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Does PEG Use Cause Dysphagia in Head and Neck Cancer Patients?

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Abstract

Percutaneous endoscopic gastrostomy (PEG) use is common in patients who undergo radiotherapy (RT) for head and neck cancer to maintain weight and nutrition during treatment. However, the true effect of PEG use on weight maintenance and its potential impact on long-term dysphagia outcomes have not been adequately studied. This retrospective study looked at swallowing-related outcomes among patients who received prophylactic PEG vs. those who did not, and among patients who maintained oral diets vs. partial oral diets vs. those who were nil per os (NPO). Outcomes were assessed at the end of RT and at 3, 6, and 12 months post RT. A comprehensive review of patients' medical charts for a 6-year period yielded 59 subjects with complete data. Results showed no difference in long-term percent weight change between the prophylactic PEG patients vs. all others, or between patients who, during RT, had oral diets vs. partial oral diets vs. NPO. However, those who did not receive prophylactic PEGs and those who maintained an oral or a partial oral diet during RT had significantly better diet outcomes at all times post RT. Dependence on a PEG may lead to adverse swallowing ability in post-irradiated head and neck cancer patients possibly due to decreased use of the swallowing musculature.

Keywords

Deglutition; Deglutition disorders; Head and neck cancer; Radiotherapy; PEG; Weight; Diet

Dysphagia is a well-known complication of radiotherapy (RT) for head and neck cancer (HNC). The incidence of dysphagia varies greatly by report, with figures ranging anywhere from 9 to 77% [1, 2]. These disparate figures are undoubtedly a result of multiple variables that may impact swallow function such as time after radiation treatment, stage of cancer, additional surgery or chemotherapy, patient characteristics, and response of the patient to the treatment. While instrumental procedures (i.e., fluoroscopy or fiberoptic endoscopic examination of swallowing [FEES]) can yield an objective diagnosis, more functional and more common indicators of a swallowing problem are weight loss, diet level, and the need for a feeding tube.

The need for a feeding tube in patients undergoing radiotherapy is a particularly interesting variable since it is viewed as both beneficial and detrimental for patients. In cancer clinics across the U.S., different institutional policies have prevailed. Some centers avoid placing a feeding tube unless the patient is showing signs of extreme weight loss or reported inability to swallow. Other centers place feeding tubes prophylactically in all patients (or those with advanced-stage cancer) before the RT regime even begins. Evidence for one policy over the other is lacking. Instead, institutional precedent and anecdotal experience are more influential in guiding a physician in his recommendation.

Evidence for best practice in this area is scant. The American Head and Neck Cancer Society's guidelines regarding PEGs state that "Due to the location of their tumors and the mucosal effects of therapy, many patients with head and neck cancer are nutritionally compromised. If highly toxic therapy is planned, placement of a PEG tube prior to starting therapy enables patients to maintain nutrition during therapy and recover more quickly" [3]. These recommendations, which appear to favor prophylactic PEG placement, come from a consensus of practitioners who were selected by the Society and are not necessarily based on evidence from well-designed research studies.

In contrast to these guidelines, recent awareness of the significant dysphagia experienced by some patients after RT and the emphasis on swallowing rehabilitation have led some clinicians to believe that relying on a feeding tube during RT may adversely affect a patient's ultimate ability to swallow. This belief originates from the perception that if a person has a feeding tube during his course of RT, he will depend on it for nutrition and will stop taking anything by mouth because of pain, altered taste, and lack of appetite. While refraining from oral intake may be more comfortable for the patient, clinicians fear that the associated reduction in swallowing frequency may ultimately lead to muscle atrophy and augment the severity of radiation fibrosis in the throat. This belief is not based on strong research either, but it is suggested from one pilot study that showed some benefit to patients who exercised their swallowing muscles during RT [4].

The best evidence for guiding clinical practice comes from well-designed prospective or retrospective research studies. Ideally, patients who received a prophylactic PEG (placed

before or during the first week of RT) would be compared to patients who received a therapeutic PEG (placed after the first week of RT) or to patients who never received a PEG and maintained a 100% oral diet. The outcome of interest would be swallowing status after a given period of time.

