

RELATIONSHIP BETWEEN SWALLOW MOTILITY DISORDERS ON VIDEOFLUOROGRAPHY AND ORAL INTAKE IN PATIENTS TREATED FOR HEAD AND NECK CANCER WITH RADIOTHERAPY WITH OR WITHOUT CHEMOTHERAPY

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Abstract: *Background.* Current research demonstrates that swallow function is impaired after treatment with organ-sparing chemoradiotherapy. Few studies, however, have related observed swallowing disorders with the patient's oral intake and diet in a large cohort of patients.

Methods. Swallowing function was examined using the modified barium swallow (MBS) procedure in 170 patients treated with radiotherapy with or without chemotherapy for cancer of the head and neck at 5 evaluation points: pretreatment

and at 1, 3, 6, and 12 months posttreatment. Fisher's exact test was used to examine the relationship between swallow motility disorders and oral intake or diet consistencies.

Results. Limitations in oral intake and diet during the first year after cancer treatment were significantly related to reduced laryngeal elevation, reduced cricopharyngeal opening, and rating of nonfunctional swallow on at least 1 swallow of any bolus type.

Conclusions. Swallow motility disorders had a significant impact on the eating ability of patients after treatment for head and neck cancer with radiotherapy with or without chemotherapy.

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The use of radiotherapy with or without chemotherapy for treatment of cancer of the head and neck as a primary treatment modality has been increasing steadily over the past 20 years.^{1–8}

Although the primary goal of treatment is cure, a perceived additional benefit of this treatment modality is the preservation of the organs of the head and neck, with the underlying assumption being that with preservation of structure there will be preservation of function.^{9,10}

Secondary to cancer cure, the adequacy of swallow function after treatment with chemoradiotherapy is of major interest. The most commonly used technique to observe the swallow, diagnose dysphagia, and develop a treatment plan for patients with impaired swallow function is the modified barium swallow (MBS) procedure with videofluorography (VFG).¹¹⁻¹⁶ Swallowing function is characterized by the motility or movement disorders observed during the MBS study.¹⁷ The current literature on swallowing function in patients treated with radiotherapy with or without chemotherapy for cancer of the head and neck indicates that, despite preservation of the structures of the head and neck, swallow function is not maintained at normal levels after treatment.¹⁸⁻²⁴ The swallow motility disorders reported in the literature for patients during the first few months after treatment with chemoradiotherapy to the head and neck are reduced tongue base retraction,^{18,20,22,24} reduced epiglottic inversion,^{18,21} slowed or reduced laryngeal elevation,^{20,21,22,24} impaired pharyngeal constrictor motility,²¹ delayed pharyngeal swallow,¹⁸ and delayed laryngeal vestibule closure.^{20,21,24} Few studies have followed patients past 6 months posttreatment.^{18,23} These studies indicate that swallow disorders persist up to 12 months posttreatment. The small number of patients followed in these studies is a limiting factor, with the largest series consisting of 26 patients studied twice during the first year posttreatment.¹⁸

Current research demonstrates that swallow function is impaired after treatment with organ-sparing chemoradiotherapy. Few studies, however, have related observed swallowing disorders with the patient's oral intake and diet. The objective of this present study was to determine which motility disorders observed during the MBS are related to reduced oral intake and diet restrictions for a larger cohort of patients treated with radiotherapy with or without chemotherapy for cancer of the head and neck, followed for up to 1 year posttreatment.

MATERIALS AND METHODS

Patients. One hundred seventy patients with cancer of the head and neck served as study subjects.

One hundred thirty-two (78%) of the patients were men, whereas 38 (22%) were women. The patients ranged in age from 35 to 80 years, with an average age of 59 years ($SD = 10$).

Eighty patients (47%) had tumors in the oropharynx. Forty-two patients (25%) had laryngeal tumors, 15 patients (9%) had tumors in the oral cavity, and 14 patients (8%) had tumors in the hypopharynx. Eight patients (5%) had tumors in the nasopharynx, and another 11 patients (6%) presented with an unknown primary. Most patients (72%) had stage IV disease.

