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# Revisiting Feeding Tube Utilization in Oropharynx Cancer: 6-Year Prospective Registry Analysis

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Author Contributions

All listed coauthors read and approved the manuscript, and performed the following:

1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of trial concept and data;
2. Drafting the work or revising it critically for important intellectual content;
3. Final approval of the version to be published;
4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Specific individual contributions in addition to all criteria above are listed as follows:
**Brady J. Anderson**, data collection, manuscript drafting; **Amy C. Moreno**, direct patient care, outcomes assessment, data collection refinement; **Yun Qing**, statistical analysis; **J. Jack Lee**, statistical analysis; **Faye M. Johnson**, direct patient care, outcomes assessment, data collection refinement; **Miriam N. Lango**, direct patient care, outcomes assessment, data collection refinement; **Carly E. A. Barbon**, direct patient care, outcomes assessment, data collection refinement; **Lavanya Tripuraneni**, data collection and management; **Ariana Sahli**, data collection and management; **Vicki Piper**, direct patient care, outcomes assessment, data collection refinement; **Neil Gross**, direct patient care, outcomes assessment, data collection refinement; **Clifton D. Fuller**, direct patient care, outcomes assessment, data collection refinement; **Stephen Y. Lai**, direct patient care, outcomes assessment, data collection refinement; **Jeffrey N. Myers**, direct patient care, outcomes assessment, data collection refinement; **Katherine A. Hutcheson**, principal Investigator; corresponding/primary author; conceived, coordinated, and directed all study activities, responsible for data collection, project integrity, manuscript content and editorial oversight and correspondence; direct oversight of study personnel.

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## Abstract

**Objective.—**Patients treated for oropharyngeal cancer (OPC) have historically demonstrated high feeding tube rates for decreased oral intake and malnutrition. We re-examined feeding tube practices in these patients.

**Study Design.—**Retrospective analysis of prospective cohort from 2015 to 2021.

**Setting.—**Single-institution NCI-Designated Comprehensive Cancer Center.

**Methods.—**With IRB approval, patients with new oropharyngeal squamous cell cancer or (unknown primary with neck metastasis) were enrolled. Baseline swallowing was assessed via videofluoroscopy and Performance Status Scale for Head and Neck Cancer (PSSHN). G-tubes or nasogastric tubes (NGT) were placed for weight loss before, during, or after treatment. Prophylactic NGT were placed during transoral robotic surgery (TORS). Tube duration was censored at last disease-free follow-up. Multivariate regression was performed for G-tube placement (odds ratio [OR] [95% confidence interval [CI]) and removal (Cox hazard ratio, hazard ratio [HR] [95% CI]).

**Results.—**Of 924 patients, most had stage I to II (81%), p16+ (89%), node-positive (88%) disease. Median follow-up was 2.6 years (interquartile range 1.5–3.9). Most (91%) received radiation/chemoradiation, and 16% received TORS. G-tube rate was 27% (5% after TORS). G-tube risk was increased with chemoradiation (OR 2.78 [1.87–4.22]) and decreased with TORS (OR 0.31 [0.15–0.57]) and PSSHN-Diet score ≥60 (OR 0.26 [0.15–0.45]). G-tube removal probability over time was lower for T3 to T4 tumors (HR 0.52 [0.38–0.71]) and higher for PSSHN-Diet score ≥60 (HR 1.65 [1.03–2.66]).

**Conclusions.—**In this modern cohort of patients treated for OPC, 27% received G-tubes—50% less than institutional rates 10 years ago. Patients with preserved baseline swallowing and/or those eligible for TORS may have lower G-tube risk and duration.

### Keywords

chemoradiation; feeding tube; gastrostomy; G-tube; nasogastric; oropharyngeal cancer (OPC); radiation; transoral robotic surgery (TORS)

Oropharyngeal cancer (OPC) incidence continues to rise, particularly in men with human papillomavirus (HPV)-related disease.[1] Patients treated for OPC often experience weight loss, as tumor-mediated pain, odynophagia, dysphagia, and cachexia are compounded by edema, mucositis, and neuromuscular dysfunction from radiotherapy (RT) with or without chemotherapy.[2] Significant weight loss and the resultant treatment interruptions are associated with worse patient outcomes,[3,4] and nutritional supplementation using feeding tubes (FT) may decrease the risk of hospitalization for malnutrition during radiation.[5]

Historically, universal prophylactic gastrostomy-tube (G-tube) placement was proposed to minimize malnutrition and treatment-related morbidity,[4,6,7] but weight loss benefits were

inconsistent and temporary when compared to as-needed FT placement.[4,6–10] Retrospective studies have not demonstrated association of prophylactic G-tube with improved overall survival when accounting for other variables.[9–11] However, prophylactic G-tubes have been associated with longer enteral feeding durations, which may correlate with decreased pharyngeal activity and long-term dysphagia.[10–14]

Alternatively, oral intake maintains pharyngeal function and provides superior nutritional benefit.[13,15,16] Nutritional strategies have evolved to prioritize oral intake and reserve FT placement for significant weight loss.[17,18] Patients may be stratified by malnutrition risk, with high-risk patients receiving prophylactic G-tube placement and lower-risk patients receiving oral nutritional supplementation, weight loss monitoring, and reactive G-tube or temporary nasogastric tube (NGT) placement when indicated.[19] Risk-based FT models represent a step toward personalized care as opposed to universal FT protocols.

A decade ago, G-tube rates in OPC treatment ranged from 59% to 83%, reflecting both prophylactic and reactive placement.[9,17,18,20] Risk factors included advanced age, current smoking status, larger T- and N-stages, higher overall stage, weight loss prior to presentation, and concurrent chemoradiation; protective factors included adherence to swallowing exercises and conformal intensity-modulated radiotherapy (IMRT) compared to 3d-conformal RT planning.[9,17,18] However, the landscape of OPC has changed significantly since these investigations.