A literature search for all such studies published between January 1991 and January 2010 yielded only ten studies with acceptable evidence, including two prospective randomized control trials. Four studies compared prophylactic vs. therapeutic PEG placement [5–8], four studies compared prophylactic PEG to oral/no PEG patients [9, 10], and two studies compared prophylactic PEG to therapeutic PEG and to oral patients (or pooled therapeutic and oral patients) [11, 12]. None of these studies reported swallow status from an instrumental swallow examination; instead, they reported weight loss, use of a feeding tube, or patient/clinician report as surrogate indicators of swallow function.

Looking at *weight loss* as a possible measure of swallow function, the literature suggested that prophylactic PEG favors less weight loss over the course of RT treatment [5,9, 10, 12–14]. Only one study, albeit a randomized clinical trial, found no significant difference in BMI change at the end of RT between patients who received prophylactic PEG vs. patients with therapeutic PEG or oral diets [11]. Reports of comparative weight loss for long-term outcomes were mixed. One study found no significant difference between the prophylactic PEG, therapeutic PEG, and 100% oral diet groups at 3 or 6 months post RT [14]. Two other studies found that prophylactic PEG patients fared better (lost less weight) than therapeutic PEG patients at 12 months post RT [7, 12].

Diet levels were not reviewed in any of the studies, but two studies did look at swallow function via clinician/patient rating scales. Chen et al. [14] found that significantly more patients who had been given a prophylactic PEG reported dysphagia at 3 and 6 months compared to patients who had 100% oral diets. Morton et al. [7] found that patients who had a PEG placed for longer durations, regardless of prophylactic or therapeutic nature, reported worse swallowing function at 12 months ($P < 0.01$).

In summary, there is a paucity of published evidence regarding dysphagia outcomes, and adequate guidelines for PEG placement are clearly lacking. In light of the preliminary results of Chen and Morton suggesting PEGs may detrimentally affect long-term dysphagia outcomes, the present study was undertaken to determine if PEG use influenced long-term swallow function in HNC patients who received radiotherapy at our institution. The first aim was to determine whether patients who received a prophylactic PEG had better or worse swallowing function, diet scores, or weight change outcomes than patients who did not receive a prophylactic PEG. The second aim of this study was to determine whether patients who used a feeding tube for all, some, or none of their nutrition fared differently in terms of eventual swallowing ability, diet level, and weight change. The results of the second question would hopefully cast light on the question of whether the act of eating and using the muscles involved in swallowing would impact long-term dysphagia outcomes.

Materials and Methods

A retrospective chart review was conducted of all head and neck cancer patients treated with RT from January 2003 to September 2008 at Boston University Medical Center. The chart reviews were performed by three authors (KVM, SEL, GPK) using the medical center electronic database and the clinical data warehouse. An initial search of various hospital databases revealed 880 patient records. After excluding patients with ineligible cancer locations (e.g., esophagus, skin) or who did not fall within our eligibility window, a final list of 150 patients remained.

Patients were then excluded from analysis if there was incomplete outcome data at baseline, incomplete outcome data at more than one time point of interest, if they received only a partial dose of RT, or if they had persistence or recurrence of HNC at the time of outcome. Of the 150 medical records, there were 59 patients who met all inclusion and exclusion criteria, and for whom adequate data was available up to 1 year post RT. Approval from the Institutional Review Board of Boston University Medical Center was obtained prior to data collection.

Age, gender, location and stage of cancer, chemotherapy, and extent of surgery were recorded for each patient. Weight, diet level, and PEG status were noted at five time periods: start of RT, completion of RT, 3 months post RT, 6 months post RT, and 12 months post RT. Diet level at each time point was categorized by 6 diet levels listed in Table 1.

Objective instrumental evaluation of swallowing ability would have been an excellent indicator of function, but very few patients had formal swallow studies so this could not be considered. Accordingly, our primary outcomes of interest were percent weight loss and mean diet levels over time, both representing common surrogates of swallow function and dysphagia.

