Received: 24 February 2020 | Revised: 3 January 2021 | Accepted: 21 January 2021

DOI: 10.1002/hed.26628

ORIGINAL ARTICLE

WILEY

Anatomical-based classification for transoral base of tongue resection

Armando De Virgilio MD, PhD[1,2] | Se-Heon Kim MD, PhD[3] | Chen-Chi Wang MD[4,5,6] | Floyd Christopher Holsinger MD[7] | Scott Magnuson MD[8] | Georges Lawson MD[9] | Raul Pellini MD[10] | Giuseppe Mercante MD[1,2] | Andrea Costantino MD[1,2] | Giuseppe Spriano MD[1,2]

[1]Depatment of Biomedical Sciences, Humanitas University, Pieve Emanuele, Milan, Italy

[2]Otorhinolaryngology Unit, IRCCS Humanitas Research Hospital, Rozzano, Milan, Italy

[3]Department of Otorhinolaryngology, Severance Hospital, Yonsei University College of Medicine, Seoul, South Korea

[4]School of Medicine, National Yang-Ming University, Taipei, Taiwan

[5]Department of Speech Language Pathology & Audiology, Chung Shan Medical University, Taichung, Taiwan

[6]Department of Otolaryngology – Head and Neck Surgery, Taichung Veterans General Hospital, Taichung, Taiwan

[7]Department of Otolaryngology – Head and Neck Surgery, Stanford University Medical Center, Palo Alto, California, USA

[8]Department of Otolaryngology – Head and Neck Surgery, University of Central Florida College of Medicine, Orlando, Florida, USA

[9]Department of Otolaryngology – Head and Neck Surgery, CHU UCL Dinant Godinne, Yvoir, Belgium

[10]Department of Otolaryngology – Head and Neck Surgery, IRCCS Regina Elena National Cancer Institute, Rome, Italy

Correspondence
Armando De Virgilio, Department of Biomedical Sciences, Humanitas University, Via Rita Levi Montalcini 4, 20090 Pieve Emanuele, Milan, Italy
Email: armando.devirgilio@gmail.com

Abstract

Background: To propose a classification of transoral base of tongue (BOT) procedures able to provide uniform terminology in order to better define post-operative results.

Methods: The classification resulted from the consensus of the different authors and is based on anatomical and surgical principles.

Results: The classification comprises three types of BOT resections: type 1 is the resection of the entire lingual tonsil to the muscular plane; type 2 is performed by removing the entire lingual tonsil and part of BOT muscles; type 3 is performed by removing the entire lingual tonsil and the entire BOT muscles. Based on the extension of the dissection, we can use the suffix A (contralateral BOT), B (supraglottic larynx), C (lateral oropharynx), and/or D (oral tongue).

Conclusion: The proposed classification could allow us to easily compare data from different centers.

KEYWORDS

base of tongue, endoscopic surgery, oropharynx, robotic surgery, transoral oropharyngectomy

1 | INTRODUCTION

The introduction of new technologies, such as surgical robots, is dramatically changing the head and neck oncologic surgery field.[1-9] In the last decade, the advent of robotic surgery introduced a new minimally invasive transoral approach to the oropharynx. Upfront transoral surgery is related to fewer long-term complications and better functions compared to open surgical approaches, achieving the same or even higher survival rates when compared to upfront radiotherapy.[10] In particular, the base of tongue (BOT), which is the second most common subsite for oropharyngeal tumors, seems to be the ideal anatomical area to be approached by transoral robotic surgery (TORS).[8]

Moreover, the number of patients which may be treated by transoral surgery is rising, especially when compared to open transmandibular approaches. In particular, the transoral approach is often used in the diagnostic workup of the head and neck occult primary tumor,[11,12] in advanced oropharyngeal carcinoma,[13,14] as well as for residual and recurrent disease.[15]