All patients received primary radiotherapy or chemoradiotherapy for treatment of their cancer. Twenty-two patients received radiotherapy only, with an average dose to the primary of 6919 cGy. One hundred forty-seven patients received chemoradiotherapy, with an average radiation dose to the primary of 6947 cGy. One patient had missing data for his radiation dose. Chemotherapy drugs included cisplatin, taxol, hydroxyurea, and 5-fluorouracil.

Study Protocol. All procedures were approved by the Institutional Review Board for studies involving human patients at each participating institution. Patients were examined at 5 points in time: before their cancer treatment with radiotherapy with or without chemotherapy, and at 1, 3, 6, and 12 months posttreatment completion. Swallowing function was examined at each of the 5 evaluation points using the MBS procedure with videofluoroscopy following a standard protocol.¹⁷ Patients were imaged in the lateral plane. The study protocol included 2 trials each of 1 mL, 3 mL, 5 mL, and 10 mL of barium liquid and 3 cc of barium paste mixed with chocolate pudding. Not all patients were able to swallow 2 trials of each food consistency at each evaluation point. A patient may have refused to attempt 1 or both trials of a consistency because of known or suspected difficulty with it; the speech-language pathologist also may have judged it as too great a clinical risk to introduce or continue with a specific consistency during the videofluorographic evaluation.

At each evaluation point, patients also were asked to estimate the percentage of their nutrition that they take orally (based on the number of calories taken orally versus number of calories taken via tube feedings) and to indicate which of the following 5 food consistencies were currently included in their diet: thin liquids, thick liquids, pastes/purées, soft masticated, crunchy masticated.

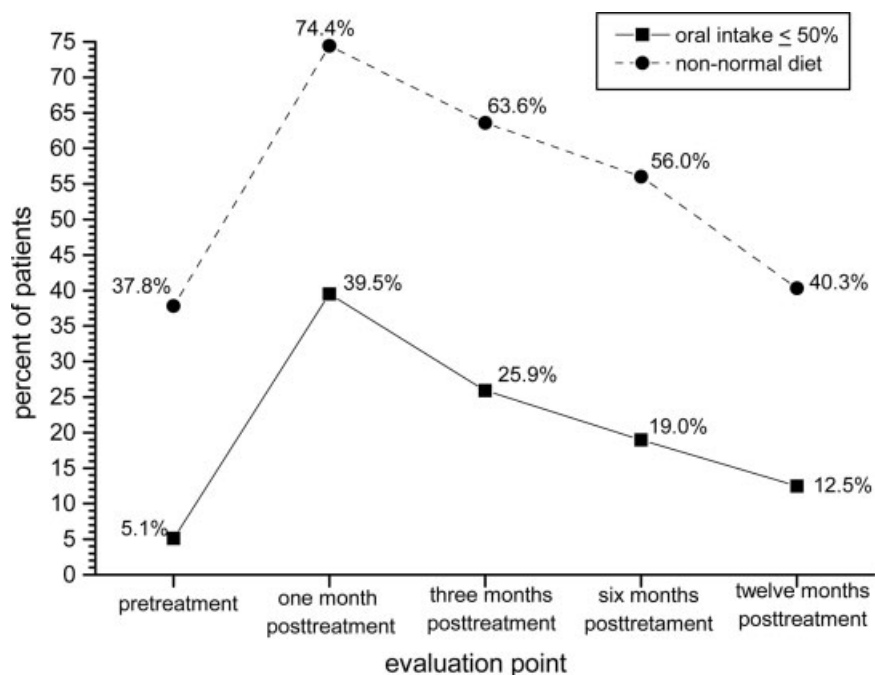


FIGURE 1. Percentage of all patients with oral intake $\leq 50\%$ at each evaluation point (■) and percentage of all patients with non-normal diet (ie, not all consistencies included in diet) at each evaluation point (●).

