Factors Associated with Swallow Dysfunction Before and After Radiation-Based Treatment for Head and Neck Cancer

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Introduction

In the United States head and neck cancers (HNC) account for around 4% of all diagnosed cancers with an estimated 65,000 new cases developing this year[7,8]. Dysphagia (swallowing dysfunction) is a significant toxicity following radiation based treatments. Changes in tongue base retraction and hyolaryngeal excursion are the most common physiologic changes reported. These declines in swallowing function are thought to be due to inflammation and/or fibrosis of the muscles integral for swallowing as a result of radiation injury[1,6,7]. Dysphagia can lead to significant decreases in quality of life for patients and contribute to serious negative clinical outcomes such as aspiration related pneumonia or tube feeding placement to maintain nutrition.
Of those who successfully complete treatment for laryngeal and/or oropharyngeal cancers, approximately 20-30% of these patients will develop a loco-regional recurrence[2]. Re-irradiation is one approach for treatment of these recurrent patients who are not appropriate candidates for surgical resection. However, re-irradiation is challenging due to the risk of severe toxicities. The specific swallowing dysfunctions of patients with recurrent HNC before and after treatment is not clearly understood[4]. The goal of this study was to investigate the relationship between swallowing function and the roles treatment status, recurrence and various demographic characteristics may play in HNC patients.
We hypothesized that patients with a recurrent HNC would have a greater number of swallowing deficits compared to their new HNC patient counterparts. Additionally, we hypothesized that HNC patients with lower socioeconomic-status markers would experience a greater number of swallowing deficits than their more affluent counterparts.

Methods

The information of newly diagnosed head and neck cancer patients was retrospectively gathered from electronic health records. The qualifications for inclusion included, a newly diagnosed squamous cell carcinoma head and neck cancer, treatment via radiation (with or without chemotherapy), and completion of a modified barium swallow study within two years of radiation treatment start date. Of our total HNC patient data base of ~300 patients, 41 of them had one or more modified barium swallow study report available for analysis.

Markers of swallowing function were collected from the MBSS reports for the purpose of analysis. Further information gathered included disease characteristics such as cancer staging, site and recurrence status as well as markers for anxiety/depressions (GAD-7 and PHQ-9 questionnaires).

In addition, various demographic characteristics were collected about each subject to characterize the population and explore the possible relationship between demographics and swallowing function. The 5-year average income of a patient's zip code was used to explore the relationship between socioeconomic status and swallowing outcomes[5].

Preliminary Spearman correlations or Chi-square models determined by the nature of the data in each variable (e.g., if DV was continuous data, used Spearman; if DV was categorical, used Chi-square) were used to investigate the relationship between MBSS performance, disease characteristics and demographic information.

Analysis

Laryngeal Elevation versus Recurrence		Recurent HNC		
		No	Yes	P-value
Standardized Residual	Within Normal Limits	1.2	-2.3	<.001
	Decreased	-1.4	2.7	

Tongue Base Retraction Pre versus Post Radiation		Radiation Status at MBSS		
		Pre	Post	P-value
Standardized Residual	Within Normal Limits	0.8	-1.1	0.025
	Decreased	-1.1	1.5	

Phayngeal Wall Residue Pre and Post Radiation		Radiation Status at MBSS		
		Pre	Post	P-value
Standardized Residual	No residue present	0.7	-1	0.049
	Residue Present	-0.9	1.3	

Vallecula Residue Pre and Post Radiation		Radiation Status at MBSS		
		Pre	Post	P-value
Standardized Residual	No residue present	1.4	-1.9	0.003
	Residue Present	-1.1	1.5	

Pyriform Sinus Residue Pre and Post Radiation		Radiation Status at MBSS		
		Pre	Post	P-value
Standardized Residual	No residue present	0.9	-1.2	0.037
	Residue Present	-0.9	1.2	

