

Long-term functional swallowing and speech outcomes after transoral robotic surgery for oropharyngeal cancer

Yong Bae Ji¹, Hae Won Choi², Chang Myeon Song¹, Bo Ram Yun², Hae Jin Park¹, Sukjoong Oh¹, and Kyung Tae¹

¹Hanyang University College of Medicine

²Hanyang University Medical Center

February 22, 2024

Abstract

Objective: Transoral robotic surgery (TORS) for oropharyngeal cancer was introduced to ensure better functional preservation with less morbidity. However, long-term functional outcomes, especially speech and swallowing outcomes, have not been thoroughly investigated. This study aimed to evaluate the long-term functional swallowing and speech outcomes after transoral robotic surgery for oropharyngeal cancer. **Methods** We studied 41 patients with oropharyngeal squamous cell carcinoma who underwent TORS between January 2010 and December 2018. Tongue mobility, maximal phonation time, articulation, verbal diadochokinesis, reading speed, and modified barium swallowing tests were performed between two and three years after TORS to analyze the long-term functional speech and swallowing outcomes. **Results:** The mean patient age was 57.7 ± 9.9 years, and the male to female ratio was 34:7. The most common subsite was the palatine tonsil (73.2%), followed by the base of tongue (22.0%). Forty patients (97.6%) underwent concomitant neck dissection, and 36 patients (87.8%) received adjuvant radiation or chemoradiation therapy. Tongue mobility, maximum phonation time, articulation, verbal diadochokinesis, and reading speed were not different from those of the normal population. Modified barium swallowing outcomes were acceptable in most patients; however, one patient (2.4%) was dependent on a percutaneous endoscopic gastrostomy tube. None of the patients required a permanent tracheostomy. **Conclusions:** Long-term speech and swallowing functions after TORS were acceptable in most patients with oropharyngeal cancer. TORS is an excellent treatment modality for oropharyngeal cancer in terms of functional outcomes.

Abstract

Objective: Transoral robotic surgery (TORS) for oropharyngeal cancer was introduced to ensure better functional preservation with less morbidity. However, long-term functional outcomes, especially speech and swallowing outcomes, have not been thoroughly investigated. This study aimed to evaluate the long-term functional swallowing and speech outcomes after transoral robotic surgery for oropharyngeal cancer.

Methods We studied 41 patients with oropharyngeal squamous cell carcinoma who underwent TORS between January 2010 and December 2018. Tongue mobility, maximal phonation time, articulation, verbal diadochokinesis, reading speed, and modified barium swallowing tests were performed between two and three years after TORS to analyze the long-term functional speech and swallowing outcomes.

Results: The mean patient age was 57.7 ± 9.9 years, and the male to female ratio was 34:7. The most common subsite was the palatine tonsil (73.2%), followed by the base of tongue (22.0%). Forty patients (97.6%) underwent concomitant neck dissection, and 36 patients (87.8%) received adjuvant radiation or chemoradiation therapy. Tongue mobility, maximum phonation time, articulation, verbal diadochokinesis, and reading speed were not different from those of the normal population. Modified barium swallowing outcomes were acceptable in most patients; however, one patient (2.4%) was dependent on a percutaneous endoscopic gastrostomy tube. None of the patients required a permanent tracheostomy.

Conclusions: Long-term speech and swallowing functions after TORS were acceptable in most patients with oropharyngeal cancer. TORS is an excellent treatment modality for oropharyngeal cancer in terms of functional outcomes.

Key words: Oropharyngeal cancer · Transoral robotic surgery · Functional outcomes · Speech · Swallowing · Modified barium swallowing

Key points

- Transoral robotic surgery (TORS) for oropharyngeal cancer has been introduced to ensure better functional preservation with less morbidity.
- Long-term functional outcomes, including speech and swallowing outcomes after TORS, were thoroughly investigated in this study.
- We evaluated speech and swallowing function 2-3 years after TORS in 41 patients with oropharyngeal squamous cell carcinoma.
- Long-term speech and swallowing functions after TORS were acceptable in most patients.
- TORS showed favorable long-term functional speech and swallowing outcomes.

INTRODUCTION

The incidence of oropharyngeal cancer, especially human papillomavirus (HPV)-related oropharyngeal squamous cell carcinoma (OPSCC), is increasing worldwide.¹ HPV-positive OPSCC has better treatment outcomes and prognoses compared to HPV-negative cancer because HPV-positive OPSCC generally occurs in younger patients who are more likely to survive longer. Therefore, preservation of function and reduction of morbidity are more critical in treating HPV-positive patients.

