Factors affecting swallow outcome following treatment for advanced oral and oropharyngeal malignancies

Nicholas Kalavrezos, MD, FRCS,[1] Stefano Cotrufo, MD, PhD,[1] Roganie Govender, MSc,[1] Pauline Rogers, MSc,[2] Phil Pirgousis, MD, FRACS,[1] Sathesh Balasundram, MCD, FFD,[1] Bagrat Lalabekyan, MSc, PhD,[1]* Colin Liew, FRCS[1]

[1]University College London Hospital, Head and Neck Cancer Service, London, United Kingdom, [2]Biostatistics Group, Research Support Centre, Joint Research Office, University College London, London, United Kingdom

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ABSTRACT: *Background.* Treatment for tumors of the oral cavity and the oropharynx disrupts normal swallow function. The ability for oral diet postoperatively varies and may be influenced by surgery and patient-related factors.

Methods. In all, 114 patients treated with surgery with and without chemoradiotherapy for advanced oral/oropharyngeal cancer were recruited. Clinicopathologic tumor parameters and reconstruction modalities were recorded. Swallow function was determined by oral intake, using the Functional Oral Intake Scale (FOIS) pretreatment and posttreatment.

Results. The median time to first attaining swallow function was 14 days. Patients were less likely to attain tube independence within 1 year of surgery if they received radiotherapy or had a low FOIS score preoperatively. Patients' time to first attaining swallow function postsurgery was inversely related to the FOIS score presurgery.

Conclusions. Swallow function recovery postsurgery is better in patients with higher FOIS presurgery, smaller tumors, and no requirement for radiotherapy. © 2013 Wiley Periodicals, Inc. *Head Neck* **36:** 47–54, 2014

KEY WORDS: swallow, head and neck cancer, oral cancer, reconstruction, radiotherapy

INTRODUCTION

The most common function-related problem resulting from head and neck cancer and its treatment is dysphagia.[1] Patients with oral and oropharyngeal tumors are reported to have the highest percentage of dysphagia with <50% oral intake achieved, compared with those with tumors of other sites of the head and neck.[2] The ability of individuals to resume an oral diet in the months following surgery varies greatly and could be influenced by many factors including additional treatments, particularly radiotherapy and chemotherapy, size,[3,4] site of the tumor,[5] and type of reconstruction,[6–9] as well as patient-related factors such as wound healing, swallow rehabilitation, and personal motivation.

Previous studies have investigated each of these factors to some extent. In one of the seminal and earliest studies, McConnell et al[7] examined how surgical variables may affect postoperative swallowing in 30 patients with oral cancer. In this study, volume of surgical resection, volume of flap reconstruction, and ratio between flap volume and resection volume did not reach significance when correlated with swallow function at 3 months postsurgery. Furthermore, the measure of swallow function used (oral pharyngeal swallow efficiency [OPSE] score) was based on a snapshot obtained during videofluoroscopy and did not necessarily correlate with the patients' day-to-day functional ability to eat and drink.

The relationship between different anatomic sites of the oral cavity and oropharynx and their impact on posttreatment swallowing has been previously investigated. Nicoletti et al[9] reported on 3 main anatomic/functional areas, including the floor of mouth with or without the mandible, the tongue, and finally the retromolar trigone with the soft palate. Furthermore, the permutations of size and site ended up with the creation of 12 subgroups of patients for analysis. More recently, Schache et al[3] examined the effect of different oral and oropharyngeal subsites and its relation to swallow function in 45 patients presurgery, immediately after and 4 months postsurgery. They modified the "oral subsite concept'' by including 3 main domains: lateral: lateral floor of mouth, mandibular body, and/or buccal cavity; anterior: anterior floor of mouth, intercanine segment of mandible, labial vestibule; and central: hemi-, or total oral tongue. Their classification was completed by the inclusion of the oropharyngeal area: retromolar trigone, soft palate, and tonsillar fossa. Their findings suggested that centrally based lesions had the worst prognosis for oral intake, whereas the lateral lesions had the best. The Functional Oral Intake Scale (FOIS) was used as a proxy measure for the swallow function.[10] The advantage of this scale in measuring

***Corresponding author:** B. Lalabekyan, University College London Hospital, Head and Neck Cancer Service, London, UK. E-mail: b.lalabekyan@nhs.net

swallow outcome over the use of single-item scores such as the OPSE is that it more accurately correlates with patient's functional swallow in everyday life and it is more consistently reproducible.

