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Percutaneous Endoscopic Gastrostomy in Oropharyngeal Cancer Patients Treated With Intensity-Modulated Radiotherapy With Concurrent Chemotherapy

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Abstract

BACKGROUND—The clinical benefit of routine placement of prophylactic percutaneous endoscopic gastrostomy (pPEG) tubes was assessed in patients with oropharyngeal cancer (OPC) who are undergoing intensity-modulated radiotherapy (IMRT) with concurrent chemotherapy.

METHODS—From 1998 through 2009, 400 consecutive patients with OPC who underwent chemoradiation were included. Of these, 325 had a pPEG and 75 did not (nPEG). Weight and albumin change from baseline to mid-IMRT, end of IMRT, 1 month post-IMRT, and 3 months post-IMRT were evaluated. The treating physicians prospectively recorded acute and late toxicities.

RESULTS—Significantly lower absolute weight loss at end of IMRT (6.80 kg vs 8.38 kg, $P = .007$), 1 month post-IMRT (9.06 kg vs 11.33 kg, $P = .006$), and 3 months post-IMRT (11.10 kg vs 13.09 kg, $P = .044$) was noted in the pPEG versus nPEG groups. This benefit in reduction of percent weight loss was consistently significant only among patients with BMI < 25. Significant differences were noted in hospital admission rate (15.1% vs 26.7%, $P = .026$) and volume of nonchemotherapy hydration (8.9 liters vs 17.2 liters, $P = .004$). There were no differences in percent albumin change, acute dysphagia, acute mucositis, acute xerostomia, chronic dysphagia, radiation treatment duration, and overall survival. Multivariate analysis noted age >55 years ($P < .001$), female sex ($P < .001$), and T3/4 category disease ($P < .001$) were significantly associated with prolonged PEG use.

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CONFLICT OF INTEREST DISCLOSURE

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CONCLUSIONS—Although pPEG reduced absolute and percent weight loss and need for hospitalizations in our cohort of patients with OPC undergoing chemoradiation, no differences were noted in radiation treatment duration, toxicity, and overall survival. Prolonged PEG use correlated with age >55 years, female sex, and T3/T4 tumors.

Keywords

percutaneous endoscopic gastrostomy; oropharyngeal cancer; intensity-modulated radiotherapy

It was estimated that 39,400 people in the United States were diagnosed with oropharyngeal cancer (OPC) in 2011 with approximately 7900 resultant deaths.¹ Combined modality treatments are widely accepted as primary curative therapy for OPC, especially stage III or IV disease. Unfortunately, the combination of chemotherapy and radiation is associated with significant treatment-related toxicities.^{2,3} Although tolerance to treatment is highly variable, approximately 50% of patients undergoing concurrent chemoradiation develop severe dysphagia, and the majority develop significant mucositis throughout treatment, both of which result in decreased oral intake and resultant malnutrition.^{4,5}

Given increased rates of malnutrition, a variety of interventions have been used to help mitigate weight loss throughout treatment. Historically, enteral feeding in patients with OPC was performed using nasogastric (NG) tubes,⁶ but this trend changed after percutaneous endoscopic gastrostomy (PEG) was first described in the literature in 1980 by Gauderer et al⁷ as a well-tolerated procedure with minimal morbidity and mortality,⁸ allowing long-term nutritional support in patients unable to safely feed orally.⁹ Current indications for PEG placement range from obstruction of the esophagus and neurological impairment to significant dysphagia preventing oral intake.^{10,11}

Given the proximity of disease to the oral and esophageal mucosa, patients with OPC are at increased risk of malnutrition resulting from treatment-related toxicity, as one study reported that OPC patients had, on average, greater weight loss than those with hypopharyngeal, laryngeal, and parotid cancers.¹² Excessive weight loss (>20%) during treatment has been associated with increased complication rates as well as decreased survival.¹³ Thus, it was thought that by providing adequate nutritional support, one could decrease dehydration, malnutrition, fatigue, and other treatment-related complications and improve overall treatment outcomes by limiting medically indicated radiation treatment breaks,¹⁴ which historically have been associated with worse outcomes.¹⁵ Multiple single-institution reports have reported decreased weight loss in patients with OPC who underwent PEG placement.¹⁴ As a result, prophylactic PEG (pPEG) tube placement is widely accepted as a means of enteral supplementation in OPC patients who are at increased risk of developing dehydration and malnutrition secondary to treatment-related mucositis and dysphagia.