The primary treatment for oropharyngeal cancer has been radical excision of the primary tumor using various approaches and subsequent adjuvant radiation treatment. This treatment strategy results in inevitable functional disturbance, especially in speech and swallowing.² Therefore, based on some landmark studies, organ preservation chemoradiation therapy has been developed and confirmed to be comparable to surgical treatment in avoiding surgical morbidity and functional loss.^{3,4} Since then, chemoradiation therapy has been considered the primary treatment for oropharyngeal cancer.

However, long-term results of chemoradiation therapy in treating head and neck cancer were reported, and high dose chemoradiation therapy resulted in significant short- and long-term morbidities such as xerostomia and dysphagia.⁵⁻⁷ A systematic review showed that 10-30% of patients require gastrostomy one year after treatment. This results in a significantly adverse impact on quality of life.⁸ Therefore, functional preservation, not merely organ preservation, are important; and treatment outcome and quality of life and function need to be considered when selecting a treatment strategy.

Transoral robotic surgery (TORS) for oropharyngeal cancer was introduced as an option with better functional preservation with less morbidity, and TORS was approved by the United States Food and Drug Administration in 2009.

Oncologic outcomes of TORS for oropharyngeal cancer are comparable to those of primary chemoradiation or radical surgery.⁹ In terms of functional outcome, TORS showed excellent short-term results, including more rapid recovery of swallowing, shorter hospitalization, and shorter operation time.¹⁰⁻¹² However, the actual long-term functional outcomes of TORS, including speech and swallowing outcomes, have not been thoroughly investigated, but some studies did evaluate long-term functional outcomes of tracheostomy, feeding tube dependency, and questionnaire-based subjective results after TORS.¹³⁻¹⁸ Therefore, this study aimed to evaluate long-term functional speech and swallowing outcomes after TORS for oropharyngeal cancer.

2 MATERIALS AND METHODS

We retrospectively reviewed data from 63 patients with OPSCC who underwent primary TORS with or without adjuvant radiation or chemoradiation therapy between January 2010 and December 2018. Of 63 patients, we excluded 22 patients from the study, including those who did not perform a swallowing and

speech test between two and three years after TORS (16 patients) and who had a previous history of head and neck surgery or irradiation (1 patient), or who had cancer recurrence within two to three years after TORS before functional evaluation (5 patients). Finally, the remaining 41 patients were included, and data from these patients were analyzed in this study. The study protocol was approved by the institutional review board.

All operations were performed by a single surgeon. We performed adjuvant radiation therapy after TORS in patients with close surgical margin or lymph node metastasis and adjuvant concurrent chemoradiation therapy in patients with positive margin or extranodal extension.

Evaluation of postoperative functional speech and swallowing outcomes was performed by the mobility of the tongue, maximal phonation time, articulation, verbal diadochokinesis, reading speed, and modified barium swallowing tests conducted between two and three years after surgery. Tracheostomy tube or percutaneous endoscopic gastrostomy (PEG) tube dependency was also investigated.

2.1 Assessment of articulation and speech

Speech and articulation functions were evaluated using the Korean Speech Mechanism Screening Test designed to assess the structure and function of articulation and speech compared to the data of the normal Korean population.¹⁹

Tongue mobility was assessed by the limitation of lingual motions (Table 1). Each tongue motion was assessed with a score of 0 (severe impairment), 1 (mild impairment), or 2 (normal). The tongue mobility score was the sum of the 8 lingual motion scores. The maximal phonation time was performed twice, and the higher value was selected.

Articulation was assessed by having the patient read Korean poetry consisting of 39 syllables. The speech-language pathologist assessed the accuracy of /r/, /s/, and /z/ pronunciation with a score of 0 (severe impairment), 1 (mild impairment), or 2 (normal). The articulation score was defined as the sum of the 3 consonant scores.

The verbal diadochokinesis test was utilized to assess oral motor function.²⁰ The patients pronounced the four sounds /p/, /t/, /k/, /p^t/, /r/, /gn/, and /a/ as rapidly as possible for 5 seconds. This was repeated three times. The speech pathologist assessed the regularity (0–14) and

Reading speed was evaluated by having the patients read Korean poetry consisting of 60 syllables, and 18.2 seconds or more was considered abnormal in adults.