The combination of treatment modalities is considered as the most efficacious in achieving the best locoregional control for advanced disease of the oral cavity but may also cause further deleterious effects to swallow recovery.[11,12]

However, protocols for treatment vary, making comparisons of studies difficult. At our institution patients with advanced oral cancer are treated with surgery followed by radiotherapy. Chemotherapy may be added to the postsurgical radiotherapy regime if there are close or positive surgical margins and/or there is evidence of lymph node extracapsular spread.[13] The addition of chemotherapy for these patients has been shown to improve survival benefit.[14] Absolute benefit of concomitant chemotherapy varies from 4% to 8.9% based on the tumor site.[15] In cases of advanced oropharyngeal cancer, primary chemoradiation is our usual practice, with surgery reserved for salvage in case of disease recurrence.[13] Bone sarcomas, which form a major part of our caseload, are generally treated with planned neoadjuvant chemotherapy followed by surgical excision.[16,17]

Several studies have reported on swallow outcome following primary radiotherapy or chemoradiotherapy for advanced oral/oropharyngeal disease.[18,19] However, large studies that examine swallow function after major ablative surgery and reconstruction to the oral cavity and oropharynx are conspicuously absent in the literature. Therefore, in this study, we examined a cohort of surgical patients treated for advanced oral and oropharyngeal malignancies to determine which factors were most likely to be related to recovery of swallow function postsurgery. At our institution, most patients with advanced disease are given a prophylactic gastrostomy feeding tube.

MATERIALS AND METHODS

A retrospective review was undertaken of medical records of 114 patients with advanced oral and oropharyngeal malignancies, who had surgery with or without radiotherapy or chemoradiation, between January 2005 and August 2009 at our institution. Patients who presented with stage III or stage IV disease were included. The patients with primary bone malignancies were also included because we are a center for the treatment of sarcomas. This study was registered by the local Clinical Governance Committee and data protection was in line with institutional guidance.

Demographic and clinical data were collected along with histologic features of the tumor, and details of the treatment and functional outcome were examined (Table 1).

Patients were grouped by whether and when they received chemotherapy and radiotherapy: patients with advanced stage of oral malignancies treated surgically only; patients with advanced stage of oral malignancies treated surgically with postoperative radiotherapy alone or postoperative chemoradiation; patients treated with surgery as a salvage modality following failure of primary chemoradiotherapy; and patients with non–squamous cell malignancies (sarcoma) treated with planned major surgery following neoadjuvant chemotherapy.

For ease of comparison, we used the same site of defect classification system described by Schache et al,[3] that is, anterior, lateral, central, and oropharyngeal. Reconstructions of surgical defects were performed with the use of free or pedicled flaps. The type of flap used was classified as fasciocutaneous (radial forearm, anterolateral thigh [ALT] flaps), myocutaneous (pectoralis major, latissimus dorsi, vastus lateralis flaps), or composite (fibula, deep circumflex artery, and scapula flaps). The size of defect (cm^2), defined as the largest cross-sectional area of the tumor, and its volume (cm^3) were obtained from the histologic report. The Functional Oral Intake Scale (FOIS)[10] was used in this study to maintain consistency with the earlier study by Schache et al.[3] This is a clinician-rated scale selected for its ability to provide a simple numerical rating to describe a patient's overall oral intake status ranging from nil by mouth (score of 1) to total oral diet with no restrictions (score of 7). The FOIS can be repeated as often as required within the clinical setting by taking a diet history. Although developed for stroke patients, the scale has been used in other populations including head and neck patients.[10,20] All patients had their swallowing assessment recorded preoperatively and at determined intervals postoperatively. For the purpose of this study, the FOIS score obtained preoperatively was included as an explanatory variable. Two outcomes based on postoperative FOIS assessments were analyzed. These were the timing for first attaining swallow function, defined as the time in days to first attaining a FOIS of ≥ 2. This reflects the day postsurgery when the patient was first allowed to have any oral intake based on a swallow assessment by a speech and language therapist. The second outcome was whether the patient achieved feeding tube independence by 12 months posttreatment, which we used as a surrogate measure of good swallow outcomes. Patients who died within 12 months of surgery were classified in accord with their swallow outcome at time of death.

Statistical methods

The background characteristics of the patients were summarized using simple descriptive statistics: frequency distributions for categorical data and mean and standard deviation (SD), or median and interquartile range (IQR), as appropriate, for continuous data.

