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Outcomes following TORS for HPV-positive oropharyngeal carcinoma: PEGs, tracheostomies, and beyond

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ABSTRACT

Objectives: To review swallowing, airway and speech outcomes following transoral robotic surgery (TORS) ± adjuvant therapy for human papillomavirus associated oropharyngeal squamous cell carcinoma (HPV[+]OPSCC).

Methods: Patients underwent TORS ± standard adjuvant therapy from 5/1/2007–5/31/2015. Clinical data were recorded and descriptive analysis was performed.

Results: 267 patients met criteria. All patients underwent surgery at Mayo, however, only 41/81 and 71/119 patients received RT and CRT at a Mayo Clinic site. A PEG was placed in 77 patients (3 prior to any treatment, 74 reactively during adjuvant therapy), with 3 PEG dependent and 3 partially PEG reliant at last follow-up. Tracheostomy was performed in 30 (11%) patients; 28 were decannulated.

Swallow evaluations were completed for 20/81 undergoing RT and 50/119 undergoing CRT at a median of 3.8 and 7.6 months post-treatment, respectively. An unrestricted oral diet was reported by 5% following RT and 12% following CRT on the Functional Oral Intake Scale. HN-PSS normalcy of diet scores indicated a diet beyond soft chewable foods for 27% following RT and 46% following CRT. No restriction of place, food, or companion was reported for the HN-PSS for public eating in 13% after RT and 33% after CRT. Aspiration of thin liquid was present in 17% and 28% following RT and CRT, respectively. HN-PSS understandability of speech was "always understandable" in 60% and 63%, following RT and CRT, respectively. Hoarseness was reported in 56% and 45% following RT and CRT respectively.

Conclusion: Long-term PEG and tracheostomy dependence in this cohort is low. However, these outcomes underrepresent the decrement in patient speech and swallowing following TORS ± standard adjuvant therapy for HPV (+)OPSCC.

1. Introduction

Despite the epidemic increase in incidence, patients diagnosed with human papilloma virus associated oropharyngeal squamous cell carcinoma (HPV[+]OPSCC) can be reassured that unlike the poor prognosis associated with HPV(−)OPSCC, oncologic outcomes are more favorable. In a 2012 meta-analysis pooling data from 42 different studies, HPV(+)OPSCC resulted in improved overall survival and disease specific survival by 53% and 74%, respectively, when compared to HPV (−)OPSCC [1]. However, unlike the relatively stable oncologic outcomes across treatment modalities, there is a large range in toxicity associated with the most commonly recommended treatments [2–5]. This has held true for both surgical and non-surgical treatment modalities, creating a strong interest in treatment modification or de-escalation to minimize morbidity.

Following surgical therapy, the standard radiation dose is typically decreased to both the primary site and at-risk nodal basins. When combined with transoral surgery this may theoretically offer decreased morbidity to the upper aerodigestive tract resulting in improved swallowing, airway and speech outcomes. In addition, many patients will be spared the need for adjuvant chemotherapy, which increases the risk for PEG-dependence at 1-year [6]. Specific quality of life (QOL)

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measures are rarely reported, and when published, comparison between studies is challenging secondary to the use of heterogeneous questionnaires [7–12]. This is likely multifactorial, and in part due to the retrospective nature of the majority of these studies which therefore rely on data points which can be easily and reliably abstracted. Regardless, functional outcomes are commonly assessed using surrogate markers such as PEG and tracheostomy rates and long-term dependence. In 2015, Yeh et al. reported comparable oncologic and improved functional outcomes for TORS compared to IMRT [5]. Tracheostomy dependence was reported among the IMRT studies as 0.1–4.5% and in TORS studies as 0% to 3.5% [5]. Long term PEG rates from patients going through primary IMRT ± chemotherapy at one year ranged from 0 to 18% [6]. While long term PEG dependence was low for TORS with the majority of studies reporting 0%, up to 30% of patients required a feeding tube during their adjuvant therapy [5,7]. Interestingly, Frenkel et al. recently advocated for earlier PEG tube placement in patients at high risk for impaired oral intake following TORS, citing increased 30-day emergency department visits and 30- or 90-day readmissions attributable to poor oral intake [13]. Perhaps in our desire to drive down the overall PEG rates, we are overlooking opportunities to alter our treatment approach to prevent swallowing dysfunction that is not transparent when looking at PEG dependence alone.