Indeed, pPEG placement has been shown in multiple studies to mitigate weight loss throughout therapy, yet many questions remain regarding the overall benefit when used routinely. Although studies have demonstrated preservation of weight, to our knowledge, no studies have demonstrated improved clinical outcomes. To this end, we analyzed a large cohort of consecutive OPC patients who were treated with intensity-modulated radiotherapy

(IMRT) and concurrent chemotherapy to assess the clinical benefit of routine pPEG tube placement.

MATERIALS AND METHODS

Patient Selection

This retrospective study was approved by the institutional review board with a waiver of informed consent. Between September 1998 and April 2009, 403 consecutive patients were identified who had American Joint Committee on Cancer (AJCC) stage I through IV (T1-4, N0-3, and M0) nonrecurrent OPC treated with concurrent IMRT and chemotherapy at Memorial Sloan-Kettering Cancer Center and its affiliated regional sites. Patients were excluded if they were diagnosed greater than 180 days prior to starting treatment (n = 1) or if they died of non-cancer-related causes (n = 2) during treatment. In total, 400 OPC patients were included in this analysis. Patient tumor sites included tonsil (n = 194, 48.5%), base of tongue (n = 188, 47.0%), and other OPC sites (n = 18, 4.5%), which included pharyngeal wall (n = 11) and soft palate (n = 7). All patients were staged according to the the current AJCC Cancer Staging Manual at time of diagnosis (i.e. 1997 or 2002), with complete history and physical examination, focused head and neck evaluation, direct flexible fiber-optic endoscopic examination, complete blood counts, liver function tests, chest X-ray, and dental evaluation.^{16,17} Computed tomography (CT) scans of the chest and abdomen, magnetic resonance imaging (MRI) scans of the head and neck region, and positron emission tomography (PET) scans were obtained whenever possible before the beginning of treatment.

PEG Placement

All PEG tubes were placed by the pull method as described.¹⁸ Dates of PEG insertion and removal were noted for each patient. A pPEG was placed in 325 patients (81.3%), of whom 7 patients did not use their pPEG despite its presence, yet these were included in the pPEG cohort in an intention-to-treat analysis. Of the 75 nPEG patients who refused pPEG placement, 26 patients (34.7%) required acute PEG placement at a mean of 4.9 weeks from the start of IMRT, 3 patients (3.5%) underwent PEG placement at a mean of 19.9 months from the end of IMRT, and 46 patients (61.3%) never required PEG placement.

Chemotherapy

Chemotherapy was administered concurrently with radiation therapy for all patients. Patients received high-dose cisplatin alone, n = 250 (62.5%), consisting of 100 mg/m² for a planned 2 or 3 cycles; cetuximab alone, n = 44 (11.0%), administered as an initial loading dose of 400 mg/m² followed by 7 weekly cycles administered at 250 mg/m²; carboplatin and 5-fluorouracil, n = 44 (11.0%), administered at 70 mg/m² daily for 4 days and 600 mg/m² as a 96-hour infusion, respectively, in 3 cycles every 3 to 4 weeks; cisplatin and bevacizumab, n = 39 (9.8%), administered at 100 mg/m² and 15 mg/kg, respectively, in 2 to 3 cycles; or other chemotherapy regimens, n = 23 (5.8%), which consisted of carboplatin/paclitaxel (n = 10), cetuximab/abraxane (n = 6), cisplatin/paclitaxel (n = 3), cetuximab/docetaxel (n = 2), paclitaxel alone (n = 1), and carboplatin alone (n = 1).

Intensity-Modulated Radiation Therapy

The guidelines for the determination and delineation of the clinical and nodal target volumes have been reported previously in detail.^{19,20} A complete description of our dose-painting IMRT (DP-IMRT) and earlier experience with IMRT using a delayed concomitant boost technique have been described in detail.²¹ Briefly, patients treated with DP-IMRT (93%), which is our current practice, received a median prescribed dose of 70 Gy to the planning target volume (PTV) PTV₇₀, 59.4 Gy to the PTV_{59.4} to the high-risk subclinical disease, and 54 Gy to PTV₅₄ to the lower risk subclinical disease. The median dose per fraction was 2.12 Gy to the PTV₇₀, 1.8 Gy to the PTV_{59.4}, and 1.64 Gy to the PTV₅₄. The remaining 7% were treated with a delayed concomitant boost technique during our earlier experience with IMRT.