2.2 Assessment of swallowing

Swallowing assessment was conducted with the modified barium swallow (MBS) study.²¹ During the MBS, the patient sits upright on a chair or stands on a platform. Thin liquids were administered to subjects with increasing volume (1, 3, 5, and 10 ml), and food items of different consistencies that have been mixed with barium-sulfate-containing products (Varibar®, Bracco Diagnostics Inc., Monroe Twp., NJ) were also administered. The standard lateral radiographic views from the lips to the cervical spine and from the nasopharynx to the upper esophageal sphincter were obtained. We evaluated swallowing performance in each process of the oral (e.g., tongue mobility and mouth residues), pharyngeal (e.g., triggering of pharyngeal swallow, laryngeal elevation and epiglottic closure and nasal regurgitation) and esophageal (e.g., obstruction, passage, and reflux) phases.

2.3 Statistical analysis

All analysis was performed using SPSS statistical software, ver. 21.0 (SPSS, Chicago, IL). Recurrence-free survival was assessed with the Kaplan-Meier method. Statistical significance was set at p values < 0.05.

2.4 Reporting guideline

This study follows the STROBE guidelines for observational studies.

3 RESULTS

The mean age of the 41 patients was 57.7 ± 9.9 years and the male to female ratio was 34:7. The most common subsite was the palatine tonsil (30 cases), followed by the base of tongue (9 cases). Pathologic testing confirmed that 38 (92.7%) were squamous cell carcinomas and 3 were basaloid squamous cell carcinoma. Nineteen out of 26 patients (73.1%) were p16 positive. According to the 8th version of the American-Joint Cancer Classification (AJCC) staging system,²² the number of T1/T2/T3/T4 patients was 17/23/1/0, the number of N0/N1/N2 patients was 12/19/10 and the number of stage I/II/III/IV patients was 7/3/19/12. Forty patients (97.6%) underwent neck dissection concomitant with TORS. Tracheostomy was performed on six (14.6%) TORS patients. The mean time of console work for TORS was 94.7 ± 41.5 min. There were 1 case of minor hematoma and 6 cases of seroma in the neck. None of the cases was converted to conventional surgery. Thirty-six patients (87.8%) received adjuvant radiation or chemoradiation therapy (Table 2).

We defined the abnormal cut-off values for tongue motility, maximal phonation time, verbal diadochokinesis, articulation tests, and reading speed as two standard deviations above or below the value of normal subjects (Table 3).

The mean tongue motility score was 15.5 ± 1.2 (range, 13 – 17) in this study. Only 3 patients had abnormal tongue motility scores below the cut-off value defined in the study (below 14.58). The mean maximum phonation time was 17.8 ± 6.9 sec (range, 9.2 – 35.7) in this study. No patient was lower than the abnormal cut-off value.

The mean articulation score was 5.9 ± 0.3 (range, 5 – 6) in this study. No patient showed an abnormal cut-off value score (lower than 4.79). The mean verbal diadochokinesis score (sum of regularity and accuracy) was 25.1 ± 2.1 in this study, which was higher than the abnormal reference value (< 21.83). The mean reading speed was 11.9 ± 2.3 sec (range, 9.1 – 15.8) in this study. All patients were below the abnormal cut-off value score (higher than 18.2 sec).¹⁹

In the subgroup analysis of articulation and speech outcomes according to primary site and T classification, there were no significant differences between the tonsil and base of tongue and between T1 and T2 primary cancers (Table 4).

MBS was performed in 32 patients. Generally, the results of MBS were favorable in all patients. However, in the oral stage, mild piecemeal deglutition was noted in 3 patients, premature bolus loss in 8 patients, and presence of mouth residue in 3 patients. Reduced laryngeal elevation and epiglottic closure and repeated swallowing were seen in only 2 patients in the pharyngeal stage. In the esophageal stage, delayed passage was noted in 7 patients, opening of pharyngoesophageal segment in 4 patients, and gastroesophageal reflux in 4 patients (Table 5). None of the patients needed nasogastric or PEG tubes before adjuvant therapy. However, one patient (2.4%) with T2 tonsil cancer required permanent PEG tube placement after chemoradiation therapy. No patients required permanent tracheostomy.

