ORIGINAL ARTICLE

Risk Factors Predicting Aspiration After Free Flap Reconstruction of Oral Cavity and Oropharyngeal Defects

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Objective: To determine risk factors predicting early postoperative aspiration in patients after microvascular free flap reconstruction of oral cavity and oropharyngeal defects.

Design: Retrospective analysis.

Setting: Academic tertiary care referral medical center.

Patients: The study included 100 patients who underwent resection of oral cavity or oropharyngeal tumors with immediate free flap reconstruction of the defect.

Main Outcome Measures: Dysphagia severity was assessed by modified barium swallow study performed within 90 days after surgery to determine the presence or absence of tracheal aspiration. Aspiration risk factors analyzed included age; sex; tumor T and N stage; comorbidity level (American Society of Anesthesiologists classification); preoperative swallowing function; history of tobacco use; surgical approach used for tumor resection; defect classification; type of free flap; history of radiation therapy, surgery, and/or chemotherapy; and surgical defect classification.

Results: The following risk factors were significant predictors of postoperative aspiration on univariate analysis: prior radiation therapy ($P < .001$), tongue base resection classification ($P = .001$), tumor N stage ($P < .001$), hypoglossal nerve sacrifice ($P = .004$), and presence of a mandibular osteotomy ($P = .01$). On multivariate analysis, only a history of radiation therapy ($P = .002$) and tongue base resection ($P = .008$) remained statistically significant predictors of aspiration.

Conclusion: Patients with resection of more than half of the tongue base and patients with a history of radiation therapy are at high risk of having early postoperative aspiration after free flap reconstruction.

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NORMAL OROPHARYNGEAL swallowing requires coordinated actions from structures of the oral cavity, pharynx, larynx, and upper esophagus. Food or liquid boluses must pass though into the esophagus without refluxing into the nasopharynx or penetrating the laryngeal airway. Some or all of these structures and their functions can be temporarily or permanently altered from the surgical management of tumors of the oral cavity and oropharynx.

During surgical resection of tumors of the oral cavity and oropharynx, head and neck surgeons are often faced with the challenge of achieving complete resection margins while preserving a functional swallowing mechanism to avoid postoperative dysphagia and aspiration. Factors considered to influence postoperative swallowing function after surgery in the oral cavity or oropharynx include resections of the mobile and base of tongue,[1,2] age younger than 60 years,[3] type of reconstruction performed,[4,5] and history of radiation therapy.[6] The resulting dysphagia and aspiration risk can lead to prolonged limitations in diet and reduced oral intake, which may necessitate alternate routes of alimentation by nasogastric or gastrostomy tubes.

The purpose of this study was to evaluate risk factors that may lead to early postoperative aspiration in patients undergoing oral cavity or oropharyngeal tumor resection with immediate free flap reconstruction of the surgical defect. We suggest that surgical teams can better formulate perioperative feeding strategies, such

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Table 1. Results of Univariate Statistical Analysis

Defect Site	Pearson χ^2 Value	*P* Value
Tongue base	18.04	.001
Hypoglossal nerve	8.07	.004
Mandibular osteotomy	6.11	.01
Palate	5.26	.07
Lingual nerve	1.37	.24
Mobile tongue	4.51	.34
Mandible	6.54	.36
Pharyngeal wall	1.91	.39
Floor of mouth	1.65	.44
Inferior alveolar nerve	0.46	.50
Lip	0.56	.53
Buccal mucosa	0.30	.62

Table 2. Results of Univariate Statistical Analysis

Variable	Pearson χ^2 Value	*P* Value
N stage	17.15	<.001
Prior radiation therapy	12.93	<.001
Preoperative dysphagia	3.38	.07
Prior chemotherapy	1.03	.31
Age	47.76	.36
Sex	0.24	.62
ASA classification	3.96	.41
T stage	3.88	.42
Surgical approach	1.13	.57
Flap type	2.21	.70
Prior surgery	0.02	.89

Abbreviation: ASA, American Society of Anesthesiologists.

as gastrostomy tube placement and aggressive swallow rehabilitation, in patients who are at high risk for aspiration.

METHODS

A retrospective review was performed in 100 patients with oral cavity or oropharyngeal tumors who underwent resection and free flap reconstruction between 1996 and 2006 at the David Geffen School of Medicine at the University of California, Los Angeles. This study was approved by the UCLA Office for the Protection of Research Subjects. There were 40 women and 60 men, with a mean age of 60 years (age range, 30-88 years). The surgical defects were due to resection of squamous cell carcinoma (n=97), ameloblastoma (n=1), and osteoradionecrosis of the mandible (n=2). Flap donor sites included the fibula (n=49), radial forearm (n=43), latissimus dorsi (n=4), rectus abdominus (n=3), and latissimus dorsi serratus anterior rib (n=1).