Single and multivariable logistic regression was used to analyze the binary variable, whether feeding tube independence was achieved by 12 months. Site of defect, largest cross-sectional area (size) and volume of defect, flap reconstruction, preoperative FOIS, age at operation, sex, and radiotherapy were the explanatory variables. Radiotherapy was defined as none (A and D above), postoperative (B above), and preoperative (C above). In multivariable logistic regression the maximum number of coefficients that can be estimated is constrained by the lower frequency of the 2 events. Ten events are required for each coefficient. Thus the following strategy was adopted: a single variable analysis of all independent variables was followed by a multivariable analysis, which included all explanatory variables with $p < .2$ in the

TABLE 1. Background characteristics.

Factor	Frequency (%) ($n = 114$)
Sex	
Female	45 (39.5)
Male	69 (60.5)
Tumor histology	
Squamous cell carcinoma	72 (63.2)
Sarcoma (hard and soft tissue)	20 (17.5)
Other	22 (19.3)
Site of defect	
Lateral	46 (40.4)
Oropharyngeal	17 (14.9)
Central	32 (28.1)
Anterior	19 (16.7)
Flap group	
Fasciocutaneous	54 (47.4)
Myocutaneous	20 (17.5)
Composite	40 (35.1)
Radiotherapy	
None	44 (38.6)
Postoperative	50 (43.9)
Postoperative without chemotherapy	37 (32.5)
Postoperative with concurrent chemotherapy	13 (11.4)
Preoperative only	20 (17.5)
Chemotherapy	
Neoadjuvant	13 (11.4)
FOIS level presurgery	
Nil by mouth	2 (1.8)
Tube dependent with minimal attempts of food or liquid	1 (0.9)
Tube dependent with consistent oral intake of food or liquid	3 (2.6)
Total oral diet of a single consistency	6 (5.3)
Total oral diet with multiple consistencies, but requiring special preparation or compensations	8 (7.0)
Total oral diet with multiple consistencies without special preparation, but specific food limitations	27 (23.7)
Total oral diet with no restrictions	67 (58.8)
Tube-dependent presurgery	
Yes	6 (5.3)
No	108 (94.7)
Age at operation, y	
Mean	54.3
SD	16.6
Range	12–84
Tumor size, cm^2	
Median	45.6
IQR	24–70
Range	4–199.5
Tumor volume, cm^3	
Median	119.4
IQR	60–292.1
Range	2.4–1097.3

Abbreviations: FOIS, Functional Oral Intake Score; IQR, interquartile range.

single-variable analysis. The final multivariable model included only those explanatory variables that were significant at the 5% level.

The time in days to first attaining swallow function postsurgery (ie, a FOIS score of ≥ 2) was analyzed using single and multivariable survival analysis techniques. Survival techniques are the appropriate statistical methods for analyzing time to event data. Patients who had not attained swallow function were censored at the date of the most recent FOIS assessment or date of death. The single-variable analysis summarized the time to first attaining swallow function with medians and Kaplan–Meier curves. The equality of Kaplan–Meier curves stratified by categorical variables was assessed with the log-rank test and confirmed in single-variable Cox regression. Cox regression was used for the multivariable analysis. The Cox regression proportional hazards assumptions were tested by assessing the Schoenfeld residuals. The following strategy was adopted for the multivariable analysis. First, a full model with all explanatory variables was fitted and variables that did not attain 5% significance were dropped.

TABLE 2. Results of Cox regression for time to first attaining swallow function, postsurgery.

