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Oropharyngeal free flap reconstruction: Transoral robotic surgery versus open approach

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Abstract

Objective: Transoral robotic surgery (TORS) has evolved since its 2009 US Food and Drug Administration approval for use in local stage T1–T2 oropharyngeal carcinoma. The ability to resect increasingly larger and more complex lesions has led to the need to introduce reconstructive techniques through this route, avoiding the classic trans-mandibular or pull-through approach. Few studies have compared the safety, efficacy, and advantages of TORS versus classic open approaches in oropharyngeal salvage surgery with reconstruction using microanastomosed flaps. Here we retrospectively compare our center's experience with the open approach and TORS and describe the technical variations used.

Methods: Between 2013 and 2021, 30 stage III–IV oropharyngeal cancer patients underwent salvage surgery with reconstruction in our center. From 2013 to 2017, 15 patients underwent surgery with the classic open approach, and from 2018 to 2021, an additional 15 patients underwent TORS. We have compared surgical outcomes, post-surgical results, and survival in the two groups.

Results: Patient characteristics were similar in the two groups. TORS was associated with shorter surgical time ($p < .001$), fewer complications ($p = .01$), shorter hospital stay ($p < .001$), and lower feeding tube requirements ($p = .003$). No significant differences were observed between the two groups in the free margin rate or survival.

Conclusion: Oropharyngeal salvage surgery with TORS with free flap reconstruction reduced associated morbidity compared to the open approach in a patient cohort with poor prognosis.

Level of Evidence: 4.

KEYWORDS

free flap reconstruction, oropharyngeal cancer, oropharynx, robotic surgery

1 | INTRODUCTION

The safety and efficacy of transoral robotic surgery (TORS) was first demonstrated by O'Malley et al. in 2006 in a series of three patients who underwent TORS for base of tongue carcinoma.[1] In 2009, TORS was approved by the US Food and Drug Administration for T1–T2 oropharyngeal carcinomas. The procedure has since been adopted by multiple groups and its initial applications have expanded.

Traditionally, resection of oropharyngeal tumors entailed the division of the mandible and the lip or the use of the pull-through technique to construct a large orocervical communication to access, resect, and extract the entire tumor. However, in 10%–60% of cases, these procedures were associated with surgical and post-surgical complications, including dysphagia, temporomandibular malocclusion, aesthetic deformity, and fistulae.[2,3] In recent years, technological improvements and increased surgical experience with TORS have led several teams to expand the size and complexity of resections performed with this method.[4,5] In contrast, a small number of teams have proposed the reconstruction of pharyngeal defects with other methods, including a local or distant free flap,[6,7] because secondary intention healing often obviates the need for reconstruction after TORS. In general, however, TORS is being increasingly used for the resection of more advanced oropharyngeal cancers, even those requiring free flap reconstruction,[8–12] especially in cases that traditionally would have been approached with lip-splitting mandibulotomy or pull-through surgery. The main indications for the use of TORS in reconstructive surgery are carotid exposure, pharyngocervical communication, the need for preservation, functional optimization, and minimization of complications.[9]

In fact, TORS has been shown to be technically feasible in complex situations, with satisfactory postoperative clinical and functional outcomes even in high-risk patients with poor oncological prognosis. Here we retrospectively report the results obtained in our institution with TORS versus open approaches for the resection of advanced oropharyngeal tumors requiring free flap reconstruction.

2 | PATIENTS AND METHODS

2.1 | Study design and patient inclusion

This was a retrospective analysis of prospectively collected data on 30 consecutive patients with stage III–IV oropharyngeal squamous cell carcinoma[13] undergoing salvage surgery on the irradiated field at University Hospital Germans Trias i Pujol (Badalona, Spain) from February 2013 to February 2021. We collected the following data from hospital patient records: prior treatment, HPV status (by p16INK4a immunohistochemistry), tumor extension, surgical margins, associated procedures, nasogastric and/or gastrostomy tube, length of hospitalization, complications, need for adjuvant treatment, and swallowing. The analysis of resected areas was based on the classification of the Sociedad Catalana de Otorrinolaringología (SCORL),[14] which is a topographical classification (Figure 1).

