



# Transoral robotic surgery for salivary carcinomas of the base of tongue: a multicenter REFCOR study

Valentine Poissonnet<sup>1</sup> · Emilien Chabrilac<sup>1</sup> · Bertille Segier<sup>2</sup> · Philippe Gorphe<sup>3</sup> · Stéphanie Wong<sup>4</sup> · Renaud Garrel<sup>5</sup> · Christophe Ferron<sup>6</sup> · Rachid Kaci<sup>7</sup> · Erwan de Monès<sup>8</sup> · Franck Jegoux<sup>9</sup> · Philippe Schultz<sup>10</sup> · Dorian Culié<sup>11</sup> · Robin Baudouin<sup>12</sup> · Diane Evrard<sup>13</sup> · Maxime Goffinet<sup>14</sup> · Sylvain Morinière<sup>15</sup> · Haitham Mirghani<sup>16</sup> · Christian Righini<sup>17</sup> · Suzy Duflo<sup>18</sup> · Jean Paul Marie<sup>19</sup> · Bruno Guelfucci<sup>20</sup> · Sarah Atallah<sup>21</sup> · Esteban Brenet<sup>22</sup> · Chloé Bertolus<sup>23</sup> · Philippe Ceruse<sup>24</sup> · Karine Aubry<sup>25</sup> · Xavier Dufour<sup>26</sup> · Patrice Gallet<sup>27</sup> · Vianney Bastit<sup>28</sup> · Emmanuelle Uro-Coste<sup>29</sup> · Sébastien Vergez<sup>1</sup>

Received: 22 December 2024 / Accepted: 4 April 2025 / Published online: 15 April 2025  
© The Author(s), under exclusive licence to Springer-Verlag London Ltd., part of Springer Nature 2025

## Abstract

Transoral robotic surgery (TORS) allows minimally invasive surgical access to the oropharynx. Its benefits are well documented for squamous cell carcinomas, but not for salivary carcinomas. The aim of this study was to describe the French experience of TORS regarding salivary gland carcinomas of the base of tongue (BOT). This was a retrospective multicentric study with a national cohort. We included all patients treated surgically for a BOT salivary gland carcinoma from January 2009 to December 2018. Descriptive analyses were performed. Among the 50 patients included, radical excision was performed through an open approach (OA;  $n = 33$ ) or using TORS ( $n = 17$ ). T1–T2 tumors were more common in the TORS-group (76.4% vs 60.6%), and so were low-grade tumors (58.8% vs 38.7%). Surgical margins were <1mm in 46.7% of patients in the TORS-group and 52% of patients in the OA-group. After 51.7 months of follow-up, two patients (11.8%) presented with a local recurrence in the TORS-group, versus eight patients (24.2%) in the OA-group. The rate of tracheostomy was 41.2% in the TORS-group and 63.6% in the OA-group. The rate of gastrostomy was 11.8% in the TORS-group and 36.4% in the OA-group. TORS is an acceptable minimally invasive option for selected BOT salivary carcinomas. It may provide good functional and oncological outcomes in selected cases, despite a high rate of close margins.

**Keywords** Salivary gland neoplasms · Carcinoma · Tongue · Transoral robotic surgery · Glossectomy

## Introduction

Salivary gland carcinomas (SGC) account for less than 5% of all head and neck cancers, and up to 20% of these involve the minor salivary glands [1–3]. About one-third of them arise from the oropharynx [2, 4], mainly from the soft palate and the base of tongue [3, 5]. Their treatment relies mostly on surgery, followed by radiotherapy (RT) or chemoradiotherapy (CRT) in case of adverse pathologic features [5–7]. Excision margins are frequently positive, leading to difficult functional and oncological outcomes, with a high rate of recurrence [2, 8].

Transoral robotic surgery (TORS) allows a minimally invasive surgical access to the oropharynx, the use of which is expanding in the field of head and neck surgery [9].

Initially used for early-stage SCC of tonsil or supraglottis [10], it is being widely used in the management of more advanced oropharyngeal squamous cell carcinoma (OPSCC) as the robotic surgeons' skills improve. Data are increasing about its satisfying survival outcomes and lower morbidity for head and neck SCC [11]. However, little is known about its use for salivary gland carcinomas (SGC). The latter has a slow submucosal growth and a high level of perineural spread (especially adenoid cystic carcinomas), thereby oncological outcomes cannot be extrapolated from SCC [5, 12]. Their relative resistance to CRT highlights the importance of selecting the best surgical approach [13, 14].

