mäkitie A *et al.* Prognostic and predictive factors in recurrent and/or metastatic head and neck squamous cell carcinoma: a review of the literature. *Crit Rev Oncol Hematol* 2019;**137**:84–91
34 Taguchi T, Nishimura G, Takahashi M, Shiono O, Komatsu M, Sano D *et al.* Treatment results and prognostic factors for advanced squamous cell carcinoma of the head and neck treated with salvage surgery after concurrent chemoradiotherapy. *Int J Clin Oncol* 2016;**21**:869–74
35 Perdoni CJ, Santarelli GD, Koo EY, Karakla DW, Bak MJ. Clinical and functional outcomes after total laryngectomy and laryngopharyngectomy: analysis by tumor subsite, salvage status, and extent of resection. *Head Neck* 2019;**41**:3133–43
36 de Casso C, Slevin NJ, Homer JJ. The impact of radiotherapy on swallowing and speech in patients who undergo total laryngectomy. *Otolaryngol Head Neck Surg* 2008;**139**:792–7
37 Clarke P, Radford K, Coffey M, Stewart M. Speech and swallow rehabilitation in head and neck cancer: United Kingdom National Multidisciplinary Guidelines. *J Laryngol Otol* 2016;**130**:S176–80

https://doi.org/10.1017/S0022215122000019 Published online by Cambridge University Press