Weight and Albumin Monitoring

Percent weight change from baseline, to mid-IMRT (mean 22.9 days from start of IMRT), end-IMRT, 1 month post-IMRT, and 3 months post-IMRT were evaluated; these dates were selected prior to institutional review board submission in an attempt to provide an overview of patient weight trends during and immediately following chemoradiation. Similarly, percent albumin change was calculated over the same time points in 243 patients who had a pre-IMRT albumin value recorded. Patients were stratified by pretreatment body mass index (BMI) into underweight and normal weight (BMI < 25; n = 108, 27.0%), overweight (BMI = 25–29.9; n = 170, 42.5%), and obese (BMI ≥ 30; n = 122, 30.5%) categories.

Toxicity Assessment

Acute toxicities were assessed by the treating radiation and medical oncology physicians using the National Cancer Institute Common Terminology Criteria for Adverse Events, version 3.0, at each weekly on-treatment visit during chemoradiation therapy and in posttreatment follow-up visits.²² Documentation was collected on institutional standardized forms specifically designed to assess and record treatment-related toxicities, including but not limited to dysphagia, mucositis, and xerostomia. The incidence of the worst grade toxicity sustained by a patient up to 90 days after the start of radiation therapy was recorded as an acute toxicity event. All late toxicity (>90 days after treatment completion) was scored using the Radiation Therapy Oncology Group late radiation morbidity scoring system.²³

Follow-Up and Response Assessment

All patients were seen by their radiation oncologists weekly during the course of treatment and in posttreatment follow-up visits jointly by their radiation oncologist, medical oncologist, and/or head and neck surgeons (planned for 4, 8, and 12 weeks after completion of treatment, then every 3 months for 2 years, followed by every 6 months thereafter). After treatment, the patients were evaluated with direct flexible fiber-optic endoscopic examinations along with posttreatment imaging studies (CT, PET/CT, MRI). Recurrences were all verified with biopsy.

Statistical Analysis

Statistical analyses were based on an intention-to-treat analysis comparing pPEG with nPEG. Differences in continuous variables were assessed with nonparametric Wilcoxon-Mann-Whitney tests. Differences in proportions and comparisons of acute and chronic toxicities were performed using the chi-square test. The comparison of rates among the groups was done using the 2-tailed log-rank test. Factors affecting lower percent weight loss at 3 months were analyzed with a high-way analysis of variance. The length of time from the end of IMRT to PEG removal was analyzed individually in univariate analysis and by competing risks regression models in multivariate analyses with backward elimination for variables for a $P \leq .10$ in univariate analysis. A P value $< .05$ was considered statistically significant for all analyses. All statistical computations were performed on JMP software (SAS Institute Inc, Cary, NC).

RESULTS

Patient Characteristics

The median duration of follow-up among living patients was 39.5 months (range, 8.1–135.3 months). The baseline clinical characteristics of the 400 patients dichotomized into pPEG and nPEG cohorts are summarized in Table 1. Significant differences between pPEG and nPEG cohorts were noted, respectively, for age (56.0 years vs 61.0 years, $P = .013$), overall follow-up (41.0 months vs 32.8 months, $P = .007$), and primary tumor site.

Treatment Characteristics

Radiation treatment duration did not differ between the pPEG and the nPEG cohorts. Significant differences between pPEG and nPEG cohorts, respectively, were noted in hospital admission rate (15.1% vs 26.7%, $P = .026$), volume of nonchemotherapy hydrations (8.9 liters vs 17.2 liters, $P = .004$), time to PEG removal (3.4 months vs 5.1 months among the acute PEG, $P = .004$), and chemotherapy regimen (Table 2).