Data Reduction and Analysis. Each individual bolus was observed for the presence of 21 motility disorders and rated as to whether the swallow was functional, that is, safe and efficient for maintaining oral nutrition. Determination of a non-functional swallow is based on observation of motility disorders observed for the individual bolus as well as prolonged transit times, excessive oral or pharyngeal residue, and/or aspiration. Possible motility disorders included (1) reduced lip closure, (2) tongue thrust, (3) reduced tongue control, (4) reduced vertical tongue movement, (5) reduced anteroposterior (AP) tongue movement, (6) reduced tongue stabilization, (7) reduced tongue lateralization, (8) reduced tongue strength, (9) oral apraxia, (10) delayed pharyngeal swallow, (11) absent pharyngeal swallow, (12) reduced velopharyngeal closure, (13) reduced tongue base retraction, (14) slowed/delayed laryngeal vestibule closure, (15) incomplete laryngeal vestibule closure, (16) reduced laryngeal elevation, (17) reduced glottic closure, (18) unilateral pharyngeal weakness, (19) bilateral pharyngeal weakness, (20) reduced cricopharyngeal opening, and (21) visible cricopharyngeal bar.

For statistical analysis, a patient was classified as having a particular motility disorder if the disorder was present on at least 1 swallow of any bolus type at an evaluation point. A patient was categorized as having a nonfunctional swallow if

at least 1 swallow on any bolus type during an evaluation point were rated as nonfunctional. Fisher's exact test was used to determine whether the presence of a motility disorder or assessment of nonfunctional swallow was significantly related to oral intake and whether the patient included all food consistencies in the diet. Oral intake was dichotomized to either greater than 50% or $\leq 50\%$; diet was classified as either normal (ie, including all 5 food consistencies) or non-normal (ie, lacking at least 1 of the 5 food consistencies).

RESULTS

One-hundred fifty-six patients received the pretreatment evaluation, 86 received the 1-month posttreatment evaluation, 108 received the 3-month posttreatment evaluation, 84 received the 6-month posttreatment evaluation, and 72 received the 12-month posttreatment evaluation.

Motility Disorders Related to Oral Intake. The number of patients with limited oral intake varied depending on evaluation point. Before cancer treatment, 5.1% of all patients had oral intake of $\leq 50\%$ of their nutrition. This number increased 1 month after treatment, then decreased over the first year (Figure 1). Table 1 lists the percentage of patients with oral intake $\leq 50\%$ by site of lesion. Those with oral cavity or oropharyngeal tumors

Table 1. Percentage of patients with oral intake $\leq 50\%$ and percentage of patients with non-normal diet (i.e., not all consistencies included in diet) at each evaluation point for all patients combined and patients by site of lesion.

	Pretreatment	1 mo post	3 mo post	6 mo post	12 mo post
All patients	<i>n</i> = 156	<i>n</i> = 86	<i>n</i> = 108	<i>n</i> = 84	<i>n</i> = 72
% with $\leq 50\%$ oral intake	5.1	39.5	25.9	19.1	12.5
% with non-normal diet	37.8	74.4	63.6	56.0	40.3
Nasopharynx	<i>n</i> = 7	<i>n</i> = 7	<i>n</i> = 4	<i>n</i> = 5	<i>n</i> = 3
% with $\leq 50\%$ oral intake	0.0	28.6	0.0	0.0	0.0
% with non-normal diet	28.6	85.7	75.0	60.0	33.3
Oral cavity	<i>n</i> = 13	<i>n</i> = 7	<i>n</i> = 7	<i>n</i> = 5	<i>n</i> = 6
% with $\leq 50\%$ oral intake	15.4	57.1	42.9	40.0	33.3
% with non-normal diet	69.2	100.0	85.7	60.0	33.3
Oropharynx	<i>n</i> = 73	<i>n</i> = 41	<i>n</i> = 56	<i>n</i> = 42	<i>n</i> = 31
% with $\leq 50\%$ oral intake	8.2	43.9	33.9	19.1	12.9
% with non-normal diet	37.0	73.2	67.9	61.9	51.6
Hypopharynx	<i>n</i> = 14	<i>n</i> = 7	<i>n</i> = 5	<i>n</i> = 2	<i>n</i> = 3
% with $\leq 50\%$ oral intake	0.0	57.1	20.0	50.0	0.0
% with non-normal diet	50.0	85.7	75.0	100.0	0.0
Larynx	<i>n</i> = 39	<i>n</i> = 20	<i>n</i> = 28	<i>n</i> = 24	<i>n</i> = 25
% with $\leq 50\%$ oral intake	0.0	25.0	17.9	16.7	12.0
% with non-normal diet	33.3	65.0	50.0	45.8	36.0
Unknown primary	<i>n</i> = 10	<i>n</i> = 4	<i>n</i> = 8	<i>n</i> = 6	<i>n</i> = 4
% with $\leq 50\%$ oral intake	0.0	25.0	0.0	16.7	0.0
% with non-normal diet	10.0	50.0	50.0	33.3	25.0