Nowadays, few efforts have been made toward the establishment of a common classification for BOT procedures, which are often reported in the present literature as "lingual tonsillectomy," "transoral BOT resection," or "TORS procedure."[16-18] However, transoral oropharyngectomies for lesions arising from the BOT have no univocal terminology at this time. In 2014, de Almeida et al.[19] and then in 2017, the Sociedad Catalana de Otorrinolaringología (SCORL) Working Group[20] proposed two classifications whose aim was mainly to identify subsites and to guide the reconstruction process. However, they did not take into consideration the location of the primary tumor or the anatomical depth landmarks. In particular, the first[19] classification is based on the anatomical defects after transoral oropharyngectomies. The authors defined four different classes based on the number of oropharyngeal subsites resected during surgery, as well as some "adverse features" found after the resection (exposed internal carotid artery, pharyngocutaneous fistula, >50% of soft palate defect). The aim of this classification was indeed to establish a reconstruction algorithm, but no indications regarding tumor resection were provided. This classification system does not use anatomical landmarks, and it is not able to guide tumor resection on the basis of the clinical T classification. Moreover, the BOT is considered only one of the oropharyngeal subsites, and no anatomical landmarks of depths were used. Similarly, the second classification[20] describes six oropharyngeal subsites without establishing precise anatomical limits or landmarks of depth. In this case, the number of resected subsites could be associated with the suffix "p" indicating a deep resection, without describing the specific anatomical planes involved.

Recently, we introduced a proposal for an anatomical-based lateral oropharyngectomies classification, which does not include procedures performed for BOT primary tumors.[21]

We believe that there is a need for a common language, and an anatomically based classification system for BOT procedures. In the present paper, we report our BOT classification proposal.

2 | CLASSIFICATION PROPOSAL

Our aim is to provide a classification that is both exhaustive and simple to use. Therefore, we have based our classification on three types which define the depth of excision and on four possible extensions (contralateral, inferior, lateral, and anterior) (Table 1).

2.1 | Type 1 base of tongue resection

Type 1 base of tongue resection (BOT 1) is the resection of the entire lingual tonsil up to the midline. This surgical procedure spares the tongue muscles (Figure 1).

Considering that the entire tonsil could be affected in various degrees of severity, it is necessary to completely resect it. This is performed to ensure no dysplastic or even carcinomatous residue. Given that BOT 1 resection ensures a histopathological examination of the entire lingual tonsil, the main role of this surgical procedure is diagnostic. However, it can also be therapeutic if

TABLE 1 Classification for transoral base of tongue (BOT) resection

BOT types			
Type 1	**Type 2**	**Type 3**	
Lingual tonsil	Lingual tonsil and part of BOT muscles	Lingual tonsil and the entire BOT muscles	
Extensions[a]			
A	**B**	**C**	**D**
Contralateral BOT	Supraglottic larynx	Lateral oropharynx	Oral tongue

[a]Suffixes can be used in combination (e.g., type 2BC, type 3ABC).

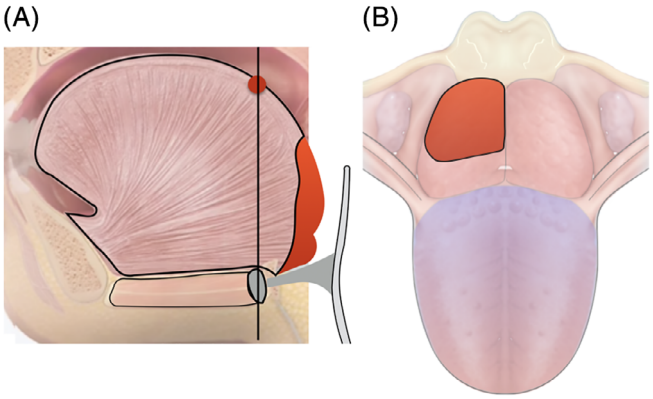

FIGURE 1 Type 1 base of tongue resection (BOT 1) is the resection of the entire lingual tonsil up to the midline. This surgical procedure spares the tongue muscles. (A) sagittal view; (B) axial view. Red circle indicates the circumvallate papillae level. The vertical line represents the virtual coronal plane connecting the hyoid bone to the circumvallate papillae. The resected area is highlighted in red [Color figure can be viewed at wileyonlinelibrary.com]