	Single variable			Multivariable			Final model		
Factor	HR	95% CI	*p* value (Significance)	Adjusted HR	95% CI	*p* value (Significance)	Adjusted HR	95% CI	*p* value (Significance)
Site of defect									
Lateral	1.00	—*	.6231	1.00	—*	.5803	—*	—*	—*
Oropharyngeal	0.87	0.47–1.59		1.43	0.66–3.08		—*	—*	—*
Central	0.72	0.44–1.18		1.00	0.49–2.04		—*	—*	—*
Anterior	0.84	0.47–1.49		0.84	0.43–1.64		—*	—*	—*
FOIS presurgery	1.70	1.36–2.12	<.0001	1.59	1.24–2.04	<.001	1.61	1.27–2.04	<.001
Age at surgery, y	0.991	0.978–1.003	.1618	0.999	0.986–1.012	.839	—*	—*	—*
Sex									
Female	1.00	—*	.4356	1.00	—*	.648	—*	—*	—*
Male	1.18	0.78–1.77	1.11	0.70–1.76	—*	—*	—*		
Tumor size, cm^2	0.989	0.983–0.996	.0004	0.990	0.983–0.997	.005	0.990	0.984–0997	.003
Tumor volume, cm^3	0.998	0.997–0.999	.0006	—*	—*	—*	—*	—*	—*
Flap group									
Fasciocutaneous	1.00	—*	.0007	1.00	—*	.3930	—*	—*	—*
Myocutaneous	0.36	0.19–0.68		0.79	0.39–1.61		—*	—*	—*
Composite	1.08	0.70–1.66		1.33	0.70–2.53		—*	—*	—*
Radiotherapy									
None	1.00	—*	.0001	1.00	—*	.0129	1.00	—*	.0015
Postoperative	0.50	0.32–0.78		0.53	0.33–0.36		0.49	0.31–0.77	
Preoperative	0.27	0.14–0.53		0.39	0.18–0.83		0.36	0.18–0.71	

Abbreviations: HR, hazard ratio; CI, confidence interval; FOIS, Functional Oral Intake Score; —*, not applicable.

Both multivariable models were confirmed in a sensitivity analysis using backward stepwise selection with variables significant at the 5% level kept in the model.

RESULTS

Characteristics of patients and their treatment

The background characteristics of the 114 patients are summarized in Table 1. Forty five (39.5%) were female. The overall mean age was 54.3 years (range, 12 to 84 years), although female patients were older than male patients: mean age 58.6 years versus 51.6 years.

The site of defect was 46 lateral (40.4%), 17 oropharyngeal (14.9%), 32 central (28.0%), and 19 anterior (16.7%). The defect surface area ranged from 4.0 cm^2 to 199.5 cm^2. The defect volume ranged from 2.4 cm^3 to 1097.3 cm^3. Defect surface and volume did not correlate to the site of defect. The 9 tumors with a volume > 500 cm^3 were double checked as possible outliers and shown to be true and were very large tumors. The flap reconstructions were undertaken: 54 fasciocutaneous (47.4%), 20 myocutaneous (17.5%), and 40 composite, that is, osseo-(myo)-cutaneous flap (35.1%).

Presurgery, only 6 patients (5.3%) were tube dependent (FOIS score of 1) and 67 patients (58.8%) were on a total oral diet with no restrictions (FOIS score of 7). The remainder were on some form of modified textured diet ranging between the extreme ends of the scale.

In terms of treatment groups, 44 patients had surgery only or surgery following neoadjuvant chemotherapy. Twenty patients had salvage surgery following failed chemoradiation. Surgery was followed by postoperative radiotherapy with or without concurrent chemotherapy in 50 patients.

Factors related to time (in days) to first attaining swallow function

Fifteen of the 114 patients (13.2%) had not regained swallow function postsurgery at the time of analysis. The status of 4 of the 15 was not known at this point and were censored at the date of their most recent FOIS assessment: all 4 had been followed up for over 1 year postsurgery. The other 11 had died within 3 months of surgery. Of these 11 patients, only 2 had not received radiotherapy, 6 had received radiotherapy presurgery, and 7 postsurgery. Five were tube dependent presurgery compared with only 6 in the cohort overall.

The median time to first attaining swallow function was 14 days (IQR: 9 to 44 days). Single-variable Cox regression (Table 2) showed FOIS presurgery, tumor size and volume, flap type, and preoperative radiotherapy to be significant predictors for time to first attaining swallow function (in days). The median times to first attaining swallow function for these variables are summarized fully in Table 3. The median time to first attaining swallow function ranged from 10 days (IQR: 8 to 23 days) for patients with a total oral diet presurgery, FOIS 7, to 91 days (IQR: 17 to 1194 days) for patients with a FOIS score presurgery <6. Patients receiving a myocutaneous flap repair took the longest to attain swallow function postsurgery, median 65 days (IQR: 14 to 1194 days). Patients who did not have radiotherapy or chemoradiotherapy recovered the quickest, median 10 days (IQR: 7 to 16 days). Kaplan–Meier curves for time to first attaining swallow function by radiotherapy are given in Figure 1.