Despite the limited number of papers reporting QOL metrics or formal swallow and speech evaluations (SwSpEvals), it is clear that swallowing, airway and speech outcomes are more complex and nuanced than the binary PEG/no PEG and tracheostomy/no tracheostomy outcomes may lead one to believe. In addition, as described above, the PEG and tracheostomy rates are quite low, which in the era of treatment de-escalation, will make comparing and quantifying improvements in patients QOL between treatment approaches challenging. More granular and patient centric data are needed. This study aims to 1) evaluate the overall PEG and tracheostomy tube rates and dependence at last follow up, and 2) evaluate SwSpEvals for patients undergoing TORS ± standard adjuvant therapy for HPV(+)OPSCC.

2. Materials and methods

2.1. Study design and patient selection

Following IRB approval (IRB: 14–004693), we performed a retrospective review of our departmental OPSCC RedCap database to identify patients (age ≥ 18 years) who underwent TORS ± standard adjuvant therapy with intent-to-cure for a primary HPV(+)OPSCC from 5/1/2007–5/31/2015. HPV status was considered positive if either HPV ISH or p16 was positive. Never-smokers were combined with current/former smokers with ≤10 pack-years for the analysis of pack-years. Patients enrolled in a de-escalation trial (www.clinicaltrials.gov: NCT01932697, NCT02908477) or with a history of head and neck cancer were excluded. During this time period there were no meaningful changes in the surgical techniques used for TORS oropharyngectomy or extent of neck dissection [3,14]. If an intraoperative communication between the pharynx and neck was identified, this was closed intraoperatively [14]. Staging is reported using both the AJCC 7th and 8th edition staging systems [15]. Treatment decisions were made based on the AJCC 7th edition.

2.2. Postoperative care

Tracheostomies were placed based on surgeon discretion. PEG tubes were most commonly recommended if there were concerns regarding malnutrition or dehydration during adjuvant therapy; however, patients were occasionally recommended a PEG by an outside institution prior to therapy. Adjuvant radiotherapy was recommended for patients with AJCC 7th edition pN2/N3 disease and all patients with pT4 tumors. Adjuvant chemotherapy was recommended for patients with pathologic extracapsular spread or positive surgical margins. Adjuvant chemotherapy with cisplatin was recommended for patients with pathologic extracapsular spread or positive surgical margins; non-cisplatin regimens were used at the discretion of the treating medical oncologist if the patient was not a candidate for cisplatin. Patients undergoing adjuvant therapy at our institution were routinely recommended SwSpEvals performed by a speech language pathologist including a modified barium swallow examination following both surgery and adjuvant therapy. Patients undergoing surgery alone were not routinely recommended SwSpEvals unless there was clinical concern, and therefore were excluded from this portion of the analysis.

2.3. Data abstraction

Pre-operative patient variables included age, sex, and smoking status. Surgical variables included surgical approach to the primary tumor, reconstruction, timing of neck dissection, laterality of neck dissection, and presence of an intraoperative pharyngotomy. Oncologic variables included human papillomavirus (HPV), primary tumor subsite, pathologic size of the primary tumor, and tumor stage. Adjuvant therapy data included institution where adjuvant therapy was administered, total gray to the primary site (granular data, including the dose to each neck, was frequently unavailable from outside institutions), and chemotherapeutic agents used. Study end was defined as last clinical follow up, death, or disease recurrence/progression. Final route of nutrition was defined as full oral, oral/PEG, and full PEG. Final airway status was defined as tracheostomy presence or absence. All available SwSpEvals for patients receiving adjuvant therapy were reviewed. Scored evaluations included the Functional Oral Intake Scale (FOIS) [16], Performance Status Scale for Head & Neck Cancer Patients (PSS-HN) [17], Penetration/Aspiration Score [18] and the presence or absence of hoarseness and hypernasality.