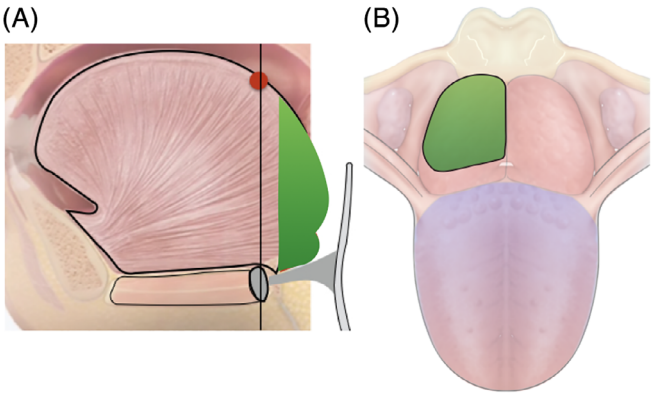

FIGURE 2 Type 2 base of tongue resection (BOT 2) is performed by removing the entire lingual tonsil and BOT muscles without reaching the virtual coronal plane connecting the hyoid bone to the circumvallate papillae. (A) Sagittal view; (B) axial view. Red circle indicates the circumvallate papillae level. The vertical line represents the virtual coronal plane connecting the hyoid bone to the circumvallate papillae. The resected area is highlighted in green [Color figure can be viewed at wileyonlinelibrary.com]

the histological results confirm hyperplasia, dysplasia, or carcinoma in situ without signs of microinvasion. Otherwise, if there are signs of invasive tumor spread, a further procedure is required.

2.2 | Type 2 base of tongue resection

Type 2 base of tongue resection (BOT 2) is performed by removing the entire lingual tonsil and part of the BOT muscles, without reaching the virtual coronal plane connecting the hyoid bone to the circumvallate papillae (Figure 2). The dissection begins from a horizontal line parallel but posterior to the circumvallate papillae line. The hyoid bone should not be visualized during the dissection. Care should be taken in identifying and ligating the lingual artery as well as its branches when encountered. The main indication for this procedure is evidence of a T1 tumors of the lingual tonsil which does not invade the BOT muscles.

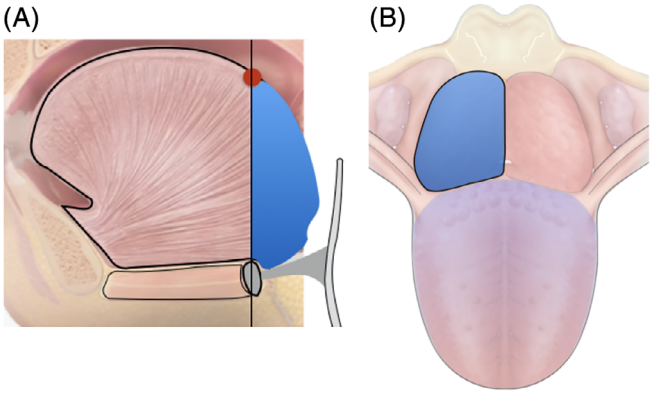

FIGURE 3 Type 3 base of tongue resection (BOT 3) is the removal of the entire lingual tonsil, and the ipsilateral base of tongue muscles up to a virtual coronal plane connecting the hyoid bone to the circumvallate papillae. (A) Sagittal view; (B) axial view. Red circle indicates the circumvallate papillae level. The vertical line represents the virtual coronal plane connecting the hyoid bone to the circumvallate papillae. The resected area is highlighted in blue [Color figure can be viewed at wileyonlinelibrary.com]

2.3 | Type 3 base of tongue resection

Type 3 base of tongue resection (BOT 3) is performed by removing the entire lingual tonsil and the ipsilateral base of tongue muscles up to the virtual coronal plane connecting the hyoid bone to the circumvallate papillae (Figure 3). The dissection begins from the midline and can proceed through the avascular plane of the tongue median raphe up to the hyoid bone. Once the hyoid bone is identified, one can easily complete the resection starting from the circumvallate papillae line. Particular care should be taken in identifying and ligating the main trunk of the lingual artery and its branches when they are encountered.