Percent weight loss, rather than absolute weight loss, was used to help account for vastly different body sizes. While weight at the *start of RT* was probably not the subject's usual weight, it was a good baseline from which change over time could be compared, especially to capture the effect of PEG use on weight during RT. However, *end of RT* was chosen as the baseline when recording *diet level* so that changes to this outcome would be a result of variables other than the acute effects of RT (such as pain). The end of RT represented a nadir in diet that was experienced by almost all patients, and any tumor-related dysphagia symptoms had been resolved. So this end-of-RT nadir served as a "normalized" starting point from which we could record changes in diet level over time between different groups of patients.

Data Analysis

Two sets of analyses were conducted to determine the impact of PEG use on long-term diet level and weight change. All analyses used the same cohort of patients, although they were categorized differently depending on the question of interest.

The first set of analyses evaluated whether patients who received a prophylactic PEG (main independent variable) had different outcomes (% weight change and diet scores) than people who did not receive a prophylactic PEG. The second set of analyses assessed whether diet level at the end of RT for all patients (main independent variable) was associated with the two outcomes of interest. Outcomes of interest for both analyses were percent weight change and diet score at 3, 6, and 12 months after completion of RT.

For each of the above analyses, generalized linear mixed-effects models were used to evaluate the relationships of interest. The mixed-effects models were used to account for the correlation from using repeated observations on the same subject. Covariates considered were chemotherapy, stage of cancer, and major surgery. However, due to insufficient data in some cells, the results were adjusted only for surgery. Potential collinearity of covariates was confirmed by calculating the correlation between independent variables; no pair of variables had a Spearman correlation > 0.40 . The association between diet status at baseline and diet scores at follow-up was evaluated in preliminary analyses using the nonparametric Kruskal–Wallis test at each time point, and the results were consistent with the parametric regression analyses. For the diet level analysis, the Tukey–Kramer method was used to identify significant pairwise differences across the different baseline diet groups. Analyses were performed using SAS software ver. 9.1 (SAS Institute, Cary, NC).

Results

Analysis 1: Prophylactic PEG vs. No/Therapeutic PEG

Table 2 summarizes patient descriptive characteristics in this analysis. Of the 59 patients in our cohort, 33 had a PEG placed at some time over the first year. The vast majority (27/33) of patients who had a PEG received it prophylactically (before or during the first week of RT). For this first set of analyses, these 27 patients were our “prophylactic PEG” cohort. Six of the 33 patients had a PEG placed therapeutically: 3 patients had a PEG placed during weeks 2–6 of RT, 2 patients had it placed 6–8 months after RT completion, and 1 patient’s date of PEG placement was not known. Our second cohort included these six therapeutic PEG patients as well as the 26 patients who never received a feeding tube.

Median duration of PEG use was 97 days or about 8 months (range = 61–2,049 days). Over the year, many patients had their PEG removed while a few had a PEG placed. The overall number of patients with a feeding tube was (1) 27/59 or 46% of all patients at the end of RT; (2) 21/59 or 36% at 3 months after the end of RT (20 were prophylactic); (3) 14/59 or 24% at 6 months (12 prophylactic); and (4) 9/59 or 15% at 12 months (7 were prophylactic).

There were 41 men and 18 women in the sample, with a mean age of 58.8 years. The most common sites for cancer were the oral cavity, oropharynx, and nasopharynx (78% in the prophylactic PEG group; 50% in the no/therapeutic PEG group). The majority of patients in both groups had advanced stage IV cancer and had chemotherapy added to their treatment, with a higher proportion in the prophylactic PEG group for each condition. Rates of minor, major, or no surgery were similar in both groups.

In order to determine whether the patients who received a prophylactic PEG had different outcomes over time than patients who did not receive a prophylactic PEG, percent weight loss and mean diet scores were analyzed over time. Table 3 summarizes these results.

Percent Weight Change—Analyses were performed using linear mixed-effects models adjusted for surgery. Percent weight loss between the two groups was analyzed from baseline at the start of RT to the end of RT, and 3, 6, and 12 months post RT. The differences were not statistically significant across time ($P = 0.19$).

Change in Diet Level—Analyses explored whether prophylactic PEG placement affected diet status across time (from baseline at the end of RT to 3, 6, and 12 months after RT). In contrast to weight change results, the prophylactic PEG group had significantly worse diet outcomes than either the no PEG group or the therapeutic PEG group across time ($P = 0.002$).