HPV-associated tumors now account for approximately 70% of all OPC cases in the United States.[9,19,21,22] Transoral robotic surgery (TORS) has demonstrated decreased weight loss and G-tube placement when compared to nonsurgical treatment.[23,24] Swallowing rehabilitation is incorporated proactively, with swallowing exercises and oral intake demonstrating improved mobility, shorter FT duration, and increased recovery to normal diet after treatment.[13,16,25,26]

Considering the current era of advanced radiotherapy, transoral surgery, and pro-active swallowing therapy, we sought to re-examine FT use in OPC treatment, exploring factors related to FT placement and duration. Our aims were to: (1) characterize patterns of FT placement (G-tubes and/or NGT), (2) identify factors related to FT duration (days on G-tubes and/or NGT), and (3) identify factors associated with G-tube placement and duration.

## Methods

In 2015 our institution began an IRB-approved (MD Anderson protocol PA11–0809), prospective registry of patients treated for OPC (MD Anderson protocol PA14–0947). With informed consent, all patients with newly diagnosed squamous cell carcinoma of the oropharynx, base of tongue (BOT), tonsil, or unknown primary metastatic to the neck were included. Histological diagnosis, anatomic subsite, tumor stage (AJCC 8th edition), p16 immunohistochemistry (and HPV RNA in situ hybridization for unknown primary), smoking status (current, former, or never), and treatment information were collected a priori. Baseline videofluoroscopic swallow evaluations were performed, recorded, and laboratory-rated by blinded speech language pathologists (SLPs) using the DIGEST protocol version 2

criteria,[27] alongside patient-reported outcomes and functional status using the Performance Status Scale for Head and Neck Cancer (PSSHN)[28] and MD Anderson Dysphagia Inventory (MDADI, 19-item composite scores).[29] After IRB approval (MD Anderson protocol PA11–0809) and waiver of informed consent, we retrospectively reviewed this database, including all patients treated with curative intent (n = 924) at our institution.

Institutional practice included reactive G-tube or NGT placement for significant weight loss (weight loss ≥5% over 1 month or ≥10% over 6 months)[30] during treatment. Patients meeting these criteria at presentation received prophylactic G-tubes (n = 13). G-tubes encompassed percutaneous endoscopic gastrostomy (PEG), percutaneous fluoroscopic gastrostomy (PFG), and jejunostomy (J-tube). Those undergoing TORS received prophylactic NGT during surgery. Although temporary, prophylactic NGT represented disruption to patients' typical oral intake or swallow ability, and some were eventually converted to long-term G-tubes.

All patients received pretreatment nutritional assessment by registered dietitian nutritionists (RDNs), who calculated nutrient and fluid goals and assessed weight loss, intake, and eating barriers to guide nutritional intervention. Those undergoing RT received additional weekly toxicity and nutritional assessments by the treating physician and an RDN, respectively, to evaluate oral diet tolerance, weight loss, hydration status, and nutrition impact symptoms (mucositis, dysgeusia, dysphagia, odynophagia, xerostomia). Preventative dietary modifications and supportive care (fluid hydration and/or analgesics for odynophagia) were frequently used. SLPs regularly instructed patients in swallowing exercises (including jaw stretch, Masako tongue-hold, Mendelsohn maneuver, supraglottic and effortful swallows) to maintain pharyngeal activity and encouraged safe, efficient oral intake throughout treatment (adopting EAT-RT protocol in 2018) as previously described.[26]

For our analysis, FT duration in situ was calculated from placement to removal or the first clinical encounter documenting FT absence. For unremoved FTs, duration was calculated until last follow-up, death, or new disease (whichever was first). In cases of multiple FTs (eg, NGT converted to G-tube), duration represented the sum of all tube placements, up to three. FT duration was plotted by Kaplan-Meier (KM) method, with patients censored at last disease-free follow-up. Patients who died (n = 38) or developed recurrence, distant metastases (DM), or second primary malignancies (SPM) were censored at occurrence (n = 25). To identify factors associated with G-tube placement and removal, univariate analysis was performed, and factors with $P < .2$ were included in backward stepwise multivariable logistic (odds ratio, OR [95% confidence interval [CI]]) and Cox hazard regression models (hazard ratio, HR [95% CI]) for placement and removal, respectively.

## Results

### Cohort Characteristics

Of 924 consecutive patients treated for OPC, the majority were male (n = 824/924, 89%) and white (729/924, 79%); median age was 64 years (interquartile range [IQR] 58–70). Overall disease stage was stage I in 556/924 (60%), stage II in 192/924 (21%), stage III in 115/924 (12%), and stage IV in 61/924 (7%). Tumors were mostly p16-positive

(839/924, 91%), T0 to T2 (682/924, 74%), originating from the tonsil (414/924, 45%) or BOT (396/924, 43%) with nodal disease (814/924, 88%).

Baseline PSSHN-Diet scores were available for 901/924 (98%); 837/901 (93%) scored ≥60 indicating solid diets, while 64/901 (7%) scored <60 indicating diets limited to soft foods or more restricted diets. Baseline videofluoroscopy (DIGEST grade) was obtained for 716/924 (77%), with 511/716 (71%) patients demonstrating grade 0 (normal swallow), 171/716 (24%) grade 1 (mild dysphagia), and 34/716 (5%) grade ≥2 (moderate-severe dysphagia). Most patients with baseline MDADI composite scores had scores ≥80 (592/759, 78%), indicating optimal swallowing-related quality of life (Table 1).

Primary treatment was nonsurgical in 772/924 (84%) and surgical in 152/924 (16%). RT involved conformal photon methods of volumetric modulated arc therapy (VMAT) or IMRT (648/838, 77%), or intensity modulated proton therapy (188/838, 22%); one patient received stereotactic body radiation due to previous radiation for supraglottic cancer, and 1 received 3D-conformal therapy. Of tonsil primaries receiving radiation, 158/365 (43%) received ipsilateral radiation. Surgery was TORS in 148/152 (97%) patients, plus 3 open resections (two with free flap reconstruction) and one traditional tonsillectomy. Most surgical patients had T0 to T2 (146/152; 96%) and N0 to N1 (146/152; 96%) disease. Concurrent therapy was predominantly platinum-based chemotherapy, with few patients receiving targeted therapy. Concurrent therapy was less common among patients receiving primary surgery (41/152, 27% vs 573/772, 74%).