2.4 | BOT extensions

BOT resection can be extended toward different structures based on the clinical features of the BOT tumor:

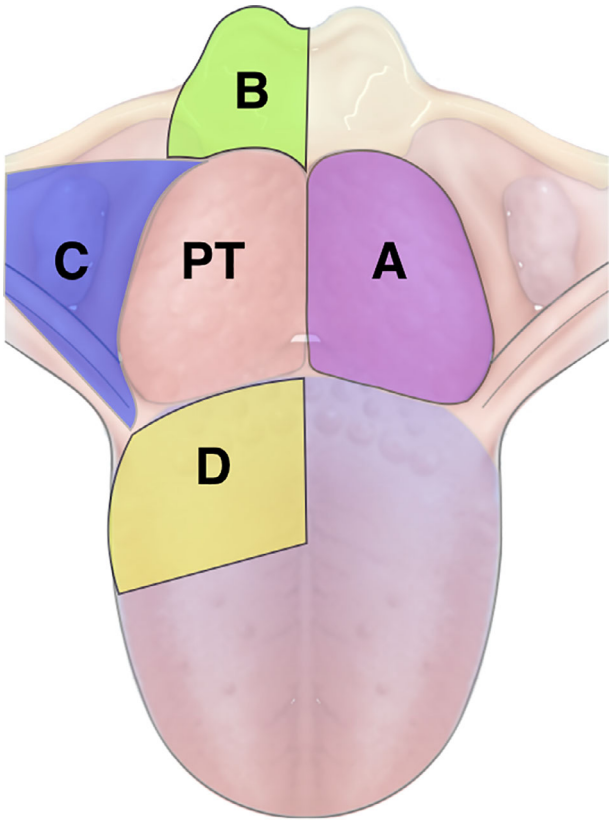

FIGURE 4 Base of tongue (BOT) extensions. Based on the clinical features of the tumor, BOT can be extended toward the contralateral BOT, supraglottic larynx, lateral oropharynx, and/or oral tongue. "A" suffix indicates the extension of the resection toward the contralateral BOT; "B" suffix indicates a resection extended to the ipsilateral supraglottic larynx; "C" suffix indicates the extension to the lateral oropharynx (ipsilateral); "D" suffix indicates a resection extended anteriorly toward the ipsilateral oral tongue [Color figure can be viewed at wileyonlinelibrary.com]

contralateral BOT, supraglottic larynx, lateral oropharynx, and oral tongue.

We can use the suffix A, B, C, and/or D to denote the extension of the dissection (Figure 4).

"A" suffix indicates the extension of the resection toward the contralateral BOT. The depth of excision is the same as the contralateral site according to the aforementioned types. This resection is not typically associated with swallowing impairment if only the lingual tonsil is removed.[11,12] Potential swallowing impairment could arise when BOT musculature is completely removed.[13,14]

"B" suffix indicates a resection extending to the ipsilateral supraglottic larynx. Dissection can be performed sparing the contralateral BOT other than the contralateral half of epiglottis, and the contralateral aryepiglottic fold. This extension is usually performed in the case of disease extension to the lingual surface of epiglottis.

"C" suffix indicates the extension to the lateral oropharynx (ipsilateral). This extension can be performed for diagnostic purposes in the unknown primary tumor workup. It includes the removal of pharyngeal tonsil and is performed in case of BOT tumors involving the amigdaloglossus sulcus mucosa or the lateral oropharynx.

"D" suffix indicates the extension to the ipsilateral oral tongue. In this case, the BOT resection begins from a line parallel but anterior to the circumvallate papillae line and includes the oral tongue muscles. This extension is performed for deeply infiltrating BOT tumors reaching the coronal plane connecting hyoid bone to the circumvallate papillae.

Different combinations can be used to synthetically describe all BOT surgical procedures. For example, BOT 1 procedure could be extended only to the supraglottic larynx (BOT 1B), or BOT 2 procedure could be extended to both the contralateral BOT and to the lateral oropharynx (BOT 2 AC).