Besides, the base of tongue (BOT) location poses specific surgical challenges such as exposure, complications, functional outcomes, and postoperative management [15]. This justifies studying them jointly, separated from tonsil tumors. The BOT has a pivotal role in food bolus propulsion,

Extended author information available on the last page of the article

laryngeal closure, and speech. Failing to preserve major neurovascular structures, such as the hypoglossal nerve or lingual artery, may result in serious functional impairment [16, 17]. The traditional surgical approach for an oropharyngeal tumor consists of transoral, transmandibular, or transcervical oropharyngectomy [18]. However, open approaches are associated with a complex postoperative course and can be disabling [19]. The transmandibular approach can cause malocclusion, plate-related complications, osteomyelitis, and osteoradionecrosis, leading to impediments of speech, breathing, and swallowing [20].

The aim of this study was to describe the oncological and functional outcomes in patients with SGC of the BOT undergoing TORS, using the multicentric database of the French National Network on rare head and neck cancers (Réseau d'Expertise Français sur les cancers ORL Rares).

## Materials and methods

This retrospective study was conducted using the French National Network on rare head and neck cancers, a French multicentric cohort with a prospective enrollment, in 33 French reference centers for head and neck cancer treatment (listed in Supplementary Data, Online Resource 1). Inclusion was performed by each center with a standardized questionnaire after an informed consent form, then data were anonymized. Patients were treated according to national recommendations after discussion with a multidisciplinary board. This survey was approved in December 2020 by the REFCOR Scientific Board. We included all patients with histologically proven SGC of the BOT treated surgically between January 2009 and December 2018. Exclusion criteria were as follows: past history of RT, location other than the BOT, insufficient follow-up data or treatment information, and non-surgical primary treatment.

Data extracted comprised: age at diagnosis, body mass index (BMI), comorbidities according to the Charlson Comorbidity Index (CCI), tobacco and alcohol consumption, and performance status (PS) score. We collected the tumor characteristics, i.e., histology, location, extension, size, and grade according to the WHO 2005 Classification, staging according to the 2009 (7th edition) American Joint Committee on Cancer (AJCC) staging system. Therapeutic strategy was recorded, including the type of surgery, neck dissection, flap reconstruction, RT (dose in gray and toxicity), type, and number of cycles of chemotherapy and/or immunotherapy. Pathological data were also recorded: surgical margin distance, perineural invasion (PNI), lymphovascular invasion (LVI), and extracapsular extension (ECE). Functional data were collected, i.e., the use of tracheostomy, nasogastric feeding tube, and gastrostomy. We collected the date, type of disease recurrence, oncological status, and quality of speech

and swallowing at the last follow-up visit. Speech and swallowing were assessed by the clinician or the speech therapist, when available.

Due to the small number of patients, analyses were only descriptive. Statistical analyses were carried out using STATA software version 16.

## Results

Fifty patients from 22 centers were included, of which 17 underwent TORS excision (34%). Patients' characteristics are shown in Table 1. There were 5 males and 12 females (respectively, 29.4% and 70.6%), with a median age of 63 years (range [24; 87]). The median BMI was 24.1 ([17.4–37.9]). In the TORS-group, tumors were mostly T1–T2 (76.5%, versus 23.5% of T3–T4 tumors) and BOT tumors mainly extended to the glosso-tonsillar sulcus and tonsil in 23.5% and 11.8% of the cases, respectively. In the open approach (OA)-group, BOT tumors often involved the glosso-tonsillar sulcus, vallecula, and floor of the mouth (33.3%, 24.2%, and 24.2%, respectively).

Table 2 shows the treatment modalities. In the TORS-group, neck dissection was performed in 70.6% of the patients versus 72.7% in the OA-group. In the OA-group, there were 29 partial BOT excisions (87.9%) and 4 total glossectomies (12.1%), including 5 transmandibular approaches (15.2%). In the TORS-group, 70.6% of the patients did not have a reconstruction flap, and 23.5% of them had a free flap versus 42.4% and 39.4% in the OA-group, respectively. In the TORS-group, 64.7% of the patients did not have any adjuvant treatment versus 33.3% in the OA-group.

Table 3 shows the main pathological findings. Of note, surgical margins were similar in the two groups, with 46.7% of the patients in the TORS-group and 52% in the OA-group achieving margins < 1 mm. The rate of PNI was also high in both groups (41.2% in the TORS-group and 50% in the OA-group).