In summary, these two analyses showed that prophylactic PEG placement by itself did not significantly influence long-term weight changes in head and neck cancer patients, but it did appear to affect diet level up to 1 year after RT. In order to probe these findings further, the next set of analyses were conducted.

Analysis II: Outcomes by Type of Nutritional Intake: 100% PEG Diet vs. Partial PEG/Partial Oral Diet vs. 100% Oral Diet

In this patient population, diet status and feeding tube status are not always analogous. This is because some patients who have a PEG still eat a full oral diet while others are partially or completely reliant on their feeding tubes. Since some people with PEGs had consistent oral diets, we speculated that PEG placement by itself may not be the most important factor influencing long-term diet outcomes. Instead, we wondered if PEG dependence, and hence less frequent use of swallowing musculature, may be more important in influencing long-term dysphagia.

Accordingly, in this second analysis we divided our 59 subjects into three cohorts based on each individual's diet level at the end of RT, regardless of PEG status. These three groups were (1) 100% NPO (nil per os) (diet level 1) representing very little swallowing muscle use, (2) partial PEG/partial oral (diet level 2) representing intermediate swallowing muscle use, and (3) 100% oral intake (diet levels 3–6) representing most swallowing muscle use. As in the first analysis, we analyzed percent weight loss and mean diet scores between groups at baseline and 3, 6, and 12 months after RT. Our hypothesis was that consistent eating and swallowing during RT would help preserve a patient's ability to swallow and thus lead to a more normal long-term diet.

Table 4 delineates descriptive characteristics in this second analysis. At the end of RT, 14 patients were 100% PEG dependent (forming group 1), 8 patients had a partial PEG and partial oral diet (forming group 2), and 37 patients had a 100% oral diet (forming group 3). Of the 37 patients who had a 100% oral diet, 9 had PEGs but were not using them. Overall, most patients reported only minor changes in diet prior to RT (average score was 4.8/6). By

the end of RT, however, many subject's diet levels dropped dramatically, with the average diet score falling to 3.4/6 (liquid or puree/wet soft food).

Patients who relied partially or completely on their PEGs for nutrition all had advanced stage III or IV cancer, while 71% of patients who had a 100% oral diet had stage 3 or 4 cancer. Across all three groups, oral cavity, oropharynx, and nasopharynx cancers were most common, and minor surgery was a common adjuvant therapy. The distribution of major, minor, and no surgery was similar in all groups. The addition of chemo agents to the radiation therapy was common, ranging from 73 to 100%. Intensity-modulated radiation therapy (IMRT) and 3D/conventional radiation therapy techniques were equally represented among the groups.

Percent Weight Change—Percent weight change was recorded at the start of RT, the end of RT, and at 3, 6, and 12 months post RT. Figure 1 shows the mean change in weight over time in these three diet groups ($n = 59$). Longitudinal regression analyses adjusted for surgery revealed no significant difference in weight change across the three groups during the 1 year follow-up (see Table 5). Thus, the results were similar to the earlier analysis of weight change between prophylactic PEG users and all other patients.

Change in Diet Level—Since the data suggested that PEG placement or PEG use alone may not significantly affect weight change, a major question of interest was whether the subjects who were completely dependent on their feeding tubes (FTs) at the end of RT were able to advance their long-term diet levels as well as subjects who were partially dependent on their FTs or as well as those who had 100% oral diets. Using the same three groups defined by diet level at the end of RT, we analyzed mean group diet scores at 3, 6, and 12 months post RT. Preliminary Kruskal–Wallis tests were used to analyze these data (separately by time point), and indicated significant differences in mean diet score between the three groups at all time points ($P < 0.01$). Linear mixed-effects models were then used to evaluate differences in average diet score across all groups longitudinally after adjusting for surgery. Once again, there was a significant difference across all three groups (global $P < 0.001$).

The post-hoc Tukey–Kramer multiple-comparisons procedure showed that both the partial PEG/partial oral group and the 100% oral group had significantly higher mean diet scores than the 100% PEG group over time. There were no significant differences in mean diet scores between the partial PEG/partial oral group and the 100% oral group. Results of statistical analyses are presented in Table 5 and are represented graphically in Fig. 2.