2.5 | Reconstruction considerations

In agreeance with the considerations already expressed by de Almeida et al.,[19] the authors recommend a reconstruction in case there is a communication between the oropharynx and the neck, resection of >50% of the soft palate, or carotid artery exposure. Communication between the cervical compartment and the oropharynx can be primarily closed in case of small defects with limited tension. In all the other cases, local, regional, or free flaps should be considered. In particular, free flap reconstruction should be used in case of BOT resection extended to the oral tongue (suffix "D"), and the selection of the specific type of flap should be appropriate for the extent of the surgical defect.

3 | DISCUSSION

The aim of our proposal is to provide a codification system of BOT surgical procedures to simplify and homogenize the interpretation and comparison of postoperative results achieved by different centers, depending on the extent of the tumor and of the resection. In fact, we believe that a common classification of BOT procedures, which may vary according to the surgeon's preference, is necessary to understand and compare different postoperative results. As already mentioned above, no univocal terminology is available for transoral oropharyngectomies performed for lesions arising from the BOT. The two classifications previously described were not developed for this purpose. The majority of studies reporting data on transoral

oropharyngectomies do not describe the extent of the surgical resection, and a comparison between different studies could not be performed from this perspective. Although the majority of transoral procedures are commonly denoted as "BOT resection," we believe that a codification of surgical procedures based on the extent of resection is needed.

A type 1 resection could be adequate if a small T1 tumor with sufficient resection margins is identified in the final pathologic report. This is particularly true if we consider the high variability of lingual tonsils size among different patients.[22] In fact, if a superficial T1 tumor is found in massive lingual tonsils, a type 1 resection could be considered sufficiently deep and consequently therapeutic. For this reason, we believe that it is necessary to include the BOT1 procedure (BOT1C if ipsilateral tonsillectomy is performed). According to our classification for the lateral oropharyngectomy,[21] BOT1C can also be classified as type 1 lateral oropharyngectomy extended to the base of tongue (LO1C). LO1C represents the resection of the palatine tonsil deep to the pharyngobasilar fascia, extended to the ipsilateral BOT. A type 1 resection is usually performed also in the diagnostic work-up of occult primary tumors, often associated to ipsilateral or bilateral tonsillectomy. However, our classification should not be used for the assessment of oncological results in the case of a diagnostic procedure. On the other hand, a univocal terminology could be useful in this setting. We agree that both descriptions can be used to define the same procedure if the primary tumor is not identified. However, if the primary tumor is identified in the BOT we should use BOT1C, while LO1C is preferred for tumors located in the palatine tonsil. Type 2 and type 3 resections are otherwise performed for therapeutic purposes. Preoperative planning is fundamental to define the tumor depth and the infiltration of BOT muscles. The BOT2 procedure could be used in case of limited muscle involvement. Specifically, the distance between the anterior margin of the tumor and the virtual plane connecting the hyoid bone to the circumvallate papillae measured at the preoperative imaging should be at least 2 cm on the axial plane. Sufficient surgical margins of at least 1 cm could not be otherwise ensured at the final histopathology report. On the other hand, if a distance inferior to 2 cm is measured, a BOT3 procedure would be more appropriate. The latter is not always easily performed in the absence of clear landmarks. The placement of the tongue retractor during surgery could indeed distort BOT anatomy, particularly in case of a massive tongue. Therefore, as already mentioned above, the resection should start along the midline in a posterior to anterior fashion, given the absence of important neurovascular structures at this level. Once the hyoid bone is identified anteriorly, the direct visualization of the circumvallate papillae line allows us to complete the resection along the aforementioned plane.

In this context, the prognostic benefit of a standardized classification system should not be underestimated. The possibility to categorize BOT resections with a unique system will simplify the analyses of oncologic outcomes when several cohorts are compared. In addition, it will lead to a better understanding of surgical indications for locally advanced tumors.