Postoperative and functional outcomes at the last follow-up visit are displayed in Table 4. The median duration of tracheostomy was 14.5 days (range [5; 225]) i.e., 11 days for the TORS-group ([5; 20]) and 18 days for the OA-group ([5; 225]). Gastrostomy tube dependency rate was higher in the OA-group than in the TORS-group (36.4% vs 11.8%), but no comparison of the duration of gastrostomy tube use was performed because of the small number of gastrostomies.

After a median follow-up of 51.7 months, recurrence occurred in 36% of patients. Recurrence location and treatment are displayed in Table 5. In the TORS-group, four patients presented with a recurrence (23.5%): one local (5.9%), one local and regional (5.9%), and two with distant metastasis (11.8%). Two of them (50%) were treated with

**Table 1** Clinical characteristics

Clinical characteristics	All patients <i>n</i> = 50(%)	TORS-group <i>n</i> = 17(%)	Open approach group <i>n</i> = 33(%)
<i>Gender</i>			
Male	19 (38.0)	5 (29.4)	14 (42.4)
Female	31 (62.0)	12 (70.6)	19 (57.6)
Age: median age [range]	62.0 [24.0–87.0]	63.0 [24.0–87.0]	59.0 [28.0–86.0]
BMI ( <i>n</i> = 44): median BMI [range]	24.1 [17.4–44.9]	24.0 [17.4–37.9]	25.4 [17.7–44.9]
<i>CCI:</i>			
0	4 (8.0)	1 (5.9)	3 (9.1)
1	6 (12.0)	3 (17.6)	3 (9.1)
2	8 (16.0)	2 (11.8)	6 (18.2)
3	15 (30.0)	4 (23.5)	11 (33.3)
≥ 4	17 (34.0)	7 (41.2)	10 (30.3)
<i>Alcohol abuse</i>			
Yes	7 (14.0)	1 (5.9)	6 (18.2)
No	43 (86.0)	16 (94.1)	27 (81.8)
Smoking: yes	12 (24.0)	2 (11.8)	10 (30.3)
<i>Pretreatment PS score:</i>			
0	42 (84.0)	16 (94.1)	26 (78.8)
≥ 1	8 (16.0)	1 (5.9)	7 (21.2)
Midline-crossing tumor:	11 (22.0)	1 (5.9)	10 (30.3)
<i>Tumor extension</i>			
Vallecula	9 (18.0)	1 (5.9)	8 (24.2)
Epiglottis	2 (4.0)	1 (5.9)	1 (3.0)
Glosso-tonsillar sulcus	15 (30.0)	4 (23.5)	11 (33.3)
Tonsil	5 (10.0)	2 (11.8)	3 (9.1)
Floor of the mouth	9 (18.0)	1 (5.9)	8 (24.2)
<i>T status</i>			
T1	16 (32.0)	9 (52.9)	7 (21.2)
T2	17 (34.0)	4 (23.5)	13 (39.4)
T3	9 (18.0)	2 (11.8)	7 (21.2)
T4	8 (16.0)	2 (11.8)	6 (18.2)
<i>N status</i>			
N0	36 (72.0)	12 (70.6)	24 (72.7)
N1	4 (8.0)	2 (11.8)	2 (6.1)
N2a	0 (0)	0 (0)	0 (0)
N2b	8 (16.0)	3 (17.6)	5 (15.2)
N2c	2 (4.0)	0 (0)	2 (6.1)

*BMI* body mass index, *CCI* Charlson comorbidity Index, *BOT* base of tongue, *PS* performance status, *TORS* transoral robotic surgery

salvage surgery. In the OA-group, among the 14 patients who experienced a recurrence (42.4%), only 2 (28.6%) benefited from salvage surgery. All eight patients who presented with a distant metastasis during follow-up in the OA-group had adenoid cystic carcinoma (ACC). Among the eight patients with high-grade tumors, three (37.5%) presented with a distant metastasis, all of which had ACC and were in the OA-group.