Multivariable models showed size and volume to confound each other, with neither attaining statistical

TABLE 3. Median time to first attaining swallow by FOIS presurgery, size and volume of tumor, flap group, and radiotherapy.

	Time to first attaining swallow postsurgery		
	Frequency	Median	IQR
FOIS presurgery			
Under 6	20	91	17–1194
6	27	14	8–40
7	67	10	8–23
Size of tumor, cm^2			
$\leq$24	30	10	8–15
>24 but $\leq$45	27	13	8–21
>45 but $\leq$70	32	22	8–71
>70	25	25	14–203
Volume of tumor, cm^3			
$\leq$60	30	10	8–26
>60 but $\leq$119	27	15	8–44
>119 but $\leq$292	28	9	7–26
>292	29	32	14–20
Flap group			
Fasciocutaneous	54	10	8–26
Myocutaneous	20	65	14–1194
Composite	40	11	8–22
Radiotherapy			
None	44	10	7–16
Postoperative	50	17	10–45
Preoperative	20	26	9–1194

Abbreviations: FOIS, Functional Oral Intake Score; IQR, interquartile range.

significance when the other was taken into account. The backward selection sensitivity analysis included size, so models including size are reported in Table 2. In the final model, FOIS presurgery ($p < .001$), size of tumor ($p = .003$), and need for radiotherapy ($p = .0015$) are predictors of time to first attaining swallow function postsurgery. On average, after adjusting for other variables of interest, patients are 61% more likely to attain swallow function for every 1 unit increase in the presurgery FOIS score (95% confidence interval [CI]: 27% to 104%). Patients receiving postoperative radiotherapy are 51% (95% CI: 23% to 69%) and those receiving preoperative radiotherapy are 74% (95% CI: 29% to 82%) less likely to attain swallow function compared with those who had surgery alone. Patients are 1.0% (95% CI: 0.3% to 1.6%) less likely to attain swallow function for every 1 cm^2 increase in size of tumor.

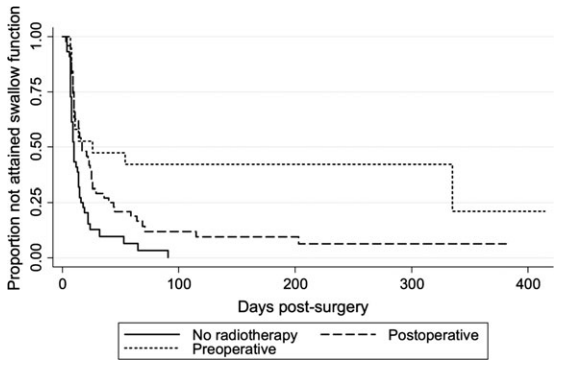

FIGURE 1. Time to first attaining swallow postsurgery in days by radiotherapy (Kaplan–Meier curves).

Factors related to whether tube independence was attained within the first 12 months postsurgery (Table 4)

Single-variable analysis showed the FOIS presurgery, age at surgery, tumor size, tumor volume, flap group, and radiotherapy to be possible predictors for attaining tube independence within the first year postsurgery (all $p < .05$). A multivariable model including these variables showed FOIS presurgery and radiotherapy to be significant predictors, $p = .008$ and $p = .009$. A final model including just these 2 variables showed that on average the odds of attaining tube independence increased 140% (adjusted odds ratio [OR] 2.39, 95% CI: 1.42 to 4.02) for each 1 unit increase in presurgery FOIS score. The odds of patients attaining tube independence if they received radiotherapy, compared with those who did not, were 79% lower if radiotherapy was administered postoperatively (adjusted OR 0.21; 95% CI: 0.07 to 0.62) and 87% lower if radiotherapy had only been administered preoperatively (adjusted OR: 0.13; 95% CI: 0.03 to 0.52).

DISCUSSION

Treatment for oral and oropharyngeal cancer may have a significant deleterious effect on a patient's swallowing and therefore pretreatment swallowing assessment and counseling on the impact of treatment on the swallowing function should be considered fundamental in head and neck cancer management.[21]

Numerous published reports[3,7,19,22] have defined multiple tumor and treatment-related factors that have a significant impact on swallow outcome in patients with oral and oropharyngeal cancer, although studies of the assessment of swallow recovery over a longer time course are lacking. Such data will provide critical information to the clinician for purposes of individual patient prognostication, and to guide intensification of rehabilitation therapy, which is the primary aim of this study. Overall, the analysis of the time taken to first regain swallow function revealed that 25% of patients in our series took over 44 days to first regain swallow function and 15 patients (13%) had not achieved this by end of follow-up or death. Similar levels of long-term dysphagia have been reported by other groups.[4–6,9,19,22,23] Interestingly, the median time taken for swallow recovery in our patients was only 14 days.