We believe that guidelines are important to obtain reproducible surgical techniques. Developing any guideline requires a common language in terms of procedural classification, and this is not available today. Our classification should fill this gap. Furthermore, this system can be useful to improve the teaching and training of inexperienced surgeons.

This is a classification of BOT procedures and remains valid independently of the surgical system, technique, or instrument used (e.g., electrocautery, ultrasound, CO^2 laser, YAG laser, or thulium laser).

Thus, each type of BOT procedure in the present classification is defined by three alternative numbers which define the depth of excision and by four suffixes which could be used in various combinations depending on the different extensions. Definition of surgical procedures using simple numbers is more comprehensible for surgeons still unfamiliar with the proposed classification. Moreover, the numerical definitions are accompanied by an alphabetical classification, allowing for a short definition of each procedure that is more practical in everyday practice. Obviously, this definition can only hold true if the classification becomes a reference, such as the TNM classification. Until that time, the present classification avoids the risk of confusion with other existing personal classifications.

One of the limitations of the present proposal is that it cannot be used to classify all oropharyngeal transoral procedures, but only those in which the primary tumor originates from BOT. However, the present classification together with the recently published one on lateral oropharyngectomies would cover the majority of oropharyngeal transoral procedures. According to large epidemiological studies, the base of tongue and the tonsillar fossa indeed represents the most frequent primary tumor subsites in the oropharynx.[23] We aim to further develop extensions of the current proposal for primary tumors of the posterior pharyngeal wall and the soft palate to allow a comprehensive classification of all oropharyngeal transoral procedures.

Our proposed classification results from an agreement among the different authors. We opted for a simple categorization. A more complex one might have been more rigorous but less practical for everyday practice.

ACKNOWLEDGMENTS

We would like to thank Daniela Sebastiani for the English Language editing.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ORCID

Armando De Virgilio https://orcid.org/0000-0003-0738-8223
Chen-Chi Wang https://orcid.org/0000-0002-5934-724X
Floyd Christopher Holsinger https://orcid.org/0000-0002-9594-1414
Giuseppe Mercante https://orcid.org/0000-0002-1009-7892
Andrea Costantino https://orcid.org/0000-0001-5551-7785