Recurrence, second primary malignancy, and distant metastasis rates were similar among surgical (15/152, 10%; including adjuvant therapy) and nonsurgical patients (75/772, 10%). After treatment, median follow-up was 2.6 years (IQR 1.5–3.9). At review, 673/924 (73%) patients had no evidence of disease (NED), 24/924 (2.6%) had progressive/residual disease, 78/924 (8.4%) were deceased, and 147/924 (16%) had not been seen within two years (Table 1).

## FT Placement (All Types)

Overall, 401/924 (43%) patients required FTs (median duration 74 days, range 1–1835). The G-tube rate was 246/924 (27%), including 207/246 (84%) PEGs, 43/246 (17%) PFGs, and 2/246 (1%) J-tubes. Of these, 229/246 (93%) were placed reactively for significant weight loss during/after treatment, 13/246 (5%) prophylactically for significant weight loss at presentation, 2/246 (1%) during free flap reconstruction, and 2/246 (1%) for long-term complications (epidural abscess, osteoradionecrosis) (see Table 2).

Of 174 NGT placed, 146/174 (84%) were placed prophylactically during TORS, 23/174 (13%) reactively for weight loss during/after treatment, 4/174 (2.3%) during follow-up for other reasons (epidural abscess, osteoradionecrosis, stroke, and dysphagia after cervical fusion), and 1/174 (0.5%) prophylactically for severe weight loss at presentation. Of these, 19/174 (11%) were later converted to G-tubes, leaving 155/924 (17%) NGT only.

### Primary Treatment

Of surgical patients, 10/152 (7%) received G-tubes: 2 during free flap surgeries, 2 during RT, and 6 for toxicity after adjuvant treatment. Of TORS patients, 7/148 (5%) received G-tubes. G-tube rates for surgery with adjuvant RT (3/32, 9%) were similar to surgery with adjuvant chemoradiation (4/37, 11%), and both were higher than surgery alone (3/69, 4%). Subgroup analysis of tonsil tumors receiving RT demonstrated lower G-tube rates for ipsilateral RT (19/158, 12%) versus bilateral RT (65/206, 32%).

### p16 Status

Patients with p16-negative tumors had higher G-tube rates (31/69, 45% vs 11/839, 25% in p16-positive), but were also higher stage (stage III in 12/67, 18% and stage IV in 45/67, 67%). Median radiation dose was 6996 cGy in both groups, and similar proportions received concurrent chemotherapy. p16-negative tumors demonstrated more recurrence, DM, and SPM, and higher mortality (17/69, 25% died vs 58/839, 7%).

### Carcinoma of Unknown Primary (CUP)

Of 84 patients with CUP, 65 (77%) were HPV-positive (p16 and HPV RNA in situ hybridization), 15 (18%) were HPV-negative, and 4 (5%) had unknown HPV-association. CUP was overwhelmingly treated nonsurgically (79/84, 94%), with radiation delivered to the pharyngeal axis. Five (6%) underwent TORS, with low NGT/DHT only rates (6/84, 7%). However, G-tube rates (17/84, 20%) resembled those of tonsil primaries (86/414, 21%).

### FT Duration (All Types)

Median FT duration was 124 days for G-tubes, and 3 days for NGT only; Table 2. Of all G-tubes, 189/246 (77%) were removed, leaving 57/924 (6%) patients with G-tubes at last follow-up. G-tube duration ≥6 months was more common with larger tumors and worse baseline PSSHN-Diet scores, and less common with tonsil primary site; Table 3. No surgical patients had G-tubes ≥6 months. Patients requiring G-tubes had higher mortality rates (34/246, 14% vs 44/678, 6.5% without G-tubes).

Overall, 58/924 patients (6.3%) had FT at last follow-up; nearly all (57/58, 98%) were G-tubes. Of these patients, 25/58 had expired with FT in situ, (4/25 disease-free), and another 14/58 were lost to follow-up (8/14 disease-free). Of the remaining 19/58 patients alive with FT in place at recent follow-up, three had DM and 16 were disease-free. Of all living, disease-free patients with recent follow-up, only 16/673 (2%) had FT.

### Factors Associated With FT Duration (All Tube Days)

KM analyses with log-rank tests demonstrated increased FT duration with larger tumors (Figure 1A), nonsurgical treatment (Figure 1B), G-tubes (Figure 1C), and p16-negative disease (Figure 1D). Longer time to FT removal was seen in patients with baseline swallowing dysfunction evidenced by higher baseline DIGEST grade (Figure 1E) or lower baseline PSSHN-Diet score (Figure 1F). Importantly, these KM curves included short-term prophylactic NGT placed during surgery. Stratified KM analysis revealed a distinctly

prolonged trajectory of FT duration among patients treated non-surgically who received G-tubes (Figure 2) compared to patients treated surgically or those never requiring G-tube.

### Factors Associated With G-tube Placement

Univariate analysis demonstrated increased G-tube placement with age (OR 1.04, [1.02–1.05]), larger tumors (OR 3.75 [2.73–5.16] for T3–T4 vs T0–T2), concurrent chemotherapy (OR 3.61 [2.51–5.31]), increased DIGEST scores (OR 3.95, [1.87, 9.12] for DIGEST 2+), and lower baseline MDADI composite score (OR 0.97, [0.96–0.98]). Decreased G-tube placement was seen with tonsil primary site (OR 0.52 [0.38–0.71] vs BOT), primary surgery (OR 0.20, [0.10–0.34]), p16-positivity (OR 0.42 [0.26–0.70]), and baseline PSSHN-Diet score ≥60 (OR 0.29, [0.18–0.49]) (see Table 4). Current smoking status was not significantly associated with G-tube placement, but stratification suggested higher G-tube rates with ≥10 pack-years (Table 1).