2.4. Statistical analysis

Because the proportions of patients with matched SwSpEvals both before and after adjuvant therapy were small compared to the overall sample size in the S-RT and S-CRT cohorts, changes in SwSpEvals were not evaluated statistically and results are reported descriptively. Continuous features were summarized with medians, interquartile ranges (IQRs), and ranges; categorical features were summarized with frequency counts and percentages. Comparisons among treatment groups were evaluated using Kruskal-Wallis, Wilcoxon rank sum, chi-square, and Fisher exact tests. Statistical analyses were performed using version 9.4 of the SAS software package (SAS Institute, Inc., Cary, NC).

3. Results

3.1. Patient characteristics and treatment data

A total of 267 patients met criteria. Table 1 presents patient, pathologic, and treatment characteristics. Of the 67 patients who underwent surgical therapy alone, 35 had no risk factors for adjuvant therapy. The remainder either refused or could not complete adjuvant therapy. Total gray or radiation to the primary is reported. Table 2 summarizes the tumor staging of patients in each treatment arm using both the 7th and 8th edition staging systems. The median duration from surgery to last clinical evaluation for all 267 patients was 4.9 years (IQR 2.3–6.7). The durations were 3.6 years (IQR 0.6–5.3), 4.9 years (IQR 2.1–6.1), and 5.2 years (IQR 3.3–7.4) for the S, S-RT, and S-CRT groups, respectively.

3.2. PEG data

Table 3 summarizes the PEG status (placement, removal and clinical swallowing status at study end) and tracheostomy status (placement, decannulation). A PEG was placed in 77 patients (30%), with 3

Table 1
Summary of clinicopathologic features and treatment strategies, N = 267.

Clinical data	
Feature	Median (IQR; range)
Age at surgery (years)	58 (50–63; 34–87)
Sex	**N (%)**
Female	30 (11)
Male	237 (89)
Pack-years (N = 244)	
≤10	162 (66)
> 10	82 (34)
Primary tumor subsite	
Tonsil	176 (66)
Base of tongue	91 (34)
Pathologic data	
Feature	N (%)
Final margin positive	7 (3%)
Extracapsular spread (N = 227)	147 (65)
HPV positive	267 (100%)
Overall treatment data	
Primary treatment	N (%)
S	67 (25)
S-RT	81 (30)
S-CRT	119 (45)
Surgical data	
	N (%)
Primary surgical approach[a]	
Transoral robotic surgery	267 (100)
Plus transoral direct access	2 (1)
Plus lateral pharyngotomy	3 (1)
Intraoperative pharyngotomy (N = 265)	
Yes	76 (29)
No	189 (71)
Reconstruction[a]	
Secondary intent	262 (98)
Primary intent	7 (3)
Regional flap	2 (1)
Neck dissection for primary management	267 (100)
Timing of neck dissection	
Concurrent with primary surgical management	267 (100)
Laterality of neck dissection	
Ipsilateral	235 (88)
Bilateral	32 (12)
Radiation data	
Where adjuvant radiation (S-RT) was provided:	(N = 81)
Elsewhere	40 (49)
Mayo Clinic, Rochester, MN	32 (40)
Mayo Health System	9 (11)
Where adjuvant chemoradiation (S-CRT) was provided:	(N = 119)
Elsewhere	48 (40)
Mayo Clinic, Rochester, MN	57 (48)
Mayo Clinic, Scottsdale, AZ	2 (2)
Mayo Health System	12 (10)
	Median (IQR; range)
Total gray to primary site (N = 154)	60 (60–60; 48–70)
Total gray to primary site	
Surgery + radiation (N = 62)	60 (60–60; 50–70)
Surgery + radiation + chemotherapy (N = 92)	60 (60–60; 48–70)
Chemotherapy data	
Chemotherapy regimen (N = 114)	
Adjuvant	114 (100)
Adjuvant chemotherapy agent (N = 100)[a]	
High-dose cisplatin	54 (54)
Weekly cisplatin	40 (40)
Weekly carboplatin	1 (1)
Weekly cetuximab + docetaxel	3 (3)
Weekly cetuximab	6 (6)

[a] Patient can be listed in multiple categories. S = surgery; R = radiation; CRT = chemoradiation.