All patients were operated on by the same team. From 2013 to 2017, surgery was performed with an open approach, while from 2018 to 2021, TORS was performed with the Da Vinci Xi® surgical system. Exclusion criteria for TORS surgery were mandibular invasion and trismus. TORS with free flap reconstruction was performed on patients with carotid exposure and/or orocervical communication to avoid hemorrhagic or fistula complications, and on patients with a complete tongue base resection with functional purposes. Decisions on whether to perform reconstructive surgery were based on resection depth and prior treatments, as previously reported[7] (Figure 2). All patients undergoing TORS were candidates for free flap reconstruction.

The study was approved by the hospital ethics committee (PI-17-267), and all individuals included in the study provided their signed informed consent in accordance with the Declaration of Helsinki.

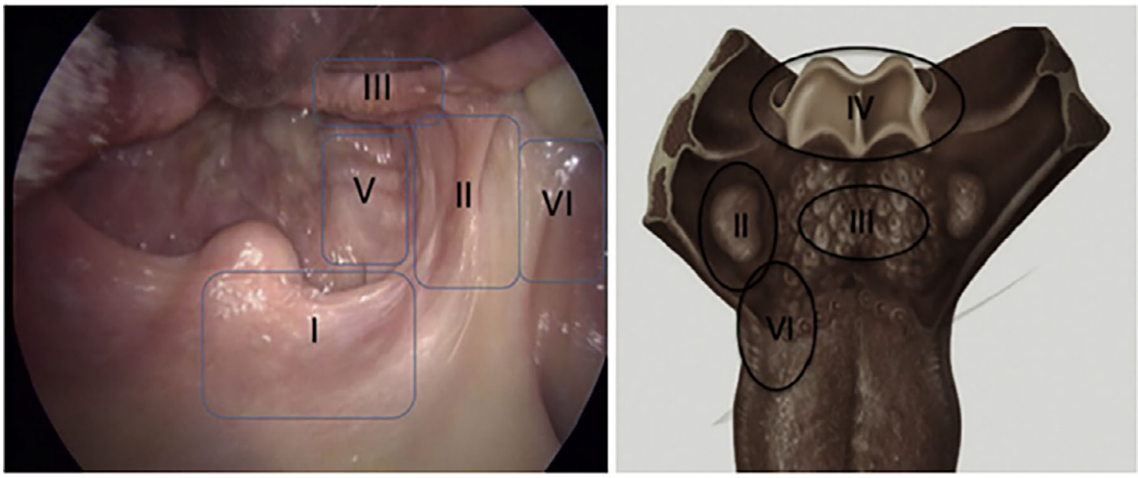

FIGURE 1 SCORL proposed topographical classification of TORS resection.[14] I-area I, soft palate; II-area II, palatine tonsil; III-area III, tongue base; IV-area IV, glossoepiglottic folds, epiglottis and pharyngoepiglottic folds; V-area V, posterior oropharyngeal wall; VI-area VI, retromolar trigone.