tended to have a higher percentage of patients with $\leq 50\%$ oral intake than those with tumors of the nasopharynx, hypopharynx, larynx, or unknown primary. Regardless of the site of the tumor, the percentage of patients who had oral intake of $\leq 50\%$ of their nutrition increased 1 month after treatment, then decreased by 12 months posttreatment.

The following motility disorders were not significantly related to oral intake $\leq 50\%$ at any of the evaluation points: reduced lip closure, tongue thrust, reduced tongue control, reduced tongue stabilization, reduced vertical tongue movement, reduced tongue lateralization, oral apraxia, slowed or delayed laryngeal vestibule closure, absent pharyngeal swallow, reduced velopharyngeal closure, unilateral pharyngeal weakness, or bilateral pharyngeal weakness.

At the pretreatment swallow study, the motility disorders that were significantly related to oral intake of $\leq 50\%$ were reduced anteroposterior tongue movement, reduced tongue strength, reduced laryngeal elevation, and rating of nonfunctional swallow. The percentage of patients who took $\leq 50\%$ of their nutrition by mouth was significantly greater when the disorder was observed.

At the posttreatment evaluations, the disorders related to reduced oral intake varied depending on the evaluation point. At 1 month posttreat-

ment completion, reduced tongue base retraction and reduced laryngeal elevation were the disorders most commonly related to oral intake of $\leq 50\%$. At 3 months posttreatment, delayed pharyngeal swallow, incomplete laryngeal vestibule closure, reduced laryngeal elevation, and a rating of nonfunctional swallow were most often related to reduced oral intake. Reduced laryngeal elevation and rating of nonfunctional swallow continued to be significantly related to reduced oral intake at 6 and 12 months posttreatment. In addition, reduced cricopharyngeal opening appeared as a new relationship.

Table 2 summarizes the percentage of patients who have an oral intake of $\leq 50\%$ and the presence of the most consistently related swallow disorders by evaluation point. Patients with reduced laryngeal elevation, reduced cricopharyngeal opening, or a rating of nonfunctional swallow were significantly more likely to take $\leq 50\%$ of their nutrition orally.

Motility Disorders Related to Non-Normal Diet. Non-normal diet was defined as a diet that did not include all the following food consistencies: thin liquids, thick liquids, pastes/purées, soft masticated, crunchy masticated. Before their cancer treatment, 37.8% of the patients had some restric-

Table 2. Number of patients with or without a specific swallow disorder and percentage of those patients who have $\leq 50\%$ oral intake by presence and absence of reduced laryngeal elevation (RLEL), reduced cricopharyngeal opening (RCPO), or rating of nonfunctional swallow on ≥ 1 bolus by evaluation point; and percentage of patients who have non-normal diet by presence and absence of RLEL, RCPO, or rating of nonfunctional swallow on ≥ 1 bolus by evaluation point.