Multivariable logistic regression revealed increased odds of G-tube placement with concurrent chemotherapy (OR 2.781, [1.873–4.215]). Protective factors included tonsil primary site (OR 0.534, [0.381–0.744]), baseline PSSHN-Diet Score ≥60 (OR 0.255, [0.145–0.445]), and primary surgery (OR 0.306, [0.150–0.572], Table 5).

### Multivariable Model for G-tube Duration

Multivariable Cox hazard analysis for duration to G-tube removal was undertaken only in the subgroup of nonsurgical patients receiving G-tubes (due to insufficient G-tube counts in the surgical cohort). This analysis demonstrated decreased hazard ratio (probability per time) of G-tube removal for T3–T4 tumors (HR 0.52, [0.38–0.71]) and increased hazard ratio (greater probability of removal) for patients with better baseline dietary ability (PSSHN Diet ≥60, HR 1.65, [1.03–2.66]; Table 6).

## Discussion

This study revisited short- and long-term FT use in OPC treatment at a large comprehensive cancer center. Unlike multi-center G-tube rates up to 83% reported a decade ago,[9,17,18,20] only 27% of our cohort underwent gastrostomy, with 6% having G-tubes at last follow-up (2% among disease-free patients). This decrease may be multifactorial, reflecting anatomic characteristics of an early-stage tumor cohort, primary TORS, highly conformal radiotherapy, and the interdisciplinary focus on oral intake, nutritional support, and swallowing therapies.

Anatomically, patients with larger tumors and more advanced disease stage had higher G-tube rates, in line with previous studies.[17,18] Similar characteristics were noted in those requiring prophylactic FT for significant weight loss at presentation, suggesting that increased tumor burden may correlate with worsening cachexia, dysphagia, and odynophagia. During RT, larger tumors receive larger target volumes with greater doses to the pharyngeal constrictor muscles and other swallowing structures. Interestingly, tonsillar tumors had lower odds of G-tube placement than more centralized (ie, BOT) tumors, possibly due to increased amenability to surgical resection, more lateralized high dose volumes, and unilateral neck radiation sparing the contralateral constrictor muscle.[31]

Patients with p16-negative tumors had higher G-tube rates, but also higher T-stage, overall stage, and higher rates of progression and mortality. The lack of independent association suggests that higher FT rates among our p16-negative cohort were confounded by their advanced disease stage. Thus, the greater prevalence of early-stage HPV-related disease may have contributed to lower G-tube rates. Although p16-positive tumors have classically presented in younger individuals with favorable outcomes, incidence may rise among older populations, with uncertain prognostic implications.[1,9,21,32] While de-intensification protocols for HPV-related tumors remain ongoing,[33] close nutritional monitoring is warranted for all patients, regardless of p16 status.

Similarly, most patients with CUP were HPV-positive, suggesting oropharyngeal primary. However, the possibility of p16-positive nasopharyngeal origin is a potential source of heterogeneity.[34] In our experience, patients with CUP presented similarly to patients with p16-positive OPC, underwent RT targeting pharyngeal muscles involved in swallowing, and demonstrated modest G-tube rates, resembling those of tonsil primary.

Regarding treatment, we noted increased G-tube placement with concurrent chemotherapy, likely due to increased mucosal toxicity. Conversely, surgical patients showed decreased odds of G-tube placement, suggesting that in carefully selected patients, local surgery may associate with decreased acute toxicity to the oropharynx. Fortunately, G-tube rates in both subgroups decreased from previous rates (34% during/after chemotherapy vs 71%−82% previously;[15,17,18] 5% following TORS vs 18%–40% previously),[35,36] possibly due to lower proportions of T3 to T4 disease, our predominantly reactive G-tube placement strategy, aggressive swallowing therapy, and/or technical refinements to radiation delivery. Treatment choices should be individualized, joint decisions between patients and providers, with FT risk considered as 1 aspect of oncologic care.

Most patients receiving TORS underwent prophylactic NGT placement intra-operatively in anticipation of post-operative dysphagia.[37,38] These tubes had short durations and low probability of G-tube conversion or long-term persistence, with most removed within 3 days (Figures 1B and 2). However, even temporary placement may disrupt patient quality of life. Institutional practices may change, as recent evidence suggests NGT placement during TORS may not be necessary.[22] Regardless, these results inform FT outcomes following this practice. When an NGT is placed, close postoperative coordination with the dietitian and SLP may expedite nutritional and swallowing recovery.[22,37]

We observed higher G-tube rates and decreased removal probability in patients with higher baseline DIGEST grades and lower PSSHN-Diet and MDADI composite scores. These findings suggest that pretreatment swallowing dysfunction is associated with increased likelihood and duration of FT placement. Proactive swallowing rehabilitation has been associated with decreased FT placement,[16] and our institution recently reported a detailed analysis of an overlapping cohort demonstrating lower posttreatment DIGEST scores for patients adhering to swallow therapy during RT.[26] While swallowing therapy may not fully ameliorate tumor- or treatment-induced swallow dysfunction, it may provide the support and skills to sustain safe oral intake and maintain pharyngeal activity through treatment, even with pre-existing swallowing impairment. Further research is needed to investigate

strategies to optimize patients with baseline dysphagia, odynophagia, and weight loss for their oncologic treatment.

## Limitations

Our study's retrospective and principally descriptive nature introduces selection bias and cannot establish causality. Thus, we may not distinguish whether decreased FT rates result from locoregional disease patterns of p16-positive disease or from treatment and supportive care changes. Gastrotomy rates among treatment subgroups (surgical vs nonsurgical, ipsilateral vs bilateral tonsil radiation) are subject to selection bias as treatments were not randomized, but rather highly preselected, and cannot be fully accounted for in multivariable adjustment. Our cohort represented a largely White non-Hispanic male sample receiving treatment at a single quaternary institution, limiting generalizability. While our analysis lacks predictive ability, more detailed statistical modeling (eg, recursive partitioning) and validation might provide data-driven guidelines or decision trees for predicting reactive G-tube placement.