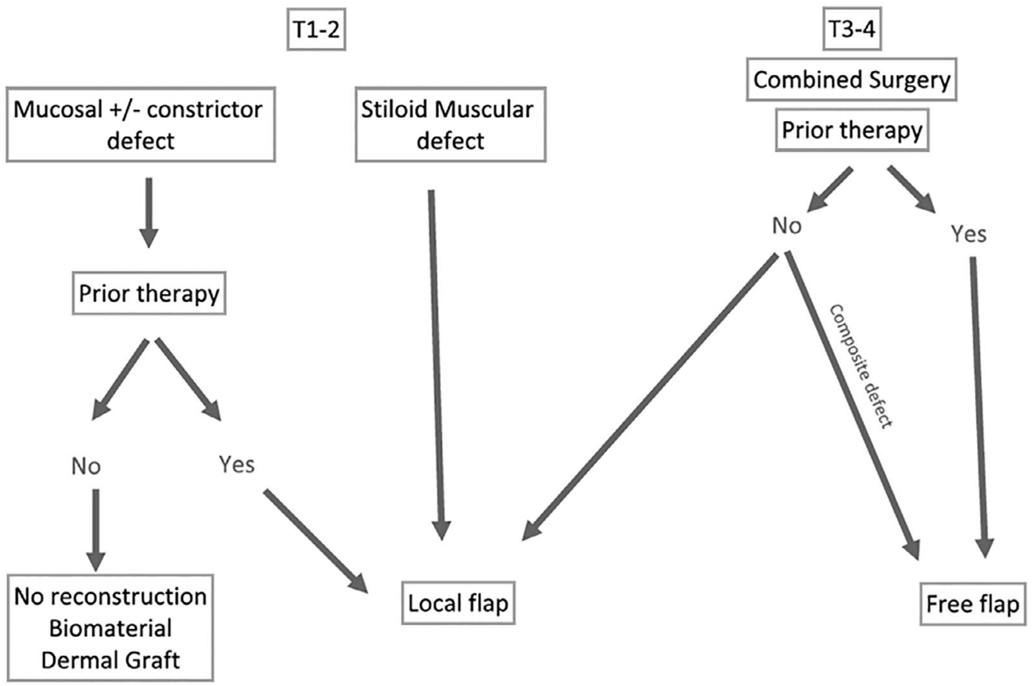

FIGURE 2 Criteria for performing reconstructive surgery after TORS.[7] The decision to use free flap reconstruction is based on surgical defect and previous treatment received.

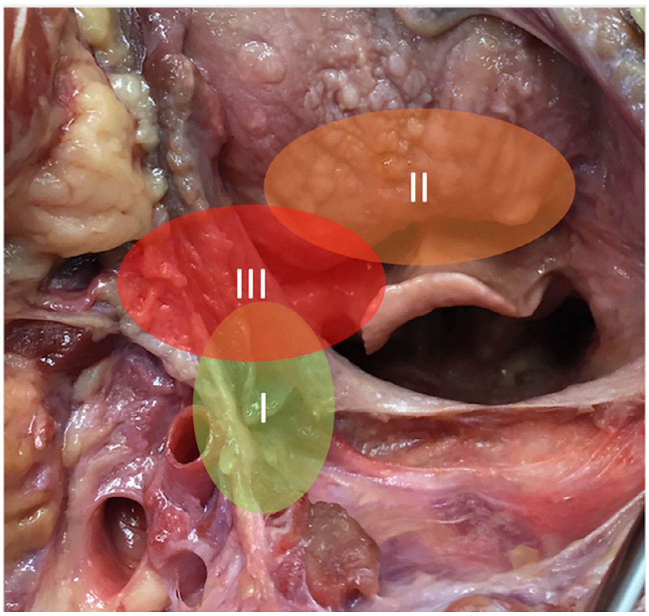

FIGURE 3 TORS type of resection requiring reconstructive surgery. I lateral oropharyngectomy with great vessel dissection; II central oropharyngectomy with organ resection and total glossectomy; III combined oropharyngectomy with cervical communication.

2.2 | Surgical techniques

Both surgical approaches were performed by a simultaneous double surgery team, with free flap harvesting and head and neck tumor resection. The open approach has been previously described.[15]

The first step in the TORS procedure was a prophylactic tracheostomy. Neck dissection surgery was performed only when required for oncological purposes. At the same time, free flap dissection was performed without autonomization and kept in place until the end of the TORS procedure in order to avoid any risk related to ischemia flap time. TORS was then performed, starting with the insertion of an FK.WO TORS mouth gag and docking of the Da Vinci Xi robotic platform.