Swallowing assessment was done by a modified barium swallow study (MBSS) in all patients. The MBSS was performed between 8 and 87 days (median, 35 days) after surgery. A single speech pathologist (A.E.) performed and analyzed all MBSSs to assess dysphagia severity using standard protocols. Each subject was given small boluses of liquid, puree, and a solid to assess the ability to swallow various food consistencies. Fluoroscopic imaging covered the field from the lips to the cervical vertebrae in the anterior to posterior direction and the soft palate to the midesophagus in the superior to inferior direction. The subject's swallowing efficiency during the oral preparation phase, the oral phase, and the pharyngeal phase was recorded. The presence or absence of tracheal aspiration was the main outcome measure analyzed in this series.

Risk factors analyzed for aspiration included age; sex; comorbidity level according to the American Society of Anesthesiology classification; preoperative swallowing function; tumor T stage; tumor N stage; history of radiation therapy, chemotherapy, or surgery; type of free flap, surgical approach used for tumor resection (ie, mandibular osteotomy, transoral, transhyoid, or lateral pharyngeal); and surgical defect classification. The presence or absence of preoperative dysphagia was determined by a review of the intake history and the review of systems from the patient's chart. Specific information regarding the presence or absence of dysphagia as a presenting symptom was available in only 78 of the 100 patients. A detailed description of the surgical defects was made by the senior author (K.E.B.) in the operative report of each patient according to the method described by Urken et al.[7] Defect subsites that were analyzed included the mandible, lips, floor of the mouth, buccal mucosa, hard palate, oral tongue, tongue base, soft palate, and lateral and posterior pharyngeal walls. Also, the effects of hypoglossal, inferior alveolar, and lingual nerve sacrifice were analyzed.

Statistical analysis was performed using SPSS statistical software (SPSS for Windows 15.0.0; SPSS Inc, Chicago, Illinois). Univariate statistical analysis was performed using the Pearson χ^2 test. As univariate analysis cannot control for interrelationships between measured variables and outcomes, multivariate analysis was performed using logistical regression on those factors showing statistical significance on univariate analysis. Statistical significance was set at a level of $P<.05$.

RESULTS

The donor defect subsites are summarized in the following tabulation:

Defect Site	Quantity
Floor of mouth	81
Mandible	58
Tongue base	52
Mobile tongue, mobile	47
Palate	44
Buccal mucosa	19
Pharyngeal wall	15
Lip	11
Mandible, osteotomy	10

Most patients had defects that involved the floor of the mouth (n=81), mandible (n=58), tongue base (n=52), and mobile tongue (n=47). The types of nerves sacrificed during resection are summarized below:

Nerve Sacrificed	Quantity
Hypoglossal	26
Lingual	53
Inferior alveolar	56

Fifty-one patients had a history of radiation therapy; 27 had a history of head and neck surgery; and 26 had a history of chemotherapy.

On univariate analysis, aspiration was significantly associated with the following risk factors: tongue base resection classification ($P=.001$), sacrifice of the hypoglossal nerve ($P=.004$), history of radiation therapy ($P<.001$), N stage ($P<.001$), and use of a mandibular osteotomy for exposure ($P=.01$) (**Table 1** and **Table 2**). Dysphagia as a presenting symptom approached statistical sig-

Table 3. Incidence of Aspiration

Amount of Tongue Base Resected	No Prior XRT With Aspiration	No Prior XRT Without Aspiration	Incidence of Aspiration Without XRT, %	Prior XRT With Aspiration	Prior XRT Without Aspiration	Incidence of Aspiration With XRT, %
None	3	23	11.54	12	9	57.14
One-fourth	3	3	50.00	5	1	83.33
Half	2	3	40.00	6	4	60.00
Three-fourths	5	2	71.43	8	0	100.00
Entire	4	1	80.00	5	1	83.33

Abbreviation: XRT, radiation therapy.

nificance on univariate analysis ($P=.07$). On multivariate analysis, aspiration was significantly correlated with the following factors: a history of radiation therapy ($P=.002$) and tongue base resection classification ($P=.008$).

Variable	*P* Value
Prior radiation therapy	.001
Tongue base resection	.006
Hypoglossal nerve defect	.07
Mandibular osteotomy	.11
N stage	.47

The incidence of aspiration according to radiation therapy status and tongue base resection classification is summarized in **Table 3**. This analysis shows that in patients without a history of radiation therapy, resection of up to half of the base of the tongue resulted in a 22% incidence of aspiration, while resection of more than half of the base of the tongue was associated with a 75% incidence of aspiration. In patients with a history of radiation therapy, the incidence of aspiration exceeded 50% regardless of the percentage of tongue base resection.