Discussion

The motivation for the current study was the possibility that extended PEG use might hinder swallowing ability. Two indicators of adverse swallowing outcomes were investigated: percent weight loss and diet level. The results of this study showed that there was no significant difference in weight loss among all groups at any time after radiation therapy. It also found that patients who had PEGs placed prophylactically, or patients who relied totally

on their PEGs for nutrition, had significantly worse diet outcomes than patients who did not receive prophylactic PEGs or who continued to eat orally despite receiving a PEG.

Two recent studies suggested that patients who have prophylactic PEGs or who use a PEG for an extended period of time experience adverse outcomes [7, 14]. However, this study is the first to present objective evidence that these patients may develop a more severe dysphagia than patients who do not receive prophylactic PEGs or who do not rely on a PEG for all their nutrition.

Placing PEG tubes prophylactically before radiotherapy is a common practice in many institutions across the U.S. This study suggests that there may be real risks involved in this practice and it should be reanalyzed for its risk/benefit ratio. The median duration of PEG placement in the group studied here was 8 months, which agrees closely with the average duration of prophylactic PEG placement reported in the literature [15–17]. This is a substantial amount of time that a patient must endure an artificial means of feeding, not to mention the associated discomfort, stigma, and hindrance to social eating. The need for long-term PEG use follows a very difficult and traumatic cancer treatment and its associated morbidities and serves to exacerbate an already-decreased quality of life.

The most common reason for placing a PEG prophylactically is to maintain weight, hydration, and nutrition, especially during the painful weeks of radiotherapy which can make this treatment more endurable and in some instances safer. Surprisingly, the current study did not find a significant difference in percent weight change between prophylactic PEG and no/therapeutic PEG patients during RT, in contrast to several other published studies mentioned earlier [5, 9, 10, 12–14]. The current study also found no significant differences in weight loss between the prophylactic PEG and no/therapeutic PEG patients at any time point after RT. When the groups were reorganized into three groups according to diet level at the end of RT rather than the presence or the absence of a prophylactic feeding tube, we still found no significant differences in percent weight loss among the groups.

While long-term weight outcomes at 3, 6, or 12 months after RT are not often reported in the literature, the current findings were in agreement with the one other study that did investigate this outcome [14]. The reason for the discrepancy between findings from the current study and most of the literature is unclear. One may question whether confounding factors such as chemotherapy, stage of cancer, or any other patient or treatment variables could have accounted for our percent weight change results. It may be that the prophylactic PEG and the 100% PEG use groups had a greater share of these adverse factors that would have caused a significantly greater decrease in weight had they not received a prophylactic PEG and/or relied on their PEG. Such a conclusion would suggest that prophylactic PEGs and PEG reliance actually helped these patients minimize weight loss during RT as well as the other patients who did not have these other risk factors.

Table 2, which summarizes the patient demographics, does not support this hypothesis. The majority of patients in all groups had stage III/IV cancer (68% of those patients without prophylactic PEG) and received chemotherapy (74% of that same group). However, while the groups looked fairly similar demographically, they were not equally matched and the

limited sample size precluded us from adjusting statistically for any confounding variable except surgery. Therefore, this question remains unsettled. A future study addressing this paradoxical issue would be extremely interesting and incredibly useful in guiding PEG placement policies.

Diet level was the other outcome investigated in this study. This is arguably the most functional and meaningful indicator of swallowing ability. Change in diet over the first year after RT has not been reported systematically in the literature, but it turned out to be very revealing in this study. When the patients were identified and grouped by the diet they were taking rather than whether they had a PEG, it became possible to study the effect on swallowing outcomes of eating and drinking orally versus depending on a PEG. The motivating question was whether consistent use of the swallowing musculature during and after RT determined long-term diet status. Would PEG reliance, perhaps coupled with radiation-induced fibrosis, translate into disuse atrophy significant enough to promote a chronic dysphagia?