We used the classical oropharyngectomy techniques,[1] which we expanded due to disease extension, finding anatomical references to control vascularization.[16] The main vessels (lingual or facial artery branches) were ligated using 5 mm metallic endoclips.

Three different TORS procedures were performed based on tumor extension:

1. Lateral oropharyngectomy with styloid diaphragm resection and carotid vessels exposure.
2. Central oropharyngectomy with total glossectomy
3. Combined oropharyngectomy with cervical communication (Figure 3).

Conjoint sections were systematically sampled at the resection margins for analysis; if positive, the resection was extended around the sampled area, and further sections were taken for biopsy.

If transoral-cervical communication did not result from the tumor resection, it was created once the resection was finished via a small incision over the mylohyoid muscle close to the mandible. A small Penrose drain was left on the communication. To avoid twisting the pedicle, the volar part was painted with a surgical pen to enable the surgeon to check its correct positioning.

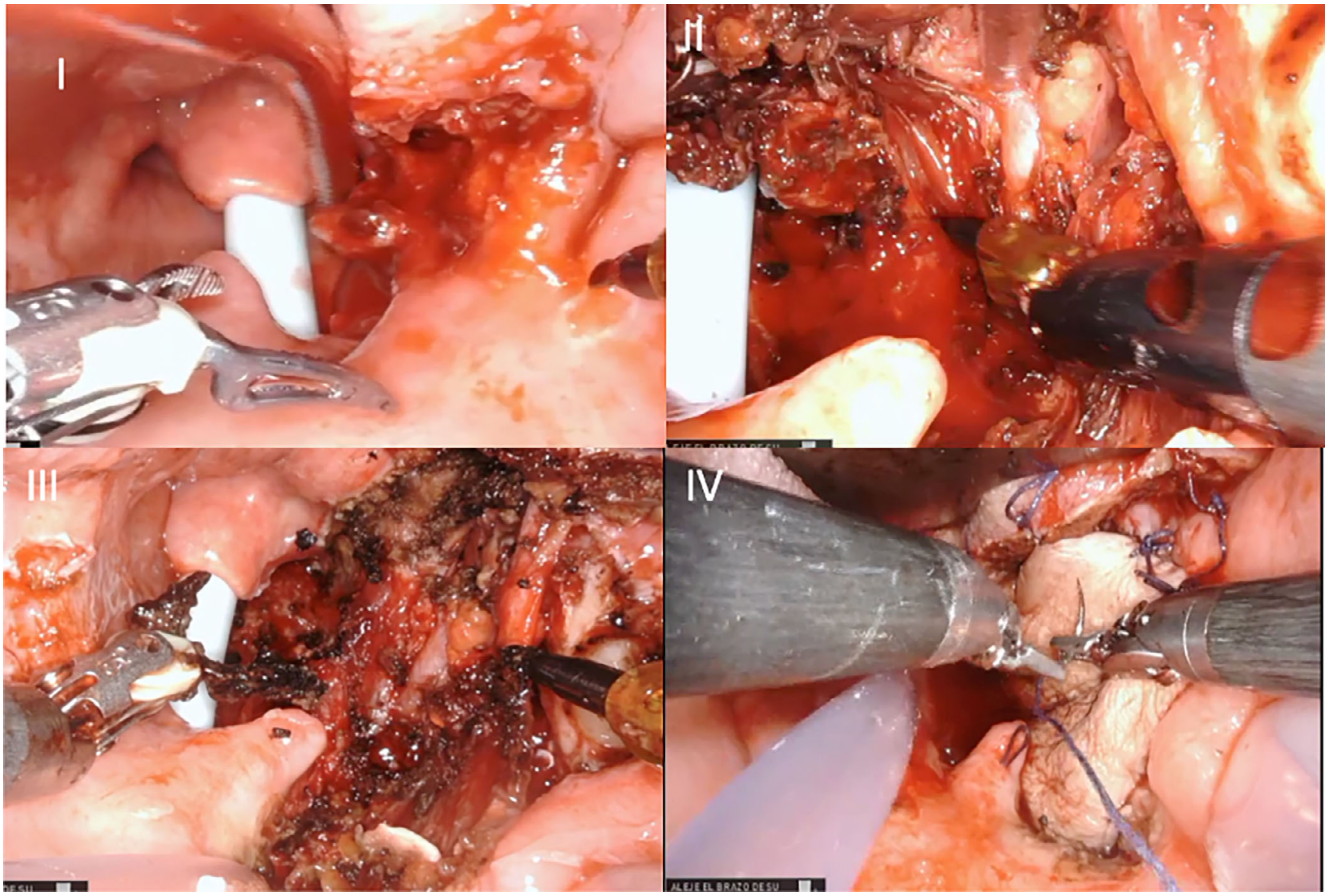

FIGURE 4 TORS with free flap reconstruction showing surgical steps. I oropharyngeal SCC area II; II vascular exposure; III lateral oropharyngectomy type I; IV robotic assisted transoral insetting of free flap.

The recipient's vessels were then prepared. If cervical lymph nodes were dissected, facial and superior thyroid vessels were normally preserved and could be used for micro-anastomoses of the flap. If lymph nodes were not dissected of if facial and superior thyroid arteries were damaged during the resection, cervical transverse vessels were dissected and used for the microanastomoses.