Early posttreatment swallowing disorders are mainly related to reduced tongue base retraction and reduced laryngeal elevation, whereas late posttreatment difficulties are attributed to delayed pharyngeal swallow and incomplete cricopharyngeal opening as well.[24] In a study of 170 patients with head and neck cancer, Pauloski et al[2] found that those with oral and oropharyngeal tumors had a higher percentage with <50% oral intake compared with those with tumors of other sites of the head and neck.

Our cohort of 114 patients with advanced-stage oral/oropharyngeal cancer had a median follow-up postsurgery of 17 months. In contrast to most published reports this longer posttreatment follow-up period has proven useful

TABLE 4. Results of logistic regression for attaining tube independence within 12 months of surgery.

	Single variable			Multivariable			Final model		
Factor	OR	95% CI	*p* value (Significance)	Adjusted OR	95% CI	*p* value (Significance)	Adjusted OR	95% CI	*p* value (Significance)
Site of defect									
Lateral	1.0	—*	.2499	—*	—*	—*	—*	—*	—*
Oropharyngeal	0.50	0.16–1.62		—*	—*	—*	—*	—*	—*
Central	0.40	0.15–1.04		—*	—*	—*	—*	—*	—*
Anterior	0.49	0.16–1.49		—*	—*	—*	—*	—*	—*
FOIS presurgery	2.50	1.58–3.98	<.0001	2.16	1.22–3.81	.008	2.39	1.42–4.02	.001
Age at surgery, y	0.97	0.95–1.00	.0439	0.99	0.96–1.02	.545	—*	—*	—*
Sex									
Female	1.0	—*	.1755	1.0	—*	.532	—*	—*	—*
Male	1.71	0.79–3.71	1.37	0.51–3.67	—*	—*	—*		
Tumor size, cm^2	0.988	0.976–0.999	.0237	0.986	0.965–1.008	.203	—*	—*	—*
Tumor volume, cm^3	0.998	0.996–1.000	.0481	1.001	0.965–1.005	.584	—*	—*	—*
Flap group									
Fasciocutaneous	1.0	—*	.0182	1.0	—*	.800	—*	—*	—*
Myocutaneous	0.24	0.08–0.73		0.64	0.14–2.96		—*	—*	—*
Composite	1.07	0.44–2.60		1.10	0.37–3.30		—*	—*	—*
Radiotherapy									
None	1.0	—*	<.0001	1.0	—*	.009	1.0	—*	.005
Postoperative	0.19	0.07–0.52		0.25		0.08–0.76		0.21	0.07–0.62
Preoperative	0.09	0.02–0.30		0.13		0.03–0.55		0.13	0.03–0.52

Abbreviations: OR, odds ratio; CI, confidence interval; FOIS, Functional Oral Intake Score; —*, not applicable.

because it has yielded prognostic data and demonstrated the evolution of swallow recovery over longer follow-up periods. We observed that patients submitted to postoperative radiotherapy may regain swallow function at a later stage compared with the surgery alone group, whereas preoperative radiotherapy seems to have a substantial adverse impact on swallowing recovery because patients in this group might require a year or more to regain swallow (see Figure 1).[19,25–27]

Of interest is that in the multivariable analysis assessing whether tube independence is attained within 12 months of surgery, no tumor characteristics reached significance in predicting swallow outcome. The 2 variables of significance that had the greatest impact on swallow function at 12 months were the presurgery baseline swallow function (FOIS presurgery) and whether the patient had radiotherapy. Suboptimal presurgical baseline swallow function may be attributed to the presence of the tumor or in the case of salvage surgery to the primary chemoradiation.[19,24] In fact, our study confirms this effect, given that patients who had preoperative radiotherapy were 87% less likely to achieve good swallow function or feeding tube independence. The consequence of reduced range of motion due to postradiation fibrosis impacts on both safety (prevention of aspiration) and efficiency (bolus clearance through the pharynx) of swallowing,[28] both of which may result in patients either remaining on feeding tubes for long periods posttreatment or having to make significant changes to the diet texture. It is therefore imperative that organ preservation is not used as the only rationale for offering patients primary chemoradiotherapy if it can be determined that surgery alone can achieve equivalent cure with lesser functional compromise.