REFERENCES

1. Marur S, D'Souza G, Westra WH, Forastiere AA. HPV-associated head and neck cancer: a virus-related cancer epidemic. *Lancet Oncol*. 2010;11:781-789.
2. Park YM, Cha D, Koh YW, Choi EC, Kim SH. Transoral robotic surgery with transoral retropharyngeal lymph node dissection in patients with tonsillar cancer: anatomical points, surgical techniques, and clinical usefulness. *J Craniofac Surg*. 2019;30:145-148.
3. de Almeida JR, Li R, Magnuson JS, et al. Oncologic outcomes after transoral robotic surgery: a multi-institutional study. *JAMA Otolaryngol Head Neck Surg*. 2015;141:1043-1051.
4. De Virgilio A, Iocca O, Malvezzi L, et al. The emerging role of robotic surgery among minimally invasive surgical approaches in the treatment of hypopharyngeal carcinoma: systematic review and meta-analysis. *J Clin Med*. 2019;8(2):256.
5. De Virgilio A, Park YM, Kim WS, Lee SY, Seol JH, Kim SH. Robotic sialoadenectomy of the submandibular gland via a modified face-lift approach. *Int J Oral Maxillofac Surg*. 2012;41:1325-1329.
6. De Virgilio A, Park YM, Kim WS, Baek SJ, Kim SH. How to optimize laryngeal and hypopharyngeal exposure in transoral robotic surgery. *Auris Nasus Larynx*. 2013;40:312-319.
7. Wang CC, Liu SA, Wu SH, Lin WJ, Jiang RS, Wang L. Transoral robotic surgery for early glottic carcinoma involving anterior commissure: preliminary reports. *Head Neck*. 2016;38:913-918.
8. Mercante G, Masiello A, Sperduti I, Cristalli G, Pellini R, Spriano G. Quality of life and functional evaluation in patients with tongue base tumors treated exclusively with transoral robotic surgery: a 1-year follow-up study. *J Craniomaxillofac Surg*. 2015;43:1561-1566.
9. Garas G, Tolley N. Robotics in otorhinolaryngology – head and neck surgery. *Ann R Coll Surg Engl*. 2018;100(Suppl 7):34-41.
10. Yeh DH, Tam S, Fung K, et al. Transoral robotic surgery vs. radiotherapy for management of oropharyngeal squamous cell carcinoma—a systematic review of the literature. *Eur J Surg Oncol*. 2015;41:1603-1614.
11. Farooq S, Khandavilli S, Dretzke J, et al. Transoral tongue base mucosectomy for the identification of the primary site in the work-up of cancers of unknown origin: systematic review and meta-analysis. *Oral Oncol*. 2019;91:97-106.
12. Di Maio P, Iocca O, De Virgilio A, et al. Role of palatine tonsillectomy in the diagnostic workup of head and neck squamous cell carcinoma of unknown primary origin: a systematic review and meta-analysis. *Head Neck*. 2019;41:1112-1121.
13. Park YM, Kim HR, Cho BC, Keum KC, Cho NH, Kim SH. Transoral robotic surgery-based therapy in patients with stage III-IV oropharyngeal squamous cell carcinoma. *Oral Oncol*. 2017;75:16-21.
14. Dabas S, Gupta K, Sharma AK, Shukla H, Ranjan R, Sharma DK. Oncological outcome following initiation of treatment for stage III and IV HPV negative oropharyngeal cancers with transoral robotic surgery (TORS). *Eur J Surg Oncol*. 2019;45:2137-2142. https://doi.org/10.1016/j.ejso.2019.06.027.
15. Paleri V, Fox H, Coward S, et al. Transoral robotic surgery for residual and recurrent oropharyngeal cancers: exploratory study of surgical innovation using the IDEAL framework for early-phase surgical studies. *Head Neck*. 2018;40:512-525.
16. Merna C, Lin HW, Bhattacharyya N. Clinical characteristics, complications, and reasons for readmission following lingual tonsillectomy. *Otolaryngol Head Neck Surg*. 2019;160:619-621.
17. Ryan JF, Motz KM, Rooper LM, et al. The impact of a stepwise approach to primary tumor detection in squamous cell carcinoma of the neck with unknown primary. *Laryngoscope*. 2019;129:1610-1616.
18. Geltzeiler M, Doerfler S, Turner M, et al. Transoral robotic surgery for management of cervical unknown primary squamous cell carcinoma: updates on efficacy, surgical technique and margin status. *Oral Oncol*. 2017;66:9-13.
19. de Almeida JR, Park RC, Villanueva NL, Miles BA, Teng MS, Genden EM. Reconstructive algorithm and classification system for transoral oropharyngeal defects. *Head Neck*. 2014;36:934-941.
20. Virós Porcuna D, Avilés Jurado F, Pollán Guisasola C, et al. Transoral oropharyngeal resection classification: proposal of the SCORL working group. *Acta Otorrinolaringol Esp*. 2017;68:289-293.
21. De Virgilio A, Kim SH, Magnuson JS, et al. Anatomical-based classification for transoral lateral oropharyngectomy. *Oral Oncol*. 2019;99:104450. https://doi.org/10.1016/j.oraloncology.2019.104450.
22. Friedman M, Wilson MN, Pulver TM, et al. Measurements of adult lingual tonsil tissue in health and disease. *Otolaryngol Head Neck Surg*. 2010;142(4):520-525.
23. Weatherspoon DJ, Chattopadhyay A, Boroumand S, Garcia I. Oral cavity and oropharyngeal cancer incidence trends and disparities in the United States: 2000–2010. *Cancer Epidemiol*. 2015;39:497-504. https://doi.org/10.1016/j.canep.2015.04.007.

How to cite this article: De Virgilio A, Kim S-H, Wang C-C, et al. Anatomical-based classification for transoral base of tongue resection. *Head & Neck*. 2021;1–6. https://doi.org/10.1002/hed.26628