The choice of flap depended on the patient's characteristics and the need for thick soft tissue or a flat flap. Normally, our horse work flap was the anterolateral thigh flap (ALT), while our second choice was the radial forearm flap—when a superthin flap was needed and the ALT flap did not meet this requirement.[11] Free flap autonomization, transoral colocation, and moving the cervical pedicle through the Penrose drain facilitated the collocation of the pedicle with no rotation or twisting. The flap insetting was done transorally. We started with parachuting sutures on the cardinal points and then adapted the flap correctly with the assistance of the robotic platform to suture it to the surgical field.

The inset was performed before microsurgical anastomosis to limit flap swelling and bleeding that would compromise visualization during the inset (Figure 4). The microsurgical anastomosis of the artery and vein in the neck was performed under direct microscopic view with 8/0 or 9/0 nylon or the microvascular anastomotic coupler system.

The flap was examined by ultrasound every 3 h during the first 24 h after surgery and then every day for 3 days.

2.3 | Swallowing assessment

Before hospital discharge, a functional swallowing assessment was performed by fiberoptic endoscopic evaluation of swallowing (FEES) and/or videofluoroscopy in the dysphagia unit of our center. Patients were evaluated as to whether they should receive a normal diet, diet adaptation, swallowing rehabilitation, or use of an enteral feeding tube. The same evaluation was performed at three and 6 months after surgery.

In the postoperative period, we used a nasogastric feeding tube. In cases where it was necessary to use a feeding tube for longer than 2 months, we considered the possibility of insetting a percutaneous gastrostomy tube.

2.4 | Statistical analyses

Descriptive statistics were used to summarize data when applicable. The chi-square test and student's *t*-test, as appropriate, were used to

TABLE 1 Patient characteristics and outcomes for all patients and according to surgical procedure.