Evaluation	Reduced laryngeal elevation					
	Patients who have $\leq 50\%$ oral intake			Patients who have non-normal diet		
	Yes-RLEL N (%)	No-RLEL N (%)	<i>p</i> value	Yes-RLEL N (%)	No-RLEL N (%)	<i>p</i> value
Pretreatment	41 (14.6)	114 (.9)	.0014*	41 (58.5)	114 (29.8)	.0014*
1 mo post	23 (65.2)	62 (30.7)	.0058*	23 (91.3)	62 (67.7)	.0288*
3 mo post	39 (38.5)	69 (18.8)	.0387*	38 (84.2)	69 (52.2)	.0014*
6 mo post	29 (34.5)	55 (10.9)	.0172*	29 (79.3)	55 (43.6)	.0024*
12 mo post	26 (26.9)	46 (4.4)	.0089*	26 (69.2)	46 (23.9)	.0003*

Evaluation	Reduced cricopharyngeal opening					
	Patients who have $\leq 50\%$ oral intake			Patients who have non-normal diet		
	Yes-RCPO N (%)	No-RCPO N (%)	<i>p</i> value	Yes-RCPO N (%)	No-RCPO N (%)	<i>p</i> value
Pretreatment	29 (10.3)	126 (3.2)	.1219	29 (48.3)	126 (34.9)	.2049
1 mo post	11 (63.6)	74 (36.5)	.1068	11 (90.9)	74 (71.6)	.2745
3 mo post	34 (38.2)	74 (20.3)	.0601	34 (76.5)	73 (57.5)	.0838
6 mo post	18 (38.9)	66 (13.6)	.0364*	18 (100.0)	66 (43.9)	<.0001*
12 mo post	16 (37.5)	56 (5.4)	.0028*	16 (75.0)	56 (30.4)	.0029*

Evaluation	Nonfunctional swallow rating					
	Patients who have $\leq 50\%$ oral intake			Patients who have non-normal diet		
	Nonfunctional swallow N (%)	Functional swallow N (%)	<i>p</i> value	Nonfunctional swallow N (%)	Functional swallow N (%)	<i>p</i> value
Pretreatment	54 (13.0)	102 (1.0)	.0026*	54 (59.3)	102 (26.5)	.0001*
1 mo post	53 (47.2)	33 (27.3)	.0747	53 (79.3)	33 (66.7)	.2131
3 mo post	79 (35.4)	29 (0.0)	<.0001*	78 (74.4)	29 (34.5)	.0002*
6 mo post	56 (28.6)	28 (0.0)	.0008*	56 (67.9)	28 (32.1)	.0025*
12 mo post	46 (19.6)	26 (0.0)	.0218*	46 (56.5)	26 (11.5)	.0002*

Abbreviations: RLEL, reduced laryngeal elevation; RCPO, reduced cricopharyngeal opening; Yes-RLEL, presence of reduced laryngeal elevation; No-RLEL, absence of reduced laryngeal elevation; Yes-RCPO, presence of reduced cricopharyngeal opening; No-RCPO, absence of reduced cricopharyngeal opening. *Significant Fisher's exact test comparing percentage of patients who have $\leq 50\%$ oral intake between the presence and absence groups or percentage of patients who have non-normal diet between the presence and absence groups.

tions in their diet. This percentage increased to nearly 75% at 1 month posttreatment, then fell to nearly pretreatment levels by 1 year after completion of their cancer treatment (Figure 1). Table 1 lists the percentage of patients with non-normal diet by site of lesion. Patients with oral cavity tumors tended to have the highest percentage of patients with non-normal diet. Regardless of site of tumor, all groups demonstrated an increase in the percentage of patients that had non-normal diet 1 month after treatment completion with a reduction in this percentage by 12 months posttreatment.

Motility disorders significantly related to non-normal diet at pretreatment were: reduced tongue strength, reduced tongue base retraction, delayed vestibule closure, reduced laryngeal elevation,

and rating of nonfunctional swallow. After treatment completion, diet was most often affected by several disorders: reduced laryngeal elevation, reduced cricopharyngeal opening, and rating of nonfunctional swallow. Reduced laryngeal elevation was related to non-normal diet at all post-treatment evaluations, whereas rating of non-functional swallow was also related at the 3-month, 6-month, and 12-month posttreatment evaluations. Reduced cricopharyngeal opening was related to non-normal diet at the 6-month and 12-month posttreatment evaluations.