Absolute and Percent Weight Loss

Significantly lower mean absolute weight loss at end-IMRT (6.80 kg vs 8.38 kg, $P = .007$), 1 month post-IMRT (9.06 kg vs 11.33 kg, $P = .006$), and 3 months post-IMRT (11.10 kg vs 13.09 kg, $P = .044$) was noted in patients with pPEG as compared to those with nPEG, with no difference at midtreatment (3.71 kg vs 3.80 kg, $P = .815$; Fig. 1). Similarly, a significantly lower percent mean weight loss was noted in patients with pPEG placement than nPEG patients at end-IMRT (7.53% vs 9.37%, $P = .002$), 1 month post-IMRT (9.92% versus 12.53%, $P = .001$), 3 months post-IMRT (12.01% versus 14.34%, $P = .009$), but not at midtreatment assessment (4.11% vs 4.16%; $P = .960$; Fig. 2). In addition, pPEG patients had a significantly lower mean change in BMI than nPEG patients at 3 months post-IMRT (3.56 vs 4.25, $P = .027$).

Univariate analysis revealed pPEG placement, Karnofsky performance status (KPS) ≥ 80 , other subsite of tumor (versus tonsil and base of tongue), and patients receiving carboplatinum plus 5-fluorouracil or other chemotherapy, which consisted largely of a taxane plus a platinum-based agent, versus cisplatin alone, cetuximab alone, and cisplatin

combined with bevacizumab were significantly associated with a lower percent weight loss at 3 months post-IMRT. Multivariate analysis confirmed a significantly lower percentage of weight loss at 3 months post-IMRT in patients with pPEG ($P = .05$), KPS ≥ 80 ($P = .007$), and other tumor subsite ($P = .05$).

Percent Weight Loss by BMI Class

Underweight and/or normal weight nPEG patients lost a significantly greater percent of their pretreatment weight than pPEG patients, respectively, at end-IMRT (7.77% vs 5.24%, $P = .045$), 1 month post-IMRT (10.55% vs 5.92%, $P < .001$), and 3 months post-IMRT (11.72% vs 6.62%, $P = .001$) (Table 3). Among overweight and obese patients, only overweight nPEG patients lost a significantly greater percent of pretreatment weight than did pPEG patients at end-IMRT (9.40% vs 7.68%, $P = .045$); otherwise, there were no significant differences in percent weight loss between pPEG and nPEG patients (Table 3).

Percent Albumin Change

No significant differences were noted in mean percent albumin change at mid-IMRT (-4.27% vs -4.62% , $P = .829$), end-IMRT (-8.03% vs -9.71% , $P = .355$), 1 month post-IMRT (-4.74% vs -7.90% , $P = .155$), and 3 months post-IMRT (-0.34% vs 0.51% , $P = .635$), between pPEG and nPEG patients, respectively.

PEG-Related Complications

Fifty-one patients (13%) experienced PEG-related complications, including PEG site infection ($n = 21$), severe pain at PEG site ($n = 9$), feeding-related nausea or vomiting ($n = 9$), leakage ($n = 7$), bleeding ($n = 2$), skin breakdown ($n = 2$), and insertion-site metastasis ($n = 1$).

Acute and Chronic Treatment Toxicities

Grade 2 or higher acute dysphagia, mucositis, and xerostomia were noted in 58.4%, 69.5%, and 28.1% of patients, respectively, with no significant differences noted between pPEG and nPEG cohorts (Table 4). When further grouped by BMI category (ie, $BM < 25$, $25-29.9$, 30), there were no significant differences in acute toxicities noted between pPEG and nPEG cohorts (Table 4).

Chronic dysphagia grade 2 was noted in 11.8% of patients, with no significant differences between pPEG and nPEG cohorts or when further grouped by BMI category (Table 4).

Treatment Response and Outcomes

The actuarial 2-year overall survival rate was 85.0%; 86.2% versus 80.0% in pPEG and nPEG cohorts, respectively, $P = .028$. An overall survival Cox model noted decreased survival for nPEG patients (hazard ratio [HR], 1.89; $P = .034$), but this effect was nullified on multivariate analyses ($P = .400$).