Table 2
Comparison of pathologic stage by primary treatment.

	S N = 67	S-RT N = 81	S-CRT N = 119	
Feature		N (%)		P-value
Pathologic T stage				
7th edition				
TX	0	0	1 (1)	0.77
T1	26 (39)	36 (44)	49 (41)	
T2	33 (49)	35 (43)	60 (50)	
T3	6 (9)	6 (7)	6 (5)	
T4a	2 (3)	4 (5)	3 (3)	
8th edition				
T0	0	0	1 (1)	0.77
T1	26 (39)	36 (44)	49 (41)	
T3	33 (49)	35 (43)	60 (50)	
T3	6 (9)	6 (7)	6 (5)	
T4	2 (3)	4 (5)	3 (3)	
Pathologic N stage				
7th edition				
N0	28 (42)	7 (9)	2 (2)	< 0.001
N1	10 (15)	10 (12)	4 (3)	
N2a	13 (19)	21 (26)	18 (15)	
N2b	14 (21)	37 (46)	75 (63)	
N2c	1 (1)	4 (5)	7 (6)	
N3	1 (1)	2 (2)	13 (11)	
8th edition				
N0	28 (42)	7 (9)	2 (2)	< 0.001
N1	35 (52)	69 (85)	90 (76)	
N2	4 (6)	5 (6)	27 (23)	
Overall AJCC stage				
7th edition				
I	12 (18)	1 (1)	0	< 0.001
II	14 (21)	4 (5)	1 (1)	
III	12 (18)	10 (12)	4 (3)	
IVa	28 (42)	64 (79)	102 (86)	
IVb	1 (1)	2 (2)	12 (10)	
8th edition				
I	57 (85)	68 (84)	87 (73)	0.083
II	8 (12)	11 (14)	28 (24)	
III	2 (3)	2 (2)	4 (3)	

S = surgery; RT = radiation; CRT = chemoradiation.

receiving a PEG prior to treatment initiation at an outside institution prior to presentation at our institution, and the rest received their PEG during treatment secondary to clinical concern. Two patients undergoing S alone received a PEG at 20 days and 2 months after surgery, respectively. Thirteen of 81 patients (16%) undergoing S-RT received a PEG. Of these, 8 had a PEG during RT; 3 had a PEG within 30 days of RT stop date, and 2 could not be determined because of missing RT stop dates (RT received elsewhere). In the S-CRT group, 59/119 patients (50%) received a PEG. Of these, 47 received their PEG during RT, 2 within 30 days of their RT stop date, and 10 could not be determined because of missing data (CRT received elsewhere). One of the two patients undergoing S alone had their PEG removed at 1.7 months following surgery. The median time to PEG removal was 4.0 and

Table 3
Comparisons of swallowing status and airway status by primary treatment.