Although we did not analyze individual weight loss data, consistent protocols allowed reactive FT placement to surrogate for significant weight loss. However, this simplification omitted granular patient data and may overestimate differences between treatment groups. We have previously shown similar subacute swallowing results across treatment modalities in patients with low-to-intermediate risk OPC; as such, reactive FT placement should not be considered a proxy for long-term dysphagia. Rather, reactive placement reflects the acute treatment toxicity resulting in pain and mucositis, exacerbated in some patients by disordered swallowing. However, even when excluding surgical patients, FT rates decreased dramatically compared with historical controls.

## Conclusion

We report an overall G-tube rate of 27% among patients treated for OPC (5% after TORS), with 2% FT persistence among disease-free patients. Patients with smaller tumors, tonsillar origin, and those undergoing TORS may have lower odds of G-tube placement, while concurrent chemotherapy and baseline swallowing dysfunction may increase risk of G-tube placement.

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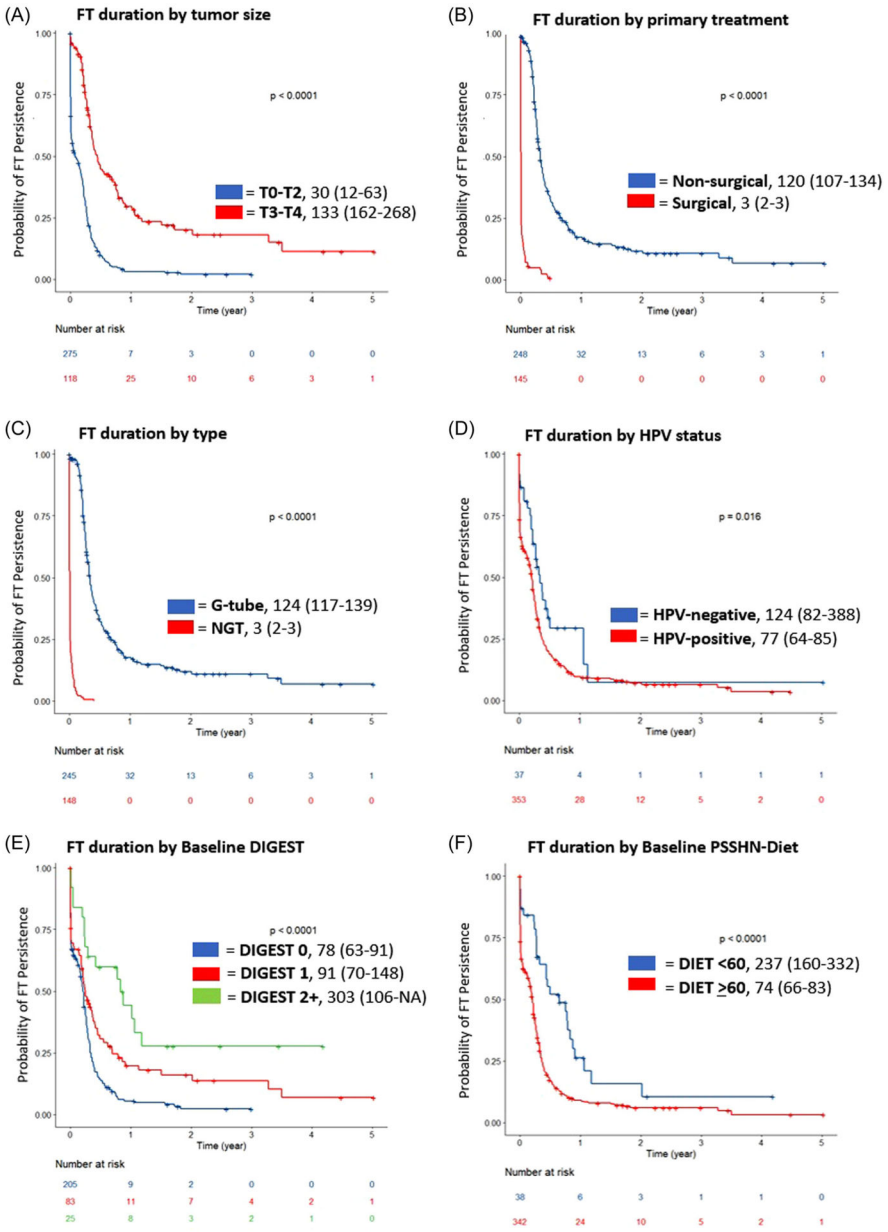


**Figure 1.**

Kaplan-Meier curves for feeding tube duration stratified by (A) tumor size, (B) primary treatment modality, (C) FT type, (D) HPV status, (E) baseline DIGEST score, and (F) baseline PSSHN-Diet score. Values included represent median duration in days (with 95% CI). Patients with DIGEST 2+ (panel E) did not have upper value for 95% confidence interval due to low count.