This analysis found that (1) the 100% oral group had significantly higher mean diet scores than the 100% PEG group across time, (2) the partial PEG/partial oral group had significantly higher mean diet scores than the 100% PEG group across time, but (3) there were no significant differences in mean diet scores between the partial PEG/partial oral and 100% oral groups. These were surprising findings. First, we showed that patients who were 100% dependent on their PEGs for nutrition (and remained NPO) not only presented with worse diet outcomes over the first year compared to patients who consumed 100% of their diets orally, but also had worse diet outcomes than patients who had a PEG but continued to take some nutrition orally. Most of those 100% PEG users had their PEGs removed sometime over the course of the year, but their diet levels did not catch up to those of the other patients. In Fig. 2, it can be seen that the 100% PEG intake group (as defined by their diet status at end of RT) were on average consuming only an oral liquid diet at 6 and 12 months post RT, whereas the partial PEG and 100% oral groups were on average consuming several food consistencies. This very functional outcome is clearly meaningful to a person's daily life. Second, this analysis showed that patients who continued to take some nutrition orally, in spite of having a PEG, attained the same long-term diet outcomes as patients who never had a PEG. This suggests that continued oral intake during RT allows for continued use of the swallowing musculature, which in turn may prevent the degree of dysphagia experienced by other patients who rely entirely on their PEGs.

The implications of this study are twofold. First, the community and the individual physician should reconsider recommending prophylactic PEG placement in patients who are likely to depend entirely on the PEG for nutrition unless it is absolutely necessary. There will always be patients who benefit from a PEG and they certainly should not be denied its convenience and ability to deliver much needed nutrition. Those patients probably consist of individuals who are severely malnourished, fragile, and have shown that they are not able to prevent a sharp and consistent weight loss.

Second, and perhaps more important, when a patient is given a PEG, this study suggests that they should be strongly encouraged to continue swallowing something orally on a regular

basis. If the purpose is to prevent atrophy and loss of function of the swallowing musculature, it does not matter what the bolus is: the patient can simply sip water throughout the day. The point is to continue exercising and moving the muscles so that they do not become atrophied, stiff, and potentially locked in by fibrotic tissue.

This interpretation is still hypothetical and should be confirmed by larger studies that are able to control for all known confounders. A prospective randomized clinical trial would provide the best evidence, of course, and would mitigate the limitations of the current study. Since prophylactic PEG placement is still the standard of care in many institutions, an RCT could feasibly be carried out whereby all prophylactic PEG patients are assigned to one of two groups, where one remains NPO and the other takes some nutrition orally throughout the duration of their PEG use. A major improvement over the current study, and all others that have addressed this topic, would be to include formal swallow studies, a standardized diet score, and a QOL scale. The issue is too important to let the status quo stand unchallenged.

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Fig. 1.

Mean percent weight change of three groups from start of RT to 1 year post RT (unadjusted at RT start, adjusted for surgery at all other time points). Groups were categorized by diet level at completion of RT (baseline)

Fig. 2.

Mean diet score over time in three groups defined by diet level at baseline (unadjusted at RT end, adjusted for surgery at all other time points)

Table 1

Diet level categories

Diet level	Description
1	NPO
2	Partial PEG/partial oral
3	Liquid diet
4	Puree and wet soft foods
5	Edentulous or regular food with difficulty or requiring liquid wash
6	Regular diet with no alterations needed

Table 2

Descriptive characteristics for prophylactic PEG vs. no/therapeutic PEG analysis

Characteristics	All patients (n = 59)	Prophylactic PEG (n = 27)	No PEG/therapeutic PEG (n = 32)
Age (years)			
Mean	58.8	57.1	60.3
Range	35–80	40–72	35–80
Sex			
Male	41 (69) ^d	18 (67)	23 (72)
Female	18 (31)	9 (33)	9 (28)
PEG placement	–	27 prophylactic	26 never 6 therapeutic
Disease stage ^a			
I	3 (5)	–	3 (9)
II	7 (12)	–	7 (22)
III	11 (19)	7 (26)	4 (13)
IV	37 (64)	20 (74)	12 (53)
Not staged	1 (2)	–	1 (3)
Tumor site			
Oral cavity, oropharynx, and nasopharynx	38 (64)	21 (78)	17 (53)
Hypopharynx and larynx	13 (22)	3 (11)	10 (31)
Malignant neoplasm of other and ill-defined sites	8 (14)	3 (11)	5 (16)
Surgery			
Minor ^d	31 (52)	15 (55)	16 (50)
Major ^b	11 (19)	4 (15)	7 (22)
None	17 (29)	8 (30)	9 (28)
Chemotherapy	47 (80)	25 (93)	22 (69)
Type of RT			
IMRT	26 (44)	12 (44)	14 (44)
3D/conventional/other	32 (54)	14 (52)	18 (56)