Clinical and Demographic Characteristics (n=41)			
		Number of Participants	Percentage
Clinical Characteristics			
Site Category	Oral cavity	12	29.3
	Larynx	13	31.7
	Tonsil	6	14.6
	Oropharynx	7	17.1
	Hypopharynx	3	7.3
T-Staging	T1, T1a	2	4.9
	T1b	1	2.4
	T2	9	22
	T3	16	39
	T4	13	31.7
N-Staging	Nx, N0	21	51.2
	N1	5	12.2
	N2, N2a	4	9.8
	N2b	4	9.8
	N2c	5	12.2
	N3	2	4.9
Reccurent HNC	No	32	78
	Yes	9	22
Radiation Status at MBSS	Prior to start	21	51.2
	After completion	20	48.8
Average PHQ-9 Score=6.10 (mild depression)			
Average GAD-7 Score= 6.51 (mild anxiety)			
Demographic Characteristics			
Race/Ethnicity	Non-Hispanic White	34	82.9
	Black	7	17.1
Relationship Status	Single/Divorced/Widowed	20	48.8
	Married/partnered	21	51.2
Income Range by Zip Code	>60K	13	31.7
	60-80K	17	41.5
	>80K	11	26.8

T-Stage and Laryngeal Elevation (Non-Significant)		T Stage					
		T1, T1a	T1b	T2	T3	T4	P-value
Standardized Residual	Within Normal Limits	-0.2	0.6	-1	0.2	0.6	0.439
	Decreased	0.2	-0.7	1.1	-0.2	-0.7	

N-Stage and Laryngeal Elevation (Non-Significant)		N Stage						
		Nx, N0	N1	N2, N2a	N2b	N2c	N3	P-value
Standardized Residual	Within Normal Limits	0.4	-0.8	0.3	0.1	0.7	-1	0.214
	Decreased	-0.4	0.9	-0.3	-0.1	-0.8	1.5	

Site Category and Laryngeal Elevation (Non-Significant)		Site Category					
		Oral cavity	Larynx	Tonsil	Oropharynx	Hypopharynx	P-value
Standardized Residual	Within Normal Limits	-0.2	0.7	-1	0.5	-0.6	0.439
	Decreased	0.2	-0.8	1.2	-0.6	0.6	

Results

- Our findings demonstrated a significant positive relationship between dysfunction in the pharyngeal stage of swallowing and recurrent head and neck cancers (p<.001). No significant relationship was found between tumour staging and site and laryngeal elevation. This suggests that those presenting with a recurrent head and neck cancer may be at greater risk of dysphagia regardless of site and tumour size compared to a patient presenting with a first time cancer.
- Modified barium swallow studies which were performed following the completion of radiation were more likely to have incomplete/impaired tongue base retraction (p=.025) and pharyngeal wall residue than MBSS performed pre radiation. This suggests that deficits are occurring in the pharyngeal phase of swallowing following treatment. In contrast post radiation MBSS were significantly less likely to have vallecular residue (p=.003) and pyriform sinus residue (p=.037). This distinction stands out as it may suggest swallowing deficits are happening in separate stages of swallowing.
- In contrast to our initial hypothesis we saw no clear significant relationship between socioeconomic status and swallowing function.

Discussion

- Recurrent HNC was associated with an increase in swallowing function deficits. As dysphagia both contributes to negative clinical outcomes and a decrease in quality of life for patients, this study lends credence to the argument that all recurrent HNC patients should receive prophylactic swallowing evaluations at the time of recurrent diagnosis.
- Changes in swallowing function following radiotherapy were observed. Deficits occurred during the pharyngeal phase of swallowing. These findings expand upon the well documented negative effects that radiotherapy can have upon swallowing ability.
- Our study did not observe any relationship between demographic characteristics/socio-economic status and swallowing function. However, we believe comparing standardized scales such as the functional oral intake scale to these factors is worth exploring in future studies as socio-economic status has repeatedly shown to be correlated with physical health[9].

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