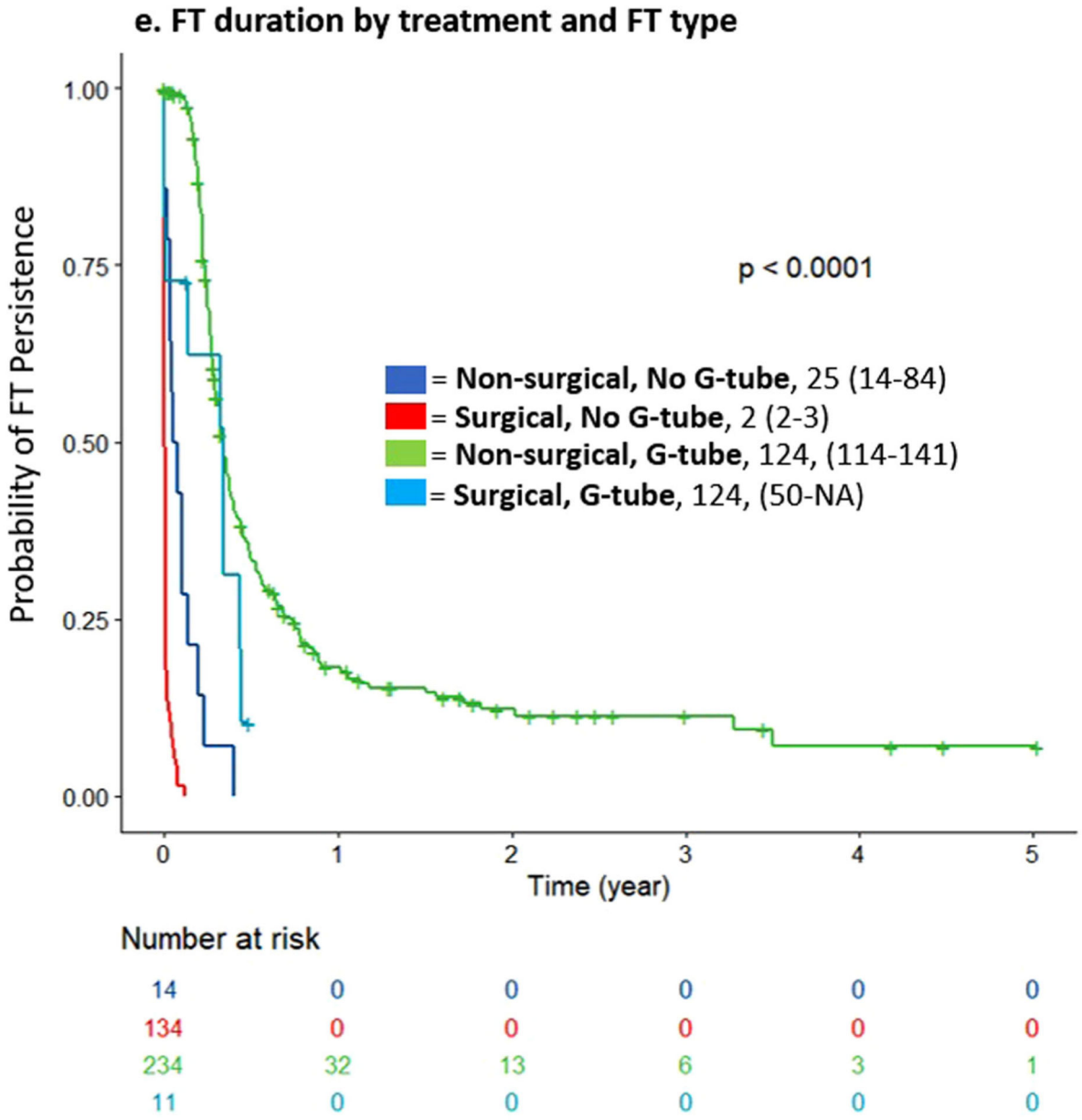


**Figure 2.**

Kaplan-Meier curves for feeding tube duration stratified by treatment and feeding tube type. Patients receiving nonsurgical treatment who underwent G-tube placement demonstrated a distinctly prolonged trajectory of feeding tube persistence. Patients receiving surgical treatment who underwent G-tube placement did not have upper value for 95% confidence interval due to low count.

**Table 1.**

Patient Demographics and Tumor Characteristics

| Characteristic | All patients (n = 924) | No feeding tube (n = 523) | G-tube (n = 246) | NGT only (n = 155) |
|---|---|---|---|---|
| Sex | | | | |
| Male | 824 | 470 (57%) | 221 (27%) | 133 (16%) |
| Female | 100 | 53 (53%) | 25 (25%) | 22 (22%) |
| Race | | | | |
| American Indian or Alaska Native | 2 | 1 (50%) | 1 (50%) | 0 (0%) |
| Asian | 10 | 6 (60%) | 2 (20%) | 2 (20%) |
| Black or African American | 17 | 8 (47%) | 5 (29%) | 4 (24%) |
| Native Hawaiian or Other Pacific Islander | 1 | 0 (0%) | 0 (0%) | 1 (100%) |
| White or Caucasian | 729 | 410 (56%) | 190 (26%) | 129 (18%) |
| Other | 22 | 14 (64%) | 6 (27%) | 2 (9%) |
| Declined to Answer | 4 | 3 (75%) | 1 (25%) | 0 (0%) |
| Unknown | 139 | 81 (58%) | 41 (29%) | 17 (12%) |
| Ethnicity | | | | |
| Not Hispanic or Latino | 657 | 365 (56%) | 178 (27%) | 114 (17%) |
| Hispanic or Latino | 37 | 28 (76%) | 5 (14%) | 4 (11%) |
| Unknown | 230 | 130 (57%) | 63 (27%) | 37 (16%) |
| Median age (IQR) | 64 (58–70) | 63 (57–70) | 66 (60–72) | 63 (57–69) |
| <50 years old | 39 | 22 (56%) | 5 (13%) | 12 (31%) |
| 50–60 years old | 242 | 150 (62%) | 52 (21%) | 40 (17%) |
| 60–70 years old | 391 | 218 (56%) | 104 (27%) | 69 (18%) |
| >70 years old | 252 | 133 (53%) | 85 (34%) | 34 (13%) |
| p16 status | | | | |
| Positive | 839 | 478 (57%) | 212 (25%) | 149 (18%) |
| Negative | 69 | 32 (46%) | 31 (45%) | 6 (9%) |
| Unknown[a] | 16 | 13 (81%) | 3 (19%) | 0 (0%) |
| Smoking status at enrollment | | | | |
| Current | 106 | 62 (58%) | 29 (27%) | 15 (14%) |
| Former | 423 | 240 (57%) | 112 (26%) | 71 (17%) |