Prolonged pPEG Use

Of the 325 pPEG patients, 289 patients (88.9%) had the PEG removed at a median of 3.32 months (range, 0–49.6 months), 16 patients (4.9%) died without PEG removal, and 20 patients (6.2%) had no PEG removal during the follow-up period. Univariate analysis noted age >55 years (HR, 0.67; 95% confidence interval [CI], 0.53–0.86; $P = .001$), female sex (HR, 0.57; 95% CI, 0.41–0.80; $P = .001$), and tumor category T3/T4 (HR, 0.46; 95% CI, 0.35–0.59; $P < .001$) were significantly associated with longer time to pPEG removal. Multivariate analysis confirmed age >55 years (HR, 0.63; $P < .001$), female sex (HR, 0.55; $P < .001$), and T3/4 category (HR, 0.44; $P < .001$) were significantly associated with a prolonged time to PEG removal.

DISCUSSION

Prophylactic PEG tube placement has been shown to be a low-risk procedure that can mitigate weight loss in patients with head and neck cancer who are undergoing concurrent chemoradiation. Overall, we report that our patients with OPC who received a pPEG tube had significantly lower absolute and percent weight loss at end of IMRT, 1 month post-IMRT, and 3 months post-IMRT. Despite this correlation, the benefit is greatest in the under/normal BMI cohort. The absolute difference in weight loss between pPEG and nPEG patients was only 1.6 kg at end of IMRT, 2.2 kg at 1 month post-IMRT, and 2.0 kg at 3 months post-IMRT. Because no differences were noted in percent albumin change, acute dysphagia, acute mucositis, acute xerostomia, chronic dysphagia, treatment duration, and overall survival, it is unlikely that this approximate 2 kg absolute difference in weight loss results in clinically significant outcomes.

Our report of an overall average weight loss of 7.1 kg at the end of IMRT is in accordance with the average loss of 8.5 kg in a report by Nguyen et al.¹⁰ The significant difference in weight loss between pPEG and nPEG represented a mere 18.9% relative reduction in weight loss. It is possible that this difference would be greater if 35% of our nPEG cohort did not undergo acute PEG placement. The suggestion that despite pPEG placement, patients were still not able maintain their weight during and after treatments is in contrast to the report by Lee et al wherein early PEG tube insertion during head and neck chemoradiation reduced weight loss by >50% (3.1 kg vs 7.0 kg, respectively).¹⁴ Age, baseline weight, and BMI may identify patients who are most likely to tolerate therapy without PEG placement and help focus primarily on prophylactic strategies for those patients at greatest risk of treatment-related toxicities. Mucositis, cancer-related anorexia, xerostomia, and ageusia all contribute to treatment-related malnutrition.^{14,24} Prophylactic PEG tube placement can address many, but not all, challenges associated with therapy. Indeed, pPEG helped reduce hospital admission rate (15.1% vs 26.7%, $P = .026$) and resulted in a lesser volume of nonchemotherapy hydrations (8.9 liters vs 17.2 liters, $P = .0004$), but there were no statistically significant differences in the percent albumin change, rates of acute toxicities, and importantly, radiation treatment duration to suggest that pPEG tubes reduce medically indicated treatment breaks, which have been associated with inferior control and survival.

Although the 2-year Kaplan-Meier curve and univariate Cox model demonstrated a survival advantage for pPEG patients, this difference was nullified on multivariate analyses, largely

driven by T (tumor) category, KPS status, and chemotherapy regimen. Similar to our report, Lee et al reported that pPEG placement did not affect duration of radiotherapy, need for unplanned treatment breaks, and overall survival at 3 years.¹⁴ It is important to note that our nPEG cohort consisted of patients who refused pPEG placement, hence, our retrospective report is limited by the nonrandomized design and the influence of selection bias cannot be fully assessed.

A total of 13% of patients experienced 1 or more PEG-related complications, the most common of which was PEG site infection, which can range from superficial cellulitis to peritonitis. Our 13% complication rate is similar to the 14% rate in the study by Finocchiaro et al,⁸ greater than the 3% rate in the study by Nguyen et al,¹⁰ but much less than the 42% complication rate given by Ehrsson et al.¹¹ Fortunately, we had no PEG-insertion-associated mortality, which is important to note because PEG insertion is an invasive procedure with a procedural-related mortality rate of approximately 2% according to 1 retrospective report.¹¹

In the current era of human papillomavirus-positive disease, long-term medical morbidities need to be carefully assessed given the younger age at diagnosis and improved outcomes in human papillomavirus-positive patients, in whom PEG dependence and/or chronic dysphagia would likely lead to a significantly decreased quality of life. Thus, it was interesting to note factors that correlated with prolonged PEG use such as age >55 years, female sex, and T3/4 disease.