	All	S	S-RT	S-CRT	
	N (%)				P-value
Swallowing status					
PEG tube placement	N = 261	N = 64	N = 79	N = 118	
Prophylactic	3 (1)	0	2 (3)	1 (1)	< 0.001
Reactive, during RT/CRT	74 (28)	2 (3)	13 (16)	59 (50)	
None	184 (71)	62 (97)	64 (81)	58 (49)	
Final route of nutrition	N = 267	N = 67	N = 81	N = 119	
Full oral	259 (97)	64 (96)	80 (99)	115 (97)	0.28
NGT	2 (1)	2 (3)	0	0	
Oral/PEG	3 (1)	1 (1)	0	2 (2)	
Full PEG	3 (1)	0	1 (1)	2 (2)	
Airway status					
Tracheostomy	N = 267	N = 67	N = 81	N = 119	
Prior to surgery	1 (< 1)	1 (1)	0	0	0.019
During surgery[a]	29 (11)	4 (6)	5 (6)	20 (17)	
None	237 (89)	62 (93)	76 (94)	99 (83)	
Tracheostomy during treatment	N = 29	N = 4	N = 5	N = 20	
Removed	27 (93)	2 (50)	5 (100)	20 (100)	0.015
Not removed	2 (7)	2 (50)	0	0	
Final airway	N = 267	N = 67	N = 81	N = 119	
Normal	265 (99)	65 (97)	81 (100)	119 (100)	0.062
Tracheostomy	2 (1)	2 (3)	0	0	

S = surgery; R = radiation; CRT = chemoradiation.
[a] One patient received a tracheostomy 2 days following surgery for hemorrhage.

4.8 months for S-RT and S-CRT, respectively. Three of 267 patients were PEG dependent at study end for a long-term PEG rate of 1%.

3.3. Airway data

No laryngectomy was performed in this cohort of patients. All but two tracheostomies were performed at the time of the primary surgery. One was performed prior to surgery, and one performed 2 days following surgery following transoral hemorrhage. Patients undergoing tracheostomy during surgery were more likely than those not receiving tracheostomy to have bilateral neck dissections (45% vs 8%), higher T stage (69% vs 56% pT2 or higher) and base of tongue tumors (69% vs 30%). While not significant, there was a trend towards decreasing tracheostomy rates over time (P = 0.085). The patient who received a tracheostomy prior to surgery was decannulated on 33 days following surgery. The median time to decannulation was 5 (unknown, 2, 5), 4 (2, 4, 6, and 13) and 6 (IQR 4–7; range 3–96) days for S, S-RT, and S-CRT respectively. All but two patients were decannulated by study end.

3.4. Swallowing and speech evaluations

SwSpEvals were performed by a Mayo speech and language pathologist in a total of 41/81 patients undergoing S-RT and 76/119 undergoing S-CRT. Of these, 35 were performed prior to RT and 70 prior to CRT, while 20 were performed after RT and 50 after CRT; there were 14 S-RT and 44 S-CRT patients with both pre and post adjuvant therapy assessments, respectively. SwSpEvals were performed a median of 1.0 (IQR 0.7–1.2) and 0.8 (0.5–1.0) months following surgery and 3.8 (2.6–7.2) and 7.6 (2.6–21.4) months following radiation completion for the S-RT and S-CRT groups, respectively. Table 4 summarizes the FOIS scores, Table 5 summarizes the penetration/aspiration scores, and Table 6 summarizes the HN-PSS for public eating, normalcy of diet, and understandability of speech. In addition, Table 6 summarizes the presence or absence of hoarseness and hypernasality.

4. Discussion

Our study demonstrates that despite low rates of PEG and tracheostomy dependence, patients are experiencing a significant decrement in functional outcomes following TORS and standard adjuvant therapy. 97% of our patients were PEG-free, and 99% were tracheostomy-free at study end; however, SwSpEval outcomes decreased substantially across almost all measured domains following adjuvant therapy. Despite the importance placed on functional outcomes in the management of HPV(+)OPSCC, there is no consensus as to what outcomes should be measured resulting in a high reliance on PEG and tracheostomy dependence as surrogate markers for function. Our results show that PEG and tracheostomy rates should not be used as primary endpoints for function in the era of modern treatment for HPV(+)OPSCC, and that more nuanced and comprehensive assessments are needed, particularly when designing clinical trials with functional and QOL endpoints.