| Characteristic | All patients (n = 924) | No feeding tube (n = 523) | G-tube (n = 246) | NGT only (n = 155) |
|---|---|---|---|---|
| Never (<100 lifetime cigarettes) | 395 | 221 (56%) | 105 (27%) | 69 (17%) |
| Pack-year smoking history (n = 920) | | | | |
| Greater than 10 pack-years | 285 | 163 (57%) | 89 (31%) | 33 (12%) |
| Less than 10 pack-years | 635 | 358 (56%) | 155 (24%) | 122 (19%) |
| Primary treatment | | | | |
| Surgery alone | 83 | 1 (1%) | 3 (4%) | 79 (95%) |
| Surgery + Radiation | 32 | 1 (3%) | 3 (9%) | 28 (88%) |
| Surgery + Chemoradiation | 37 | 2 (5%) | 4 (11%) | 31 (84%) |
| RT Alone | 152 | 132 (87%) | 19 (13%) | 1 (0.7%) |
| Induction + RT/CRT | 158 | 93 (59%) | 61 (39%) | 4 (3%) |
| Concurrent CRT | 462 | 294 (64%) | 156 (34%) | 12 (3%) |
| Concurrent chemotherapy | 614 | 356 (58%) | 209 (34%) | 49 (8%) |
| Median radiation dose (cGy), IQR | 6996 (6770–6996) | 6996 (6900–6996) | 6996 (6930–6996) | 6000 (6000–6600) |
| Overall Stage (n = 920) | | | | |
| I | 556 | 330 (59%) | 88 (16%) | 138 (25%) |
| II | 192 | 105 (55%) | 77 (40%) | 10 (5%) |
| III | 115 | 56 (49%) | 55 (48%) | 4 (3%) |
| IV | 61 | 32 (52%) | 26 (43%) | 3 (5%) |
| T Stage | | | | |
| T0–T2 | 682 | 403 (59%) | 133 (20%) | 146 (21%) |
| T3–T4 | 236 | 115 (49%) | 113 (48%) | 8 (3%) |
| Tx | 6 | 5 (83%) | 0 (0%) | 1 (17%) |
| N Stage | | | | |
| N0 | 108 | 41 (38%) | 24 (22%) | 43 (40%) |
| N1 | 602 | 370 (61%) | 128 (21%) | 104 (17%) |
| N2 | 190 | 95 (50%) | 88 (46%) | 7 (4%) |
| N3 | 22 | 15 (68%) | 6 (27%) | 1 (5%) |
| Nx | 2 | 2 (100%) | 0 (0%) | 0 (0%) |
| Anatomic subsite | | | | |
| Tonsil | 414 | 247 (60%) | 86 (21%) | 81 (20%) |
| Base of tongue | 396 | 200 (51%) | 133 (34%) | 63 (16%) |

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| Characteristic | All patients (n = 924) | No feeding tube (n = 523) | G-tube (n = 246) | NGT only (n = 155) |
|---|---|---|---|---|
| Unknown primary | 84 | 61 (73%) | 17 (20%) | 6 (7%) |
| Glossopharyngeal Sulcus | 12 | 8 (67%) | 1 (8%) | 3 (25%) |
| Soft palate | 9 | 4 (44%) | 4 (44%) | 1 (11%) |
| Pharyngeal qall | 9 | 3 (33%) | 5 (56%) | 1 (11%) |
| Median follow-up, y (IQR) | 2.6 (1.5–3.9) | 2.6 (1.5–3.7) | 2.4 (1.2–3.9) | 3.0 (1.8–4.1) |
| Follow up length[b] | | | | |
| <1 year | 141 | 76 (54%) | 45 (32%) | 20 (14%) |
| 1–2 years | 195 | 118 (61%) | 51 (26%) | 26 (13%) |
| 2–3 years | 197 | 111 (56%) | 52 (27%) | 34 (17%) |
| 3–4 years | 177 | 112 (63%) | 38 (22%) | 27 (15%) |
| 4–5 years | 144 | 74 (51%) | 36 (25%) | 34 (24%) |
| >5 years | 62 | 28 (45%) | 21 (34%) | 13 (21%) |
| Deceased during treatment | 8 | 5 (62%) | 3 (38%) | 0 (0%) |
| Recurrence, Second Primary, or Distant Metastasis | 90 | 45[b] (50%) | 32 (36%) | 13 (14%) |
| Survival status at last follow-up | | | | |
| Alive with no disease | 673 | 407 (60%) | 145 (22%) | 121 (18%) |
| Alive with disease | 24 | 12 (50%) | 9 (38%) | 3 (13%) |
| Deceased | 78 | 40 (52%) | 34 (43%) | 4 (5%) |
| Lost follow-Up (Last visit >2 y) | 147 | 62 (42%) | 58 (39%) | 27 (18%) |
| PSSHN Diet Score (baseline) | | | | |
| ≥60 | 837 | 489 (58%) | 207 (25%) | 141 (17%) |
| <60 | 64 | 25 (39%) | 34 (53%) | 5 (8%) |
| N/A | 23 | 9 (39%) | 5 (22%) | 9 (39%) |
| DIGEST Grade (baseline) | (n = 716) | | | |
| 0 | 511 | 294 (58%) | 130 (25%) | 87 (17%) |
| 1 | 171 | 95 (56%) | 40 (23%) | 36 (21%) |
| 2+ | 34 | 17 (50%) | 11 (32%) | 6 (18%) |
| MDADI-composite (baseline) | (n = 759) | | | |
| 80+ (optimal) | 592 | 351 (59%) | 136 (23%) | 105 (18%) |
| <80 (suboptimal) | 167 | 82 (49%) | 68 (41%) | 17 (10%) |

[a]Patients with unknown status were referred from outside facilities with tumor samples insufficient for or equivocal for p16 staining.

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[b] Follow-up was calculated from completion of definitive therapy (RT or primary surgery) to last documented surveillance imaging. Patients last seen over two years prior to data extraction (2/8/2022) were considered lost to follow-up.