The results of our review compare well with some other studies, which report a higher incidence of dysphagia after primary radiotherapy, independent of the site of the primary lesion, compared with similar patients treated with surgery only.[28,29] These findings are observed not just in clinical outcomes of swallow function but also in patient-reported quality of life (QOL) outcomes as found in studies by Schliephake et al[30] and Mittal et al.[31] Zuydam et al[32] reported that the combination of surgery and radiotherapy may have a more deleterious effect for oropharyngeal compared with oral sites.[32] Unfortunately, we had only 17 patients with oropharyngeal tumors in our cohort and therefore have insufficient data for a comparison. There is no evidence in our limited data to confirm the findings of Zuydam et al[32] (data not presented).

Patients with myocutaneous flaps that represented the smallest group of the 3 (17.5%) took the longest time, in days postsurgery, to achieve swallow function (Table 3). Reconstruction of the oral cavity with thin, pliable fasciocutaneous flaps (ie, radial forearm for smaller and ALT flaps for larger defects) correlates well with unimpaired swallow recovery (Table 4). Of interest is that the use of composite flaps has no adverse impact in swallow recovery. There is a general consensus of the superiority of fasciocutaneous flap reconstruction compared with bulky myocutaneous flaps because of the supple nature of the fasciocutaneous tissue providing adequate replacement of intraoral structures without causing tethering and distortion to the mobility of the floor of mouth and tongue elevators.[28,32,33] This is particularly true in large resections of the oral tongue, where reconstruction with thin fasciocutaneous flaps allows the necessary tongue or roof of mouth contact, which is required for bolus movement into the hypopharynx.[34]

In contrast, large bulky myocutaneous flaps can actually hinder the bolus movement by restricting the mobility of the remaining normal tongue and may explain why patients with these flaps took the longest to achieve swallow function.

Tumor size has been implicated as one of the prognosticators of eventual ability to swallow. However, in contrast to reports on the significance of tumor size on swallow recovery, especially in the presence of bilateral floor of mouth tumors,[26,31] in our series tumor size was a significant predictor for early recovery only of swallow function. Moreover, the site of defect, even in the single-variable analyses, did not prove a significant factor affecting the functional swallow outcome postsurgery, a finding similarly observed in the smaller patient subgroup reported by Schache et al.[3] A possible explanation for these inconsistencies is that, although it might be anticipated that poorer scores would be obtained for larger tumors in particular subsites, scores may have been improved by other uncontrolled factors, most notably, intensive swallow rehabilitation and patient motivation. Improved swallowing and improved FOIS scores may therefore counteract the effect of some variables such as tumor size and site, which have been shown to be significant in other studies. This was particularly relevant in the study reported by Schache et al,[3] the outcomes of which initiated further analysis and which formed the foundation part of this review. The outcomes were measured only up to 4 months, a timeframe that is too short to quantify swallow recovery and this deficiency has been addressed in the current study.

In the adjusted analysis, patient's sex and age were not related to attaining tube independence within 12 months postsurgery (Table 4), and this is consistent with the published data.[26]

Overall, there is correlation between extent of pretreatment dysphagia and location and size of the tumor.[2,34] Ten of 20 patients with low pretreatment FOIS score (FOIS <6), had tumor volume >292 cm^3. The low FOIS score was also consistent with central, anterior, and oropharyngeal locations of the original tumor. Our study also demonstrated a consistent relationship between pretreatment FOIS score and recovery of swallow function posttreatment. Pretreatment biomechanical changes caused by the tumor are likely to be carried over and may contribute to posttreatment swallowing impairment.[19,21] Previous studies demonstrated correlation between site and swallow recovery, and our previous study on a small cohort of patients with a shorter follow-up was consistent with these studies, although there is no evidence in the current analysis.

CONCLUSIONS

In this study we have identified and established various tumor and treatment related factors that may predict swallow recovery. Presurgery FOIS or baseline swallow function and radiotherapy were shown to have a statistically significant impact on posttreatment swallow function. The true impact of chemotherapy could not be fully established in this study. Tumor-related factors such as size (ie, largest cross-sectional area of the tumor) were related to immediate postoperative swallow function but were not statistically significant in the long term and may be counteracted by the positive influence of intensive swallow rehabilitation.

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