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Characteristics	All patients (n = 59)	Prophylactic PEG (n = 27)	No PEG/therapeutic PEG (n = 32)
Unknown	1 (2)	1 (4)	–

Except for age, all values are number (percent)

^a Stage according to AJCC TNM Staging Guide, 2004

^b Biopsy, neck dissection, and/or tonsillectomy

^c Any surgery more extensive than biopsy, neck dissection, and/or tonsillectomy

^d Values in parentheses indicate percent of group that the adjacent number represents

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Adjusted mean differences in percent weight change and diet levels based on prophylactic PEG use (yes: $n = 27$, no: $n = 31$) at completion of RT

Table 3

	% weight change		Diet level	
	Adjusted mean difference (95% CI) ^a	P value	Adjusted mean difference (95% CI) ^a	P value
Prophylactic PEG (yes vs. no)	-2.19 (-5.50, 1.12)	0.19	-1.11 (-1.78, -0.44)	0.002

^a Adjusted for surgery and time since baseline

Descriptive characteristics of total PEG vs. partial PEG vs. 100% oral groups at baseline (end of RT)

Table 4

Characteristics	All patients (n = 59)	Group 1: all intake via PEG (n = 14)	Group 2: partial PEG/ partial oral (n = 8)	Group 3: 100% oral (n = 37)
Age (years)				
Mean	58.8	61.3	54.9	58.8
Range	35–80	51–79	51–68	35–80
Sex				
Male	41 (69) ^d	9 (64)	7 (88)	25 (68)
Female	18 (31)	5 (36)	1 (12)	12 (32)
Disease stage ^a				
I	3 (5)	–	–	3 (8)
II	7 (12)	–	–	7 (19)
III	11 (19)	5 (36)	1 (12)	5 (14)
IV	37 (63)	9 (64)	7 (88)	21 (57)
Not staged	1 (2)	–	–	1 (3)
Tumor site				
Oral cavity, oropharynx, and nasopharynx	38 (64)	10 (71)	5 (62)	23 (62)
Hypopharynx and larynx	13 (22)	2 (14)	3 (38)	8 (22)
Malignant neoplasm of other and ill-defined sites	8 (14)	2 (14)	–	6 (16)
Surgery				
Minor ^b	31 (52)	11 (79)	4 (50)	16 (43)
Major ^c	11 (19)	–	3 (38)	8 (22)
None	17 (29)	3 (21)	1 (12)	13 (35)
Chemotherapy	47 (80)	12 (86)	8 (100)	27 (73)
Type of RT				
IMRT	26 (44)	5 (36)	4 (50)	17 (46)
3D/conventional/other	32 (54)	8 (57)	4 (50)	20 (54)
Unknown	1 (2)	1 (7)	–	–

Except for age, all values are number (percent)

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^aStage according to AJCC TNM Staging Guide, 2004

^bBiopsy, neck dissection, and/or tonsillectomy

^cAny surgery more extensive than biopsy, neck dissection, and/or tonsillectomy

^dValues in parentheses indicate percent of group that the adjacent number represented

Adjusted mean differences in percent weight change and diet levels based on diet level^a at completion of RT

Table 5

	% weight change		Diet level	
	Adjusted mean difference (95% CI) ^b	P value	Adjusted mean difference (95% CI) ^b	P value
Diet level ^c		0.27		<0.001
Group 2 vs. 1	-3.56 (-10.50, 3.37)		1.61 (0.53, 2.70) ^d	
Group 3 vs. 1	0.39 (-4.55, 5.33)		2.49 (1.73, 3.26) ^d	
Group 3 vs. 2	3.95 (-1.85, 9.76)		0.88 (-0.03, 1.79)	

^a Group 1: 100% PEG, *n* = 14; Group 2: partial PEG/partial oral, *n* = 8; Group 3: 100% oral, *n* = 37

^b Adjusted for surgery and time since baseline

^c Reported *P* values for predictor correspond to global test

^d Significantly different based on Tukey–Kramer method