## Discussion

Literature regarding minor SGC is rather scarce, because of their rarity, without clear-cut recommendations. TORS is a novel mini-invasive approach for early-stage head and neck cancers [21–24] and has not yet been extensively studied for SGC. Therefore, its indications and use in SGC management are not yet well defined. Unlike OA or RT,

**Table 2** Treatment modalities

	All patients <i>n</i> = 50(%)	TORS-group <i>n</i> = 17(%)	Open approach group <i>n</i> = 33(%)
<i>If neck dissection (n = 36)</i>			
Ipsilateral	17 (47.2)	8 (66.7)	9 (37.5)
Bilateral	19 (52.8)	4 (33.3)	15 (62.5)
<i>Reconstruction</i>			
No flap	26 (52.0)	12 (70.6)	14 (42.4)
Pedicled flap	7 (14.0)	1 (5.9)	6 (18.2)
Free flap	17 (34.0)	4 (23.5)	13 (39.4)
<i>Postoperative treatment</i>			
None	22 (44.0)	11 (64.7)	11 (33.3)
RT alone	21 (42.0)	4 (23.5)	17 (51.5)
CRT	7 (14.0)	2 (11.8)	5 (15.2)

RT Radiotherapy, CRT Chemoradiotherapy, TORS transoral robotic surgery

TORS has the advantage to preserve the floor of the mouth and constrictor muscles near the tumor, as well as the major neurovascular structures and surrounding healthy

tissues, which may have a crucial impact on postoperative functional outcomes [11, 25].

### Prognostic factors for positive excision margins

The association of PNI with a concealed submucosal growth results in a high rate of positive margins. Their excision often relies on palpation more than vision. The lack of haptic feedback of TORS could therefore represent a caveat. However, our study concurs with the rest of the literature, showing similar rates of close or positive margins regardless of the approach [14]. On a large series of oropharyngeal salivary gland carcinomas (OPSGC) operated on with OA, Iyer et al. found 46% of positive margins, and a mandibulotomy was required in 61% of cases [5]. In a series of, respectively, 10 and 20 cases of early-stage OPSGC treated with TORS, Villanueva et al. reported a locoregional control rate of 80% and no positive margins, whereas Schoppy et al. reported 90% of disease-free survival and 5% of positive margins [26, 27]. These rates of *positive* margins for OPSGC cannot be compared to our 46.7% rate of *close* (<1 mm) margins for BOT SGC. In a recent series of OPSGC, Llerena et al. reported that

**Table 3** Histopathological features

	All patients <i>n</i> = 50(%)	TORS-group <i>n</i> = 17(%)	Open approach group <i>n</i> = 33(%)
<i>Histology</i>			
Adenoid cystic carcinoma	15 (30.0)	4 (23.5)	11 (33.3)
Mucoepidermoid carcinoma	21 (42.0)	6 (35.3)	15 (45.5)
Other adenocarcinoma	14 (28.0)	7 (41.2)	7 (21.2)
<i>Tumor size (mm) (n = 49)</i>			
Median [range]	22.0 [2–60]	23.0 [8–52]	22.0 [2–60]
Missing	1	0	1
<i>Surgical margin distance (n = 40)</i>			
< 1 mm	20 (50.0)	7 (46.7)	13 (52.0)
1–5 mm	16 (40.0)	7 (46.7)	9 (36.0)
> 5 mm	4 (10.0)	1 (6.7)	3 (12.0)
Missing	10	2	8
ECE ( <i>n</i> = 39):	9 (23.1)	1 (7.7)	8 (30.8)
Missing	11	4	7
LVI ( <i>n</i> = 36):	6 (16.7)	2 (18.2)	4 (16.0)
Missing	14	6	8
PNI ( <i>n</i> = 45):	21 (46.7)	7 (41.2)	14 (50.0)
Missing	5	0	5
<i>Grade (n = 48)</i>			
Low	22 (45.8)	10 (58.8)	12 (38.7)
Intermediate	18 (37.5)	5 (29.4)	13 (41.9)
High	8 (16.7)	2 (11.8)	6 (19.4)
Missing	2	0	2

ECE extracapsular extension, LVI lymphovascular invasion, PNI perineural invasion, TORS transoral robotic surgery