At Memorial Sloan-Kettering Cancer Center, we have created a multidisciplinary team to evaluate and address speech and swallowing before, during, and after chemoradiation. Given the data presented here, we no longer recommend routine pPEG placement and have adopted selective use of PEG tubes. Our interdisciplinary team manages acute toxicities as they arise and, if necessary, recommend hospitalization or occasionally acute PEG placement. This allows us to focus on early patient rehabilitation to help prevent treatment-related morbidities and adopt a system of selective NG or PEG tube use only in patients who have a clear indication. Our treatment-support paradigms have shifted likely secondary to decreased treatment-related toxicities and from improved interdisciplinary team management.^{20,21,25} Identification of patients who are in need of PEG use prior to chemoradiation is needed, and such a project is currently underway at our institution.

In conclusion, pPEG placement for all patients undergoing concurrent chemoradiation therapy is associated with a significant reduction in absolute and percent weight loss at end of IMRT, 1 month post-IMRT, and 3 months post-IMRT. However, the benefit in reduction of percent weight loss was consistently significant among patients with BMI < 25. Despite these differences in weight loss, patients who received pPEG tubes showed only a modest 2 kg absolute weight difference with no significant differences in percent albumin change, acute dysphagia, mucositis, and xerostomia rates, chronic dysphagia rates, radiation therapy duration, as well as overall survival, suggesting that an objective overall benefit is minimal at best. Furthermore, prolonged PEG use correlated with age >55 years, female sex, and T3/T4 tumors.

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Figure 1.
Mean absolute weight loss is shown by time point for all patients.

Figure 2.
Percent weight loss is shown by time point for all patients.

Table 1**Patient, Tumor, and Treatment Characteristics**

Characteristic	pPEG (n = 325)	nPEG (n = 75)	
	Median (Range)		<i>P</i>
Age, y	56.0 (27.0–91.0)	61.0 (37.0–84.0)	0.013
Pretreatment weight, kg ^a	87.0 (42.0–157.0)	87.0 (50.6–151.5)	0.875
Pretreatment BMI	27.3 (13.4–54.1)	27.6 (18.2–45.7)	0.494
Overall follow-up, mo ^b	41.0 (8.5–131.9)	32.8 (8.7–135.4)	0.007
	n (Column Percent)		<i>P</i>
Sex			
Male	282 (86.8 %)	65 (86.7 %)	0.981
Female	43 (13.2 %)	10 (13.3 %)	
Tumor site			
Tonsil	148 (45.5 %)	46 (61.3 %)	0.03
Base of tongue	160 (49.2 %)	28 (37.3 %)	
Other	17 (5.2 %)	1 (1.3 %)	
Tumor Category			
T1	78 (24.0 %)	21 (28.0 %)	0.097
T2	126 (38.8 %)	37 (49.3 %)	
T3	70 (21.5 %)	8 (10.7 %)	
T4	51 (15.7 %)	9 (12.0 %)	
Nodal Category			
N0	19 (5.8 %)	2 (2.7 %)	0.73
N1	71 (21.8 %)	16 (21.3 %)	
N2	227 (69.8 %)	55 (73.3 %)	
N3	8 (2.5 %)	2 (2.7 %)	
KPS ^c			
100–90	259 (82.0 %)	63 (90.0 %)	0.071
80	57 (18.0 %)	7 (10.0 %)	

Abbreviations: BMI, body mass index; KPS, Karnofsky performance status; nPEG, no prophylactic percutaneous endoscopic gastrostomy; pPEG, prophylactic percutaneous endoscopic gastrostomy;

^aWeight prior to radiotherapy at a median of 0 (range, –31 to 2) days for pPEG and –1 (range –18 to 2) days for nPEG.

^bAmong living patients.

^cN=316 pPEG patients and 70 nPEG patients.