Table 2 summarizes the percentage of patients who have a non-normal diet and the presence of the most consistently correlated swallow disorders by evaluation point. Patients with reduced

laryngeal elevation, reduced cricopharyngeal opening, or rating of nonfunctional swallow were significantly more likely to have a non-normal diet.

DISCUSSION

One hundred seventy patients with cancerous tumors of various sites of the head and neck were analyzed before and for up to 1 year after completion of treatment with radiotherapy with or without chemotherapy to determine which swallowing disorders observed on the MBS procedure were related to reduced oral intake and limitations in diet. Those with oral cavity or oropharyngeal tumors tended to have a higher percentage of patients with $\leq 50\%$ oral intake than those with tumors of the nasopharynx, hypopharynx, larynx, or unknown primary. Patients with oral cavity tumors tended to have a highest percentage of patients with non-normal diet. Regardless of site of tumor, the percentage of patients with reduced oral intake or non-normal diet increased 1 month after treatment completion and decreased by 12 months posttreatment. Because of the small number of patients in the oral cavity, nasopharynx, hypopharynx, and unknown primary groups, no statistical analyses were performed by site of lesion. The specific swallowing disorders characteristic of patients with specific sites of lesion are the topic of another manuscript currently in preparation.

Before cancer treatment, any swallowing disorders, limitation in oral intake, and deviations from a normal diet would be attributable to the effect of the tumor. Pauloski et al²⁵ reported that patients diagnosed with cancers of the head and neck demonstrated swallowing function before their cancer treatment that was significantly worse than that of control patients of comparable age. Before treatment, a small number of patients would be expected to have oral intake of less than 50%. In this study, we found that approximately 5.1% of all patients at pretreatment had limited oral intake. The disorders observed in this study at the pretreatment evaluation (ie, reduced tongue strength and AP movement, reduced laryngeal elevation, and rating of nonfunctional swallow) suggest the reason for a reduction in oral intake. Reduced tongue strength and AP movement can result in poor bolus clearance from the oral cavity. A patient who has difficulty clearing the bolus from the oral cavity may be unable to ingest sufficient nutrients orally and may need to

supplement oral intake with tube feeding.²⁶ Reduced laryngeal elevation affects pharyngeal clearance²⁷ and may result in residue in the pyriform sinuses; this residue can be aspirated after the swallow.¹¹ The presence of aspiration defines a swallow as nonfunctional. In this study, a rating of nonfunctional swallow was significantly related to reduced oral intake in patients before their cancer treatment.

Before treatment, 38% of patients in this study had a non-normal diet, that is, not all food consistencies were included in their pretreatment diet. The disorders associated with a non-normal diet before treatment can explain why patients may limit their diet choices. Reduced tongue strength, reduced tongue base retraction, and reduced laryngeal elevation can all result in residue in the oral or pharyngeal cavity. Patients who have enough difficulty clearing residue from the aerodigestive tract may avoid troublesome food consistencies. Slowed or delayed laryngeal vestibule closure is an indicator of prolonged bolus transit. If a particular food consistency takes too long for a patient to consume, then he or she is likely to eliminate it from the diet.¹¹

After cancer treatment with chemoradiotherapy, the swallowing disorders most commonly associated with reduced oral intake and limitation in food consistencies were reduced laryngeal elevation, reduced cricopharyngeal opening, and rating of nonfunctional swallow on at least 1 swallow on any bolus type. Patients with these disorders or a rating of nonfunctional swallow on at least 1 swallow on any bolus type were significantly more likely to have an oral intake of $\leq 50\%$ and a non-normal diet.