In order to analyze functional outcomes associated with treatment for HPV(+)OPSCC, ideally we would have long-term validated and homogenous data for comparison. Unfortunately, as Roets et al. highlight, interpretation of validated functional outcomes is “hampered by multiple confounding factors, including the use of different QOL questionnaires, the small inclusion and heterogeneous populations, short follow-up with large dropout of patients at long term follow up” and lack of balance in stages across treatment types [19]. In our data, it was interesting to note that using the 8th edition criteria, despite an increase in N stage with number of treatment modalities, there was no statistical difference in overall tumor stage across treatment groups. An added challenge to interpretation of published data is the timing of SwSpEvals. In a review of the literature including 17 articles looking at QOL outcomes following treatment for OPSCC, the most important time frame for worsening of swallowing, xerostomia, and speech occurred at three months following therapy [19]. While symptoms can and do change over time, the majority of long-term toxicities are present at 3-months following treatment [7,19,20]. Our study is limited by the lack of long-term information; however, this 3-month time point is captured.

Despite the overwhelmingly heterogeneous data available in the literature, there is an overall trend demonstrating improved swallowing outcomes when combining TORS with adjuvant therapy for appropriate patients. In a stage matched trial comparing 31 patients undergoing transoral surgery (15 transoral laser microsurgery [TLM] and 15 TORS) with 31 CRT patients, Chen et al. reported that the only outcome that differed between the two groups at 12-months on the UWQOL was swallowing (P = 0.01), with 74% of transoral patients reporting being able to swallow “as well as ever” compared to 32% in the CRT group [21]. More et al. presented MD Anderson Dysphagia Inventory (MDADI) scores prior to treatment (baseline) and at 3-, 6-, and 12-months following treatment for 20 TORS ± adjuvant and 20 CRT patients with stage matched OPSCC and supraglottic (supraglottic: TORS n = 1, CRT n = 2) squamous cell carcinoma and found no significant difference prior to treatment or at 3-months [22]. However, at 6- and 12-months there was an improvement back to baseline in the TORS patients that was not seen for the CRT group and this difference reached statistical significance at both time points [22]. Our data also demonstrate a substantial impact on swallowing outcomes following standard adjuvant therapy. The percentage of patients reporting a total oral diet with no restrictions on the FOIS dropped from 20% to 5% following RT and from 26% to 12% following CRT. Aspiration with thin liquids at any point during the swallow attempt on modified barium swallow was similar before and after RT (15% vs 17%) but increased following CRT (19% vs 28%). Using the HN-PSS for public eating, patients reporting no restriction of place, food or companion decreased from 65% to 13% following RT and from 60% to 33% after CRT. HN-PSS normalcy of diet was similarly impacted by adjuvant therapy with a score of 100, or a full diet with no restrictions, dropping from 55% to 13% following RT and from 45% to 19% following CRT. Taken together, this would

Table 4
Functional Oral Intake Scale (FOIS) scores following surgery and following adjuvant therapy for patients undergoing S-RT and S-CRT.

FOIS score	S-RT		S-CRT	
	Post Op (N = 35) N (%)	Post RT (N = 20) N (%)	Post Op (N = 69) N (%)	Post CRT (N = 50) N (%)
1 – NPO (nothing by mouth)	1 (3)	0	1 (1)	2 (4)
2 – Tube dependent, minimal attempts of food or liquid	1 (3)	0	3 (4)	2 (4)
3 – Tube dependent with consistent oral intake of food or liquid	0	2 (10)	2 (3)	0
4 – Oral diet, single consistency	5 (14)	7 (35)	12 (17)	8 (16)
5 - Oral diet, multiple consistencies, requiring special preparation or compensations	10 (29)	5 (25)	19 (28)	12 (24)
6 – Oral diet, multiple consistencies, no special preparation, specific food limitations	11 (31)	5 (25)	14 (20)	20 (40)
7 – Total oral diet, no restrictions	7 (20)	1 (5)	18 (26)	6 (12)

Table 5
Penetration/aspiration scores following surgery and following adjuvant therapy for patients undergoing S-RT and S-CRT.