**Table 4** Postoperative outcomes and functional outcomes at the last follow-up visit

	All patients <i>n</i> = 50(%)	TORS-group <i>n</i> = 17(%)	Open approach group <i>n</i> = 33(%)
<i>Tracheostomy</i>			
No tracheostomy	22 (44.0)	10 (58.8)	12 (36.4)
Transient tracheostomy	28 (56.0)	7 (41.2)	21 (63.6)
Definitive tracheostomy	0 (0.0)	0 (0.0)	0 (0.0)
<i>Gastrostomy</i>			
No gastrostomy	36 (72.0)	15 (88.2)	21 (63.6)
Transient gastrostomy	7 (14.0)	2 (11.8)	5 (15.2)
Definitive gastrostomy	7 (14.0)	0 (0.0)	7 (21.2)
<i>Feeding during treatment</i>			
No enteral support	11 (22.0)	6 (35.3)	5 (15.2)
Nasogastric tube only	25 (50.0)	9 (52.9)	16 (48.5)
Gastrostomy after nasogastric tube	8 (16.0)	2 (11.8)	6 (18.2)
Immediate gastrostomy	6 (12.0)	0 (0.0)	6 (18.2)
<i>Speech quality impairment</i>			
Mild	34 (68.0)	15 (88.2)	19 (57.6)
Moderate	15 (30.0)	2 (11.8)	13 (39.4)
Severe	1 (2.0)	0 (0.0)	1 (3.0)
<i>Food intake</i>			
Oral, all textures	28 (56.0)	12 (70.6)	16 (48.5)
Oral, restricted textures	15 (30.0)	5 (29.4)	10 (30.3)
Oral and enteral	3 (6.0)	0 (0.0)	3 (9.1)
Mainly enteral, oral intake for pleasure	2 (4.0)	0 (0.0)	2 (6.1)
Enteral only	2 (4.0)	0 (0.0)	2 (6.1)

*TORS* transoral robotic surgery**Table 5** Tumor recurrences (incidence and treatment) and distant metastasis

	All patients <i>n</i> = 50(%)	TORS-group <i>n</i> = 17(%)	Open approach group <i>n</i> = 33(%)
Overall recurrences (%):	18 (36.0)	4 (23.5)	14 (42.4)
Local	2	1 (5.9)	1 (3.0)
Local and regional	6	1 (5.9)	5 (15.2)
Local recurrence + distant metastasis	1	0 (0)	1 (3.0)
Local and regional recurrence + distant metastasis	1	0 (0)	1 (3.0)
Distant metastasis	8	2 (11.8)	6 (18.2)
<i>Treatment of recurrences (%)</i>			
Surgery	6 (12.0)	2 (11.8)	4 (12.1)
RT alone	3 (6.0)	0 (0)	3 (9.1)
CT alone	5 (10.0)	1 (5.9)	4 (12.1)
Concurrent CRT	1 (2.0)	0 (0)	1 (3.0)
Immunotherapy	2 (4.0)	0 (0)	2 (6.1)
Supportive care	1 (2.0)	1 (5.9)	0 (0)
Distant metastasis location (%):	10 (20.0)	2 (11.8)	7 (21.2)
Lung	7 (14.0)	2 (11.8)	5 (15.2)
Liver	2 (4.0)	1 (5.9)	1 (3.0)
Bone	1 (2.0)	0 (0)	1 (3.0)
Skin	1 (2.0)	0 (0)	1 (3.0)

RT radiotherapy, CT chemotherapy, CRT chemoradiotherapy, TORS transoral robotic surgery

TORS was not associated with more positive margins than OA [8]. They found ACC, age, T4a tumor stage, and treatment at a lower volume institution to be predictive of positive margins. In the context of OPSCC, some authors observed fewer positive margins in TORS cases versus conventional approaches when the tumor extended inferiorly [28]. While mainly studied in the setting of ACC [29], PNI is a typical feature of all SGC. In a large series by Liu et al., some degree of PNI was observed in 78% of ACC, 60% of mucoepidermoid carcinomas, and 65% of other histologies of SGC [30]. Their presence is more common in advanced T status, N+ status, higher tumor grade, and lymphovascular invasion [30], which could therefore be considered indications for a more extensive surgical resection to ensure clear margins.

In our study, the high rate of PNI (46.7%) mirrors the high rate of close margins <1 mm (46.7% in the TORS-group and 52% in the OA-group). This highlights the complexity of achieving negative margins for these tumors, whatever the approach. These data should have led to a high rate of adjuvant treatment, yet only 44% of patients received it, which is lower than that reported in the literature [11, 27, 28, 31]. This could be partly explained by the high rate of low-grade tumors and/or clinicopathological review of margins during the multidisciplinary team meeting, taking into consideration thermal damages to the edge of the specimen, or margins harvested intraoperatively, which is a common practice in the French Robotic Surgery group of GETTEC. In France, adjuvant therapy is offered in cases of insufficient margins and/or adverse pathological features (tumor grade, PNI, LVI) [32].