4 DISCUSSION

Oncologic outcomes after TORS in oropharynx cancer are generally favorable. Also, despite initial concerns about the imperfection of en bloc resection, TORS is recognized by many researchers as a relatively safe technique. In a systematic review involving 12 TORS studies with 772 patients, adverse events of TORS were hemorrhage (2.4%), fistula (2.5%), and placement of gastrostomy tubes at the time of surgery (1.4%), although the need for gastrostomy tubes increased to 30% of patients during adjuvant treatment.²³ A study that analyzed data from 305 patients from the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) datasets showed a low, 7.9%, complication rate and a 0.7% 1-month mortality rate.²⁴

There were no severe complications or mortality in this study, but there were some minor complications such as minor hematoma and seroma. Also, no procedure was interrupted or converted to conventional radical surgery because the tumor could not be removed during TORS.

Several studies reported that the temporary tracheostomy rate was from 0 to 31% (less than 10% in most studies) and the permanent tracheostomy rate was 0-2%.^{9,15,16,18} In this study, temporary tracheostomy was

performed on six patients during TORS. However, none of these patients required permanent tracheostomy.

Functional outcomes are essential, particularly in HPV-related oropharyngeal cancer, because this cancer occurs in relatively younger patients who respond well to both surgical and non-surgical treatment modalities and show good prognoses. Therefore, post-treatment morbidity, such as xerostomia and dysphagia, can be a life-long problem in these patients. From a functional outcome point of view, primary TORS can be an excellent alternative to concurrent chemoradiation therapy.⁷

To evaluate speech-related function, we used the Korean Speech Mechanism Screening Test, a functional scale specially designed for use in Korea. The test has been validated in the normal Korean population and includes tests for tongue mobility, maximal phonation time, verbal diadochokinesis, articulation, and reading speed. In this study, long-term functional speech outcomes were acceptable and comparable to those of normal subjects. All speech parameters, including tongue mobility, maximal phonation time, verbal diadochokinesis, articulation, and reading speed, were not different from those of the normal population.

Some previous papers also reported favorable speech function after TORS for oropharyngeal cancer as measured by other methods. For example, a study conducted by Moore et al. revealed that all 45 patients who underwent TORS for oropharyngeal cancer showed normal speech function at four weeks postoperatively. In that study, speech was assessed as normal, having minor dysphonia, or having gross dysphonia. However, 4 of that study's patients had rhinolalia when discharged from the hospital.¹⁵ Dziegielewski et al. also reported speech function was not different from the preoperative baseline in 76 patients 12 months postoperatively when assessed using a health-related quality of life questionnaire.¹¹

To analyze swallowing outcomes after TORS, various methods, such as feeding tube rate, fiberoptic endoscopic evaluation, MBS, and swallowing-related quality of life, were used in previous studies. Swallowing function usually declines in immediate postoperative periods and is restored within several weeks.^{10,14,15,23} In addition, postoperative swallowing outcome is related with preoperative function, T-classification, nodal status, location of primary tumors, and need for adjuvant chemoradiation.¹⁵

The perioperative feeding tube rate in TORS varies from 3% to 100% but is relatively lower than that when using non-surgical therapy (29% to 60%).^{10,14,15} Sinclair et al. reported that ten out of 42 primary TORS patients with cancer of the oropharynx required gastrostomy tubes. However, this rate improved over time, even after 12 months, and no one required a PEG tube by the commencement of radiation therapy.¹⁸ Chronic PEG tube dependence was reported to be from 0 to 7%.¹⁴ Sharma et al. reported that stage-matched patients undergoing TORS for oropharyngeal cancer had lower PEG tube dependency compared to patients undergoing non-surgical therapy (33.3% vs. 84.1%), although the PEG tube prevalence decreased over time in both TORS and non-surgical groups.¹⁷ In this study, only 1 patient (2.4%) was dependent on a PEG tube at 36 months of follow-up.