Penetration aspiration scores		S-RT		S-CRT	
		Post Op	Post RT	Post Op	Post CRT
		N = 34	N = 18	N = 68	N = 47
Thin	Does not enter airway	19 (56)	6 (33)	33 (49)	17 (36)
	Penetration	10 (29)	9 (50)	22 (32)	17 (36)
	Aspiration	5 (15)	3 (17)	13 (19)	13 (28)
Nectar		N = 24	N = 14	N = 60	N = 39
	Does not enter airway	16 (67)	10 (71)	44 (73)	21 (54)
	Penetration	5 (21)	2 (14)	8 (13)	14 (36)
	Aspiration	3 (13)	2 (14)	8 (13)	4 (10)
Puree		N = 35	N = 18	N = 69	N = 46
	Does not enter airway	31 (89)	17 (94)	61 (88)	43 (93)
	Penetration	4 (11)	0	3 (4)	0
	Aspiration	0	1 (6)	5 (7)	3 (7)
Solid		N = 26	N = 17	N = 52	N = 40
	Does not enter airway	25 (96)	16 (94)	52 (100)	39 (98)
	Penetration	1 (4)	1 (6)	0	0
	Aspiration	0	0	0	1 (2)

"Does not enter airway" = 1 – contrast does not enter airway; "Penetration" = 2–5 – contrast enters airway but does not pass vocal folds; "Aspiration" = 6–8 – contrast passes through glottis.

suggest that TORS based protocols may offer patients improved swallowing outcomes compared to primary CRT protocols, but that there is the potential to improve patient reported swallowing QOL by modifying our adjuvant regimens.

Speech outcomes in the literature are similarly difficult to interpret, yet represent a significant concern for patients. In 2018, Sethia et al. published a prospective cohort of 111 patients with OPSCC undergoing TORS alone (n = 13), TORS + RT (n = 31) and TORS + CRT (n = 67) who were given the Head and Neck Cancer inventory preoperatively, and at 3-weeks, 3-, 6-, and 12-months post treatment [23]. These authors report that the speech subdomain (functional) scores for TORS alone were significantly higher than for adjuvant CRT at 3-months (P = 0.04) and for adjuvant RT at 6-months (P = 0.03) [23]. Speech measures in our study were very good overall but did demonstrate worsening function following standard adjuvant therapy. Patients reported as "always understandable" on the HN-PSS understandability of speech domain decreased from 90% to 60% following RT and from 74% to 63% following CRT. Hoarseness nearly doubled for both S-RT (32% to 56%) and S-CRT (24% to 45%) following adjuvant therapy. Detailed QOL patient-centric data analyzing speech offers insight into potential areas for improvement.

Finally, regarding airway outcomes, as recently as 2002, Parson reported that in surgical series for BOT carcinoma 15–20% of patients would require a total laryngectomy [24]. This has changed dramatically, with only a single functional laryngectomy required for side effects from radiation reported in the contemporary review by Yeh et al. [5]. The tracheostomy dependency rates have also improved to 0.1–4.5% for IMRT and 0–3.5% for TORS-based therapy in contemporary studies [5]. In the present series, a tracheostomy was placed prior to or during treatment in 30 patients (11%) with all but two tracheostomy-free at study end. While not significant, there was a trend towards decreasing tracheostomy rates over time (P = 0.085). A tracheostomy was more likely in association with bilateral neck dissections, base of tongue tumors, higher T stage, but this does not appear to negatively impact airway outcome or result in long-term dependence (11% placement vs 1% long-term dependence).

This is a retrospective study with important limitations. There is selection bias into treatment arms, limiting our ability to stage match patients. We were unable to compare QOL outcomes directly to TORS only patients as SwSpEvals were uncommon in this group and generally only recommended when there was clinically relevant swallowing dysfunction. While more common practice for patients undergoing adjuvant therapy, SwSpEvals were not available for all patients and there was a significant decrease in the patients undergoing post-adjuvant assessment. In addition, the timing of post-adjuvant formal evaluations was limited for most patients to < 12 months, making comment on long term recovery of function impossible. The slight improvement in patients undergoing S-CRT when compared to S-RT is likely related to the longer duration of follow up (7.6 vs 3.8 months post treatment). Although surgery was universally performed at our institution, patients frequently sought adjuvant therapy closer to home, making it challenging to assess the quality of adjuvant therapy. Finally, this was a single institution study that may limit its generalizability to other centers.