**Table 2.**

Feeding Tube Characteristics

| Characteristics | Total (n = 401) | G-tube | NGT |
|---|---|---|---|
| Initial NGT converted to later G-tube | 19 | - | - |
| G-tube ever | 246 | - | - |
| NGT only | 155 | - | - |
| Median duration (days) | 74 (range 1–1835) | 124 (95% CI 117, 139) | 3 (95% CI 2, 3) |
| Timing of first tube placement | Total | Initial G-tube | Initial NGT |
| During radiation | 172 | 163 | 9 |
| During surgery | 148 | 2 | 146 |
| Following Primary Treatment due to dysphagia of index OPC | 62 | 48 | 14 |
| Following Primary Treatment for other reasons | 5 | 1 | 4 |
| Placed before primary treatment | 14 | 13 | 1 |
| | Total | G-tube | NGT |
| Feeding tube in place at last follow-up[a] | 58 | 57 | 1 |
| No evidence of disease | 29 | 28 | 1 |
| With disease | 18 | 18 | 0 |
| Unknown disease status[b] | 11 | 11 | 0 |

[a]Regardless of date of last follow-up; includes those with last visit >2 years ago and those who were deceased with tube in situ. Of note, although they had tubes in place prior, 13 of these patients had also developed recurrences, SPM, or distant metastases, which may have increased the likelihood of feeding tube dependency.

[b]For example a patient who received an “indeterminate scan” 2 days before expiring due to a ruptured aneurysm.

**Table 3.**

G-Tube Duration

| Characteristic | Total G-tubes | Duration ≥6 months | Duration ≥1 year | Duration ≥2 years |
|---|---|---|---|---|
| All patients | 246 | 70 (28%) | 31 (13%) | 13 (5%) |
| T Stage | | | | |
| T0–T2 | 133 | 24 (18%) | 7 (5%) | 3 (2%) |
| T3–T4 | 113 | 46 (41%) | 24 (21%) | 10 (9%) |
| Primary site | | | | |
| BOT | 133 | 42 (32%) | 19 (14%) | 10 (8%) |
| Other | 27 | 11 (41%) | 4 (15%) | 1 (4%) |
| Tonsil | 86 | 17 (20%) | 8 (9%) | 2 (2%) |
| PSSHN diet (baseline) | | | | |
| <60 | 34 | 17 (50%) | 6 (18%) | 3 (9%) |
| ≥60 | 207 | 51 (25%) | 23 (11%) | 10 (5%) |
| NA | 5 | 2 (40%) | 2 (40%) | 0 |
| Concurrent therapy | | | | |
| No | 37 | 15 (41%) | 8 (22%) | 3 (8%) |
| Yes | 209 | 55 (26%) | 23 (11%) | 10 (5%) |
| Primary surgery | | | | |
| No | 236 | 70 (30%) | 31 (13%) | 13 (6%) |
| Yes | 10 | 0 (0%) | 0 (0%) | 0 (0%) |

Overall feeding tube duration in days for patients who received G-tubes.

**Table 4.**

Univariate Analysis for Factors Associated with G-tube Placement

| Characteristic | OR | 95% CI |
|---|---|---|
| Age | 1.04 | 1.02, 1.05 |
| Smoking status | | |
| Current | - | - |
| Former | 0.97 | 0.61, 1.58 |
| Never | 0.97 | 0.61, 1.60 |
| PSSHN Score | | |
| <60 | - | - |
| ≥60 | 0.29 | 0.18, 0.49 |
| MDADI composite | 0.97 | 0.96, 0.98 |
| DIGEST | | |
| 0 | - | - |
| 1 | 1.51 | 1.06, 2.15 |
| 2+ | 3.95 | 1.87, 9.12 |
| Primary site | - | - |
| BOT | - | - |
| Other | 0.61 | 0.37, 0.97 |
| Tonsil | 0.52 | 0.38, 0.71 |
| HPV | | |
| Negative | - | - |
| Positive | 0.42 | 0.26, 0.70 |
| T Stage | | |
| T0–T2 | - | - |
| T3–4 | 3.75 | 2.73, 5.16 |
| N Stage | | |
| N+ | - | - |
| N0 | 0.74 | 0.45, 1.18 |
| Primary treatment | | |
| Concurrent CRT | - | - |
| Induction + RT/CRT | 1.234 | 0.85, 1.79 |
| RT alone | 0.28 | 0.16, 0.46 |
| Surgery alone | 0.10 | 0.03, 0.25 |
| Surgery + RT/CRT | 0.25 | 0.11, 0.51 |
| Primary surgery | | |
| No | - | - |
| Yes | 0.20 | 0.10, 0.34 |
| Concurrent therapy | | |
| No | - | - |
| Yes | 3.61 | 2.51, 5.31 |

Abbreviations: BOT, base of tongue; CI, confidence interval; HPV, human papillomavirus; OR, odds ratio.

**Table 5.**

Multivariable Logistic Regression Model for G-tube Placement

| Characteristic | OR | 95% CI |
|---|---|---|
| Primary site | - | - |
| BOT | - | - |
| Other | 0.679 | 0.40, 1.12 |
| Tonsil | 0.534 | 0.38, 0.74 |
| Primary surgery | | |
| No | - | - |
| Yes | 0.306 | 0.15, 0.57 |
| PSSHN score | | |
| <60 | - | - |
| ≥60 | 0.255 | 0.15, 0.45 |
| Concurrent therapy | | |
| No | - | - |
| Yes | 2.78 | 1.87, 4.22 |

Abbreviations: BOT, base of tongue; CI, confidence interval; OR, odds ratio; PSSHN, Performance Status Scale for Head and Neck Cancer.

**Table 6.**

Multivariable Cox Model Analysis for G-tube Duration Among Nonsurgical Patients

| Characteristic | HR | 95% CI |
|---|---|---|
| T Stage | | |
| T0–T2 | - | - |
| T3–T4 | 0.52 | 0.38, 0.71 |
| Primary site | | |
| BOT | - | - |
| Other | 0.88 | 0.52, 1.47 |
| Tonsil | 1.35 | 0.99, 1.85 |
| PSSHN diet | | |
| <60 | - | - |
| ≥60 | 1.65 | 1.03, 2.66 |

Multivariable Cox model for analysis for G-tube duration among nonsurgical patients. In this analysis, the removal of feeding tube was the event of interest, with hazard ratios representing the probability of removal occurring over time. Therefore, larger ratios represented higher probability FT removal over time.

Abbreviations: CI, confidence interval; HR, hazard ratio.