Variable	All patients N = 30 N (100%)	Open approach N = 15 N (50%)	TORS N = 15 N (50%)	p[a]
Age, years—median (range)	64.4 (51–80)	64.8 (53–80)	64.1 (51–79)	
Sex				
Male	22 (73.3)	13 (86.7)	9 (60)	
Female	8 (16.7)	2 (13.3)	6 (40)	
HPV status (by p16INK4a IHC)				
p16-negative	27 (90)	14 (93.4)	13 (86.7)	
p16-positive	3 (10)	1 (6.6)	2 (13.3)	
SCORL classification				
II	16 (53.3)	8 (53.3)	8 (53.3)	
III	14(46.7)	7 (46.7)	7 (46.7)	
T cathegory of recurrent tumor				
T1	1 (3.3)	1 (6.7)	0	
T2	7 (23.3)	3 (20)	4 (26.6)	
T3	9 (30)	2 (13.3)	7 (46.7)	
T4	13 (43.3)	9 (60)	4 (26.6)	
Flap type				
Radial forearm	5 (16.6)	4 (26.6)	1 (6.6)	
Anterolateral thigh	25 (83.4)	11 (73.4)	14 (93.4)	
Surgery, min—mean (range)	345.9 (215–492)	416.2 (341–492)	275.7 (215–336)	<.001
Free margin rate	70%	66.7%	73.3%	.21
Hospital stay, days—mean (range)	27.1 (13–45)	35.2 (26–45)	19 (13–25)	<.001
Surgical complications[b]	33.3%	40%	26.6%	.01
Feeding tube—days (range)	39 (12–66)	48 (31–66)	30 (12–47)	.003
One-year survival	63.3%	60%	66.6%	.73
Two-year survival	40%	20%	60%	.64

Abbreviation: IHC, immunohistochemistry.
[a]*p*-value for comparison between open-approach and TORS groups.
[b]Percent of patients with surgical complications.

compare qualitative and quantitative variables. Survival curves were estimated using the Kaplan–Meier method. Analysis of variance (ANOVA) was used to analyze the differences among group means in a sample. Multiple regression was used to explore the relationship between the continuous and independent variables. All statistical analyses were performed with SPSS v24 (SPSS Inc.) and R v3.5.1. Significance was set at $p \leq .05$.

3 | RESULTS

3.1 | Patient characteristics

A total of 30 patients with oropharyngeal squamous cell carcinoma underwent salvage surgery with flap reconstruction at our center and were included in the study: 15 with the open approach and 15 with TORS. Twelve patients in the open-approach group and ten in the TORS group had relapsed after prior chemoradiotherapy, while three and five, respectively, had second primary tumors on the irradiated field. Patient characteristics, including tumor stage and location, type of flap, and surgical outcomes, are shown in Table 1.

Lateral oropharyngectomy with vessel exposure was performed in six cases, total glossectomy in six cases, and combined oropharyngectomy with orocervical communication in three cases.

3.2 | Surgical outcomes

The mean duration of surgery was significantly longer with the open approach than with TORS (416.2 min [range, 341–492 min] vs. 275.7 min [range, 215–336 min]), respectively ($p < .001$). The free margin rate was similar in the two groups: 66.7% with the open approach and 73.3% with TORS ($p = .21$).

3.3 | Postoperative outcomes

Postoperative outcomes were also significantly poorer with the open approach than with TORS. The mean length of hospital stay was 35.2 days (range, 26–45 days) for those undergoing surgery with the open approach, compared to 19 days (range, 13–25 days) for those undergoing TORS ($p < .001$). Complications occurred in six patients (40%) with the open approach (hemorrhage in two, pharyngocutaneous fistula in two, and flap necrosis in two) and in four patients (26.6%) in the TORS group (flap necrosis in three and cervical hematoma in one; $p = .01$).

All 30 patients required a feeding tube after surgery. The mean time was 48 days (range, 31–66 days) for patients undergoing the open approach and 30 days (range, 12–47 days) for those undergoing TORS ($p = .003$).

3.4 | Survival

With a median follow-up of 60 months, 1- and 2-year survival rates for patients undergoing the open approach were 60% and 20%, respectively. One patient died due to surgical complications, three patients had local tumor relapse, one regional recurrence, and three distant metastases. There was no significant association between survival and clinical T classification or free margin rate.

Median follow-up was 24 months in the TORS group, and 1- and 2-year survival rates were 66.6% and 60%, respectively. Three patients had local tumor relapse, two regional recurrence, and one distant metastases. There was no significant association between survival and clinical T classification or free margin rate.