Laryngeal elevation is necessary for pharyngeal clearance²⁷ and is a major contributor to normal cricopharyngeal opening. Cricopharyngeal opening is created by the elevation and anterior movement of the hypolaryngeal complex.²⁸⁻³¹ In the presence of reduced laryngeal elevation, it is not surprising to see reduced cricopharyngeal opening also occur. Both reduced laryngeal elevation and reduced cricopharyngeal opening can result in excessive postswallow residue, which is at risk of being aspirated. Therefore, it is logical to see a relationship between reduced laryngeal elevation and reduced cricopharyngeal opening with reduced oral intake and restrictions in diet consistencies. The relationship between these nutrition variables and a rating of nonfunctional swallow on at least 1 bolus as observed in this study is also logical. A determination of nonfunctional swallow

is based on several observations from the MBS study including prolonged transit times, excessive oral or pharyngeal residue, and aspiration as well as the presence of swallow motility disorders. Depending on their severity, these problems may lead to the patient's self-restriction in the amount of food taken orally, restrictions on some types of food consistencies, and the need for augmentation of nutrition by nonoral means.

Reduced laryngeal elevation and reduced cricopharyngeal opening may be manifestations of fibrosis of the pharyngeal musculature after radiotherapy. Radiation causes fibrosis of the pharyngeal muscles, with resultant impairment of pharyngeal contraction and fibrosis of the soft tissues, which impairs laryngeal elevation.¹⁹ In their long-term follow-up of 10 patients, Smith et al²³ found that more than 1 year posttreatment, mean duration of laryngeal elevation was significantly prolonged compared with normal. There was a tendency for laryngeal elevation duration to increase over time, suggesting that fibrosis rather than a neurologic process was the major cause of swallow dysfunction after radiotherapy. In our study, the impact of reduced cricopharyngeal opening on oral intake and diet began to appear at 3 months posttreatment and was significantly related to restrictions in sustenance at 6 and 12 months posttreatment. Because cricopharyngeal opening is dependent on hyolaryngeal elevation and anterior movement to pull open the relaxed sphincter, the appearance of reduced cricopharyngeal opening in conjunction with reduced laryngeal elevation at the later evaluation points suggests the progression of fibrosis in the irradiated patients.

Reduced tongue base retraction is a commonly reported motility disorder in the literature, with observed percentages ranging from 55% to 100% of patients treated with chemoradiotherapy.^{18,20,22,24} Reduction in tongue base retraction was also observed in the patients in this study with similarly high percentages of 77.4% pretreatment, 84.7% at 1 month, 92.6% at 3 months, 94.0% at 6 months, and 86.1% at 12 months posttreatment. Despite its high frequency of occurrence, reduced tongue base retraction was not significantly correlated with reduced oral intake or non-normal diet. When nearly every patient in a study demonstrates a specific motility disorder, such as reduced tongue base retraction, that disorder cannot be significantly related to oral intake or non-normal diet unless every patient has restricted nutrition, which is not the case in this study (Figure 1). At

its worst, oral intake was restricted to $\leq 50\%$ of all nutrition in 40% of the patients and non-normal diet occurred in 74% of the patients, both at the 1-month posttreatment evaluation. Although reduced tongue base retraction is indisputably a significant problem for patients treated with chemoradiotherapy, it does not have a differential effect on oral intake and diet in this study.

Reduced laryngeal elevation is reported as a frequently occurring motility disorder after chemoradiation, with 67% to 100% of patients demonstrating the problem in studies with fewer than 15 patients.²⁰⁻²⁴ In our larger cohort of patients, the presence of reduced laryngeal elevation ranged from a low of 26.5% pretreatment to 36.1% at 12 months posttreatment. Although reduced laryngeal elevation occurred less frequently among patients in this study, when the disorder did occur, it had a significant impact on oral intake and diet; it was especially profound on the diet consistencies that patients were able to consume, as observed in Table 2, where more than 70% of the patients with reduced laryngeal elevation had non-normal diets at the various posttreatment evaluations.

CONCLUSION

The purpose of this study was to determine which swallow motility disorders observed on VFG were significantly associated with limitations in oral intake and food consistencies included in the diet of patients treated with chemoradiotherapy for head and neck cancer. The results of this study show that limitations in oral intake and diet after cancer treatment were significantly related to reduced laryngeal elevation, reduced cricopharyngeal opening, and rating of nonfunctional swallow on at least 1 swallow of any bolus type. Although other motility disorders are observed in the swallow of these treated patients, they are not differentially related to oral intake and diet.

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