In this study, we objectively evaluated swallowing outcomes using MBS. The MBS test was performed in 32 out of 41 patients. Most patients showed favorable swallowing outcome in this study, although there were minor impairments in some patients. No prior research has evaluated swallowing outcome after TORS using MBS. Most previous studies were based on questionnaires, including the University of Washington Quality of Life Questionnaire,¹² the EAT-10,¹³ and the MD Anderson Dysphagia Inventory.¹⁸ In a study comparing 92 patients with early-stage oropharyngeal cancer treated with TORS with/without adjuvant therapy and 46 patients treated with definitive chemoradiation therapy, the two groups showed similar locoregional control rate, overall survival, and disease-free survival. However, the TORS group had a significantly better saliva-related quality of life than the definitive chemoradiation therapy group until 24 months after treatment.¹² Achim et al. also reported an adverse effect of adjuvant therapy on swallowing. This group showed that the TORS-only group showed faster restoration of swallowing and less weight loss in the long-term than the TORS with radiation or chemoradiation therapy group.¹³ However, generally, swallowing function and health-related quality of life deteriorate in the immediate postoperative stage and then gradually recover after TORS regardless of the need for adjuvant therapy.^{13,18}

Limitations of the study

This study has some limitations. First, the design was retrospective in nature, and the sample size was relatively small. Therefore, bias may have been introduced. However, we have routinely collected data on postoperative functional outcomes in head and neck cancer for more than 15 years. Therefore, the reliability and consistency of our data may be adequate. Second, in this study, most patients (87.8%) received adjuvant radiation or chemoradiation therapy after TORS. Therefore, it is a limitation to evaluate functional outcomes after TORS only, excluding the effect of adjuvant treatment. Third, we did not compare the functional results of TORS with those of conventional radical surgery or concurrent chemoradiation therapy. Further comparative studies with larger sample sizes and long-term follow-up are necessary to more clearly determine postoperative long-term functional speech and swallowing outcomes after TORS.

5 CONCLUSIONS

TORS showed favorable long-term functional speech and swallowing outcomes. It can be an excellent treatment modality for oropharyngeal cancer in terms of functional outcomes.

REFERENCES

1. Schache AG, Powell NG, Cuschieri KS, et al. HPV-related oropharynx cancer in the United Kingdom: an evolution in the understanding of disease etiology. *Cancer Res.* 2016;76(22):6598-6606. <https://doi.org/10.1158/0008-5472.CAN-16-0633>
2. Shaha AR. Mandibulotomy and mandibulectomy in difficult tumors of the base of the tongue and oropharynx. *Semin Surg Oncol.* 1991;7(1):25-30. doi: 10.1002/ssu.2980070107.
3. O'Hara J, MacKenzie K. Surgical versus non-surgical management of early stage oropharyngeal squamous cell carcinoma. *Eur Arch Otorhinolaryngol.* 2011;268(3):437-442. <https://doi.org/10.1007/s00405-010-1362-4>
4. Pignon J-P, Le Maitre A, Maillard E, Bourhis J, Group M-NC. Meta-analysis of chemotherapy in head and neck cancer (MACH-NC): an update on 93 randomised trials and 17,346 patients. *Radiother Oncol.* 2009;92(1):4-14. <https://doi.org/10.1016/j.radonc.2009.04.014>
5. Abendstein H, Nordgren M, Boysen M, et al. Quality of life and head and neck cancer: a 5 year prospective study. *Laryngoscope.* 2005;115(12):2183-2192. <https://doi.org/10.1097/01.MLG.0000181507.69620.14>
6. Peponi E, Glanzmann C, Willi B, Huber G, Studer G. Dysphagia in head and neck cancer patients following intensity modulated radiotherapy (IMRT). *Radiat Oncol.* 2011;6(1):1. <https://doi.org/10.1186/1748-717X-6-1>
7. Wilson JA, Carding PN, Patterson JM. Dysphagia after nonsurgical head and neck cancer treatment: patients' perspectives. *Otolaryngol Head Neck Surg.* 2011;145(5):767-771. <https://doi.org/10.1177/0194599811414506>
8. Paleri V, Patterson J. Use of gastrostomy in head and neck cancer: a systematic review to identify areas for future research. *Clin Otolaryngol.* 2010;35(3):177-189. <https://doi.org/10.1111/j.1749-4486.2010.02128.x>
9. Weinstein GS, O'Malley BW, Cohen MA, Quon H. Transoral robotic surgery for advanced oropharyngeal carcinoma. *Arch Otolaryngol Head Neck Surg.* 2010;136(11):1079-1085. <https://doi.org/10.1001/archoto.2010.191>
10. Iseli TA, Kulbersh BD, Iseli CE, Carroll WR, Rosenthal EL, Magnuson JS. Functional outcomes after transoral robotic surgery for head and neck cancer. *Otolaryngol Head Neck Surg.* 2009;141(2):166-171. <https://doi.org/10.1016/j.otohns.2009.05.014>
11. Dziegielewski PT, Teknos TN, Durmus K, et al. Transoral Robotic Surgery for Oropharyngeal Cancer: Long-term Quality of Life and Functional Outcomes. *JAMA Otolaryngol Head Neck Surg.* 2013;139(11):1099-1108. <https://doi.org/10.1001/jamaoto.2013.2747>
12. Ling DC, Chapman BV, Kim J, et al. Oncologic outcomes and patient-reported quality of life in patients with oropharyngeal squamous cell carcinoma treated with definitive transoral robotic surgery versus definitive