COMMENT

Cancers of the upper aerodigestive tract constitute nearly 4% of all malignant neoplasms. In the head and neck region, oral cavity and oropharynx tumors together account for approximately 52.8% of all malignant neoplasms.[8] Surgery with and without radiation therapy remains the current standard of care in the treatment of the majority of oral cancers.[9] Microvascular flap reconstruction has proved to be very reliable for repairing defects in the oral cavity and the oropharynx as a direct result of the low incidence of free flap failure, the high incidence of primary wound healing,[10,11] and the ability to obtain acceptable results in restoring bony and soft tissue contour.[12] However, even with the best means of treatment and reconstruction available, significant dysphagia is reported to affect 12% to 69% of patients with head and neck cancer 6 to 9 months after treatment.[13] Severe dysphagia can lead to malnutrition, aspiration pneumonia, and even death.[14,15]

Enteral feeding is therefore required in many patients after treatment of oral cavity and oropharyngeal cancer. Citing a low incidence of morbidity, some studies have advocated prophylactic gastrostomy tubes in patients undergoing treatment for head and neck cancer.[14,16,17] However, enteral feeding is not without its disadvantages. Other studies have shown that enteral feeding may be counterproductive when it is not needed. Gillespie et al[18] reported that patients who had been without oral intake for more than 2 weeks had worse swallowing outcomes, possibly owing to swallowing deconditioning, atrophy of pharyngeal musculature, or increased pharyngeal fibrosis. Cheng et al[19] demonstrated that patients with head and neck cancer who receive enteral feedings have a substantially decreased quality of life.

According to these studies, it would be advantageous to avoid enteral feedings in patients who are able to swallow safely. The difficulty lies in predicting which patients would benefit from gastrostomy tube placement after free flap reconstruction of oral cavity and oropharyngeal defects. The present series showed a statistically significant relationship between the incidence of perioperative aspiration and the risk factors of tongue base resection classification ($P=.008$) and a history of radiation therapy ($P=.002$) after multivariate analysis.

The increased dysphagia and aspiration that follow extensive tongue base resection are probably the result of reduction of the bolus driving pressure that propels the food bolus toward the esophagus. Pauloski et al[1] found that the total volume and percentage of tongue base resected were associated with postoperative swallowing dysfunction in 144 patients treated for oral and oropharyngeal cancer 3 months after surgery. McConnel et al[20] found that as the percentage of tongue base resected increased, the efficiency of oropharyngeal swallowing decreased. Similarly, Nicoletti et al[21] found that cases involving smaller resections had better functional outcomes. In their study, swallowing was affected most by the resection of the base of the tongue and the retromolar trigone.

Many reconstructive techniques are used to repair tongue defects. Small defects of the tongue can usually be closed primarily without significant functional loss and with minimal dysphagia. However, prior studies have shown that when more than 50% of the tongue base is resected, free flap reconstruction may provide the best swallowing outcomes.[22,23] Hsiao et al[5] compared patients who had tongue defects that were closed primarily with patients with similar defects that were reconstructed with radial forearm free flaps. Their findings showed that the patients who had tongue defects closed primarily had impaired swallowing compared with those whose defects were reconstructed with microvascular free flaps.

The present series also demonstrates that a history of radiation therapy is a significant predictor of postoperative aspiration. The detrimental effects of radiation therapy on swallowing function are well documented in the literature. Radiotherapy results in long-term swallowing dysfunction due to reduced tongue base movement, reduced laryngeal elevation, reduced salivary flow, edema, and fibrosis.[6,24] Zuydam et al[25] found that radiotherapy exacerbated swallowing dysfunction in patients with more than 25% of the tongue base resected. Their findings also indicate that swallow therapy was effective in treating select patients with postoperative dysphagia and aspiration.

It is important to consider the shortcomings of our analysis. We chose to analyze the presence of aspiration on MBSSs as the main outcome measure as it is an objective finding that indicates an increased risk for aspiration pneumonia. However, not all patients with aspiration on MBSSs will develop aspiration pneumonia while taking oral nutrition. Other factors such as pulmonary reserve and the presence of a protective cough reflex should be considered when making dietary recommendations in patients with aspiration noted on MBSSs. Furthermore, our analysis fails to account for the potential impacts of additional postoperative treatments (eg, radiation therapy and chemotherapy) on deglutition, and these impacts need to be anticipated and considered when recommendations for oral vs enteral nutrition are being made. Finally, our analysis is limited to swallowing function within 90 days of surgery and may not be an indication of long-term functional outcomes. While Pauloski et al[1] noted similar swallowing performance when patients were assessed at 3 months and at 12 months after surgery, other studies have documented progressive improvement in head and neck–specific quality of life over a period of at least 12 months after the completion of treatment.[26]

In conclusion, early swallowing in patients undergoing oral cavity and oropharyngeal resection with free flap reconstruction is significantly affected by a history of radiation therapy and surgical extirpation of more than 50% of the tongue base. Patients with either of these factors are much more likely to have difficulty with aspiration during the first 3 months of the postoperative period. We recommend that patients with these risk factors should be considered likely candidates for perioperative gastrostomy tube placement.

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