5. Conclusions

In 267 patients undergoing TORS for HPV(+)OPSCC, PEG was placed more often for S-CRT, and more often during adjuvant therapy. Tracheostomy was only placed in the perioperative setting, and was more common in patients with bilateral nodal disease, base of tongue tumors, and larger primary tumors. 97% of our patients were PEG free, and 99% were tracheostomy free at study end. While these represent important outcome variables, we emphasize that these data obscure the QOL outcomes experienced by patients. In our study, patients with HPV (+)OPSCC undergoing TORS demonstrated decline in function for almost all measures following standard adjuvant therapy on validated measures associated with QOL. Our data emphasize the potential for improved swallowing and speech outcomes following future deescalated therapy protocols, while underscoring the need for more specific reporting on functional outcomes.

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Table 6
Swallowing and Speech Outcomes following TORS and S-RT or S-CRT.

		S-RT		S-CRT	
		Post Op	Post RT	Post Op	Post CRT
Head and neck performance status scales		N = 20	N = 15	N = 35	N = 39
		N (%)			
Public eating	0 – Always eats alone	1 (5)	1 (7)	0	1 (3)
	25 - Eats only at home in presence of selected persons	1 (5)	2 (13)	3 (9)	6 (15)
	50 - Eats only in presence of selected persons in selected places	1 (5)	2 (13)	4 (11)	4 (10)
	75 - No restriction of place, but restricts diet when in public	4 (20)	8 (53)	7 (20)	15 (38)
	100 - No restriction of place, food, or companion	13 (65)	2 (13)	21 (60)	13 (33)
		N = 20	N = 15	N = 38	N = 42
Normalcy of diet	0 - Non oral feeding (feeding tube)	1 (5)	0	0	2 (5)
	10 - Cold liquids	0	1 (7)	0	0
	20 - Warm liquids	0	1 (7)	0	1 (2)
	30 - Pureed foods (in blender)	0	1 (7)	4 (11)	2 (5)
	40 - Soft foods requiring no chewing	2 (10)	1 (7)	0	4 (10)
	50 - Soft, chewable foods	2 (10)	7 (47)	8 (21)	14 (33)
	60 - Dry bread and crackers	0	1 (7)	4 (11)	1 (2)
	70 - Carrots, celery	0	0	1 (3)	2 (5)
	80 - All meat	2 (10)	0	3 (8)	4 (10)
	90 – Peanuts / Liquid wash	2 (10)	1 (7)	1 (3)	4 (10)
	100 – Full diet (no restrictions)	11 (55)	2 (13)	17 (45)	8 (19)
		N = 21	N = 15	N = 38	N = 43
Understand-ability of Speech	0 - Never understandable; may use written communication	0	0	0	0
	25 - Difficult to understand	0	0	0	0
	50 - Usually understandable; face-to-face contact necessary	0	0	2 (5)	0
	75 - Understandable most of the time; occasional repetition necessary	2 (10)	6 (40)	8 (21)	16 (37)
	100 - Always understandable	19 (90)	9 (60)	28 (74)	27 (63)
Hoarseness and hypernasality		N = 31	N = 18	N = 67	N = 47
		N (%)			
Hoarseness		10 (32)	10 (56)	16 (24)	21 (45)
Hypernasality		2 (6)	1 (6)	5 (7)	2 (4)

IRB approval

14-004693.

Evidence level

2a.

Meeting information

These data were presented as a poster presentation by Melanie H. Quick at the American Head and Neck Society meeting in National Harbor, MD, from 4/17/18–4/22/18.

Declaration of Competing Interest

None.

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