chemoradiation. *Oral Oncol.* 2016;61:41-46. <https://doi.org/10.1016/j.oraloncology.2016.08.004>

13. Achim V, Bolognone RK, Palmer AD, et al. Long-term functional and quality-of-life outcomes after transoral robotic surgery in patients with oropharyngeal cancer. *JAMA Otolaryngol Head Neck Surg.* 2018;144(1):18-27. <https://doi.org/10.1001/jamaoto.2017.1790>
14. Hutcheson KA, Holsinger FC, Kupferman ME, Lewin JS. Functional outcomes after TORS for oropharyngeal cancer: a systematic review. *Eur Arch Otorhinolaryngol* . 2015;272(2):463-471. <https://doi.org/10.1007/s00405-014-2985-7>
15. Moore EJ, Olsen KD, Kasperbauer JL. Transoral robotic surgery for oropharyngeal squamous cell carcinoma: a prospective study of feasibility and functional outcomes. *Laryngoscope* 2009;119(11):2156-2164. <https://doi.org/10.1002/lary.20647>
16. Moore EJ, Olsen SM, Laborde RR, et al. Long-term Functional and Oncologic Results of Transoral Robotic Surgery for Oropharyngeal Squamous Cell Carcinoma. *Mayo Clin Proc.* 2012;87(3):219-225. <https://doi.org/10.1016/j.mayocp.2011.10.007>
17. Sharma A, Patel S, Baik FM, et al. Survival and Gastrostomy Prevalence in Patients With Oropharyngeal Cancer Treated With Transoral Robotic Surgery vs Chemoradiotherapy. *JAMA Otolaryngol Head Neck Surg.* 2016;142(7):691-697. <https://doi.org/10.1001/jamaoto.2016.1106>
18. Sinclair CF, McColloch NL, Carroll WR, Rosenthal EL, Desmond RA, Magnuson JS. Patient-Perceived and Objective Functional Outcomes Following Transoral Robotic Surgery for Early Oropharyngeal Carcinoma. *Arch Otolaryngol Head Neck Surg.* 2011;137(11):1112-1116. <https://doi.org/10.1001/archoto.2011.172>
19. Shin MJ KJ, Lee SB, Lee SY. Speech mechanism screening test. Seoul, South Korea: Hakjisa Publisher; 2010.
20. Bressmann T, Sader R, Whitehill TL, Samman N. Consonant intelligibility and tongue motility in patients with partial glossectomy. *J Oral Maxillofac Surg.* 2004;62(3):298-303. <https://doi.org/10.1016/j.joms.2003.04.017>
21. Fynes MM, Smith C, Brodsky MB. The Modified Barium Swallow Study: When, How, and Why? *Appl Radiol.* 2019;48:3-8.
22. Brierley JD, Gospodarowicz MK, Wittekind C (Eds.) TNM classification of malignant tumours. Oxford, UK; Wiley-Blackwell; 2017.
23. De Almeida JR, Byrd JK, Wu R, et al. A systematic review of transoral robotic surgery and radiotherapy for early oropharynx cancer: a systematic review. *Laryngoscope.* 2014;124(9):2096-2102. <https://doi.org/10.1002/lary.24712>
24. Su HK, Ozbek U, Likhterov I, et al. Safety of transoral surgery for oropharyngeal malignancies: an analysis of the ACS NSQIP. *Laryngoscope.* 2016;126(11):2484-2491. <https://doi.org/10.1002/lary.26024>

Hosted file

TORS for oropharyngeal cancer_ClinORL-TABLE.docx available at <https://authorea.com/users/499867/articles/580862-long-term-functional-swallowing-and-speech-outcomes-after-transoral-robotic-surgery-for-oropharyngeal-cancer>