Table 2

Treatment Data of 400 Oropharyngeal Cancer Patients

	pPEG (n = 325)	nPEG (n = 75)	P
	Median (range)		
Treatment duration, d	45.0 (35.0–67.0)	45.0 (32.0–65.0)	0.784
Time to PEG removal, mo	3.4 (–0.1–58.8)	5.1 (1.0–65.6)	0.004
	Mean ± SD		
Days hospitalized (if admitted)	5.2 ± 5.0	5.7 ± 3.7	0.700
Volume of nonchemotherapy hydrations (liters)	8.9 ± 11.6	17.2 ± 19.8	0.004
	n (column percent)		
Hospital admission	49 (15.1 %)	20 (26.7 %)	0.026
Chemotherapy			
Cisplatin	218 (67.1 %)	32 (42.7 %)	<0.001
Cetuximab	11 (3.4 %)	33 (44.0 %)	
Carboplatin + 5-FU	41 (12.6 %)	3 (4.0 %)	
Cisplatin + bevacizumab	39 (12.0 %)	0 (0.0 %)	
Other	16 (4.9 %)	7 (9.3 %)	
Treatment Intent			
Definitive	314 (96.6 %)	71 (94.7 %)	0.423
Postoperative	11 (3.4 %)	4 (5 %)	

Abbreviations: 5-FU, 5-fluorouracil; nPEG, no prophylactic percutaneous endoscopic gastrostomy; pPEG, prophylactic percutaneous endoscopic gastrostomy; ST, standard deviation.

Table 3**Percent Weight Loss by BMI Class**

	BMI	pPEG		nPEG		P
		n	Mean $\pm$ SD	n	Mean $\pm$ SD	
Mid-RT	<25	88	2.97% $\pm$ 3.91%	19	3.02% $\pm$ 4.75%	0.96
	25–29.9	139	4.35% $\pm$ 3.26%	28	4.60% $\pm$ 3.20%	0.706
	>30	94	4.83% $\pm$ 2.90%	26	4.51% $\pm$ 1.85%	0.613
End-RT	<25	88	5.24% $\pm$ 4.96%	20	7.77% $\pm$ 5.77%	0.017
	25–29.9	138	7.68% $\pm$ 4.08%	27	9.40% $\pm$ 3.88%	0.045
	>30	92	9.50% $\pm$ 4.02%	26	10.11% $\pm$ 2.96%	0.47
1 mo Post-RT	<25	82	5.92% $\pm$ 5.85%	18	10.55% $\pm$ 5.33%	<0.001
	25–29.9	134	10.31% $\pm$ 4.77%	24	12.04% $\pm$ 4.03%	0.097
	>30	84	13.21% $\pm$ 4.62%	21	13.87% $\pm$ 5.50%	0.575
3 mo Post-RT	<25	84	6.62% $\pm$ 6.57%	18	11.72% $\pm$ 4.53%	0.001
	25–29.9	133	12.66% $\pm$ 5.73%	27	13.36% $\pm$ 4.72%	0.555
	>30	86	16.25% $\pm$ 5.63%	25	16.88% $\pm$ 6.09%	0.628

Abbreviations: BMI, body mass index; nPEG, no prophylactic percutaneous endoscopic gastrostomy; pPEG, prophylactic percutaneous endoscopic gastrostomy; RT, radiotherapy; SD, standard deviation.

Table 4**pPEG Versus nPEG and Toxicities**

	pPEG	nPEG	
	% Toxicity	Grade 2	P
Acute Dysphagia			
Overall	58.0%	60.0%	0.754
BMI <25	55.7%	55.0%	0.956
BMI 25–29.9	53.2%	60.7%	0.465
BMI >30	67.4%	63.0%	0.669
Acute Mucositis			
Overall	68.0%	76.0%	0.175
BMI <25	62.5%	75.0%	0.291
BMI 25–29.9	68.3%	75.0%	0.483
BMI >30	72.6%	77.8%	0.592
Acute Xerostomia			
Overall	28.1%	28.0%	0.988
BMI <25	32.2%	35.0%	0.809
BMI 25–29.9	26.8%	10.7%	0.070
BMI >30	26.3%	40.7%	0.147
Chronic Dysphagia			
Overall	10.8%	16.0%	0.208
BMI <25	13.8%	20.0%	0.483
BMI 25–29.9	9.9%	14.3%	0.487
BMI >30	9.5%	14.8%	0.427

Abbreviations: BMI, body mass index; nPEG, no prophylactic percutaneous endoscopic gastrostomy; pPEG, prophylactic percutaneous endoscopic gastrostomy.