4 | DISCUSSION

The goals of head and neck oncological surgery and reconstruction are to heal the patient, improve quality of life, and minimize complications. The use of robotic-assisted surgery is increasing because it reduces morbidity that can occur as a result of larger resections requiring mandibular splitting for access. It has also been shown to reduce complications arising from chemoradiotherapy.[3–5] In the present retrospective study, we have compared two groups of oropharyngeal cancer patients with poor prognosis who underwent a surgical procedure generally associated with a high rate of complications. Until 2017 patients had undergone surgery with the open approach, but in 2018, based on reports by other investigators,[17,18] we introduced TORS in the salvage setting in order to reduce patient morbidity.[19]

Importantly, our TORS group had fewer complications ($p = .01$), better functional results ($p = .003$), and shorter surgical time ($p < .001$). White et al.[18] compared groups of recurrent oropharyngeal carcinoma patients who underwent open surgery plus reconstruction versus TORS without reconstruction and also found better results in the TORS group. Our TORS group required a free flap reconstruction due to advanced local oropharyngeal carcinoma requiring surgery with carotid exposure, pharyngocervical communication or total tongue resection. Even so, our TORS patients still showed better results than our open-approach patients. These superior results may be due to the reduced extent of surgery with TORS, which eliminates the need for a mandibulotomy or pull-through approach. With TORS, we were thus able to minimize surgical damage in an area where healing is difficult.

The TORS group also had a shorter hospital stay than the open-approach group. Moreover, the fact that less tissue is dissected with TORS and only the affected tumor and margins are removed allows the patient to preserve more healthy tissue and have a more functional bucopharynx.

We used a very thin suprafascial-free ALT flap for reconstruction with TORS. The limited space with TORS compared to the open approach makes a thinner flap more appropriate. A superthin ALT flap can be safely harvested with a suprafascial dissection by using a preoperative ultrasound study.[20] In patients with thick thighs, if the ultrasound ruled out an appropriate perforator for suprafascial dissection, we dissected the radial forearm flap. Although some authors prefer the radial forearm flap because it is thin and pliable,[21] whenever possible, we avoided using this flap because of the visible scar left at the donor site.

While regional flaps can be used in oropharyngeal reconstruction, such as the submental and supraclavicular flaps, the free flap is currently recognized as the standard for the resection type needed in our patients in the salvage setting.[17] Depending on the type of resection with TORS, the goal of the free flap can be vessel coverage, fistula prevention, preservation of tongue function, or a combination of these factors. In patients with carotid exposure, free flap coverage not only separates the exposed carotid from saliva and oral contents but also provides a physical barrier to protect the vessels during postoperative radiation. The free flap also prevents postoperative hemorrhage, which can occur in more than 10% of patients undergoing TORS in the salvage setting.[22]

Our study has several limitations, including its retrospective and observational nature and the relatively small sample size. Our analyses were limited to the data gleaned through a review of patient hospital records, which may have been misclassified. In addition, the results presented here represent the experience of only a single institution. Nevertheless, we believe that this information will be useful to physicians and surgeons at other centers who may be interested in comparing experiences in TORS and oropharyngeal reconstruction.

5 | CONCLUSION

TORS and free flap reconstruction have changed head and neck surgery planning. It reduces postoperative morbidity resulting from larger resections requiring mandibular splitting as well as complications from chemoradiotherapy. However, because this is a relatively novel technique, refinement and planning are still needed. In our center, we changed from the open approach to TORS using the following innovations: thinner flaps, preplanning with ultrasound, selection of donor site to avoid unnecessary dissection, and a two-team approach to reduce surgical time. We recommend considering these aspects when planning oropharyngeal surgery. TORS with reconstruction has clearly shown superior results in our center, and further studies with a larger number of patients are warranted.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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