### Recurrences and distant metastases

In a multicenter Turkish series, 17.2% of minor SGC were associated with distant metastasis at the time of diagnosis, mainly adenocarcinomas (19.7%), salivary duct carcinoma (18.9%), carcinoma ex-pleomorphic adenoma (16.7%), ACC (16.4%), acinic cell carcinomas (15.4%), and mucoepidermoid carcinomas (12.7%). A third of patients who were not metastatic at diagnosis developed distant metastasis during follow-up, and 37.1% developed locoregional recurrences [33]. The histology with the highest rate of recurrence and/or distant metastasis is ACC [33, 34]. In our study, distant metastasis occurred in 20% of the patients, 11.8% in the TORS-group and 24.2% in the OA-group. A total of 53.3% of ACC patients and 37.5% of patients with high-grade tumors presented with a distant metastasis, all of which were in the OA-group. This is in accordance with the literature, considering that the propensity for recurrences greatly varies depending on the length of follow-up, tumor stages and histologies [27, 35].

### Patient selection

Accurate patient selection is key to carry out TORS procedure safely, using imaging assessment (especially MRI), and clinical examination and/or prior panendoscopy to determine the quality of surgical exposure [36]. The decision to perform TORS is usually based on T status, tumor location, exposure, and surgeon experience [19]. In most cases, TORS is indicated for T1–T2 tumors, and a free flap is not necessary, but many reconstructive options remain possible [37]. In our study, there were two T4 tumors in the TORS-group, from the same high-volume center, which remain exceptions. Besides, in the TORS-group, tumor extension concerned mostly glosso-tonsillar sulcus and tonsil, while tumors extending to the floor of the mouth were more common in the OA-group. This highlights that involvement of the floor of the mouth is not a good indication to perform TORS. For Weinstein et al., one of the major functional contraindications for TORS in oropharyngeal cancer is a resection requiring more than 50% of the deep BOT musculature [38]. Limitations of exposure was reported for 21.2% of the patients by Gaino et al., who established a score to determine the probability of difficult oropharyngeal exposure using gender, macroglossia, and interincisor gap (Pharyngoscore). They found that the BOT was the least accessible oropharyngeal subsite [39].

In a recent series of OPSCC, Oliver et al. reported a lower 30-day postoperative mortality and positive margin rate in high-volume centers (> 10 cases per year) than in low-volume centers [23]. The BOT is particularly difficult to visualize with a direct transoral approach. After primary TORS, the defect can often be left to heal secondarily, with a low tendency for retraction, therefore reducing the necessity of a flap [40]. In our study, 70.6% of the patients in the TORS-group had no reconstructive flap.

### Benefits and risks of TORS

Regarding functional outcomes, many series reported TORS to be associated with a shorter hospital stay, a lower rate of tracheostomy and gastrostomy, and a reduced blood loss and operative time [19, 28, 31]. In our series, 41.2% of TORS-group had a tracheostomy for a median duration of 11 days, and 11.8% required a temporary gastrostomy. The incidence of tracheostomy, much higher in our TORS cohort than in high-volume centers in North America, may be explained by the tumor location to the BOT, and by a wider use of locoregional or free flaps. In North America, TORS is more commonly used for tonsillar tumors rather than BOT tumors [28, 41, 42], and most series report mainly T1–T2 tumors [8, 26–28, 31]. The criteria for tracheostomy for TORS depend on the size and location of the tumor, the bleeding risk, pharyngolaryngeal exposure, and patient comorbidities [43].

Many authors recommend tracheostomy in case of tumors located in the BOT given the risk of obstructive edema and secondary bleeding in the airway [24, 44].

One of the major risk of TORS without flap repair is the postoperative bleeding [45]. Some authors recommend prophylactic arterial ligation to reduce the risk of severe bleeding [46], while others recommend prophylactic tracheostomy to avoid asphyxia caused by hemorrhage or laryngeal edema [43]. Conversion to OA may be required, with a 14% rate reported in the literature [39]. Avoidance of a transcervical or transmandibular approach thanks to TORS permits a more rapid transition to adjuvant therapy [26]. Bollig et al., on a large series of OPSGC, reported no significant differences in the positive margin rate, 30-day mortality, or OS between TORS and non-robotic approach. The 30-day unplanned readmission rate was higher in the TORS-group, but the length of stay was lower for the BOT tumors undergoing TORS [14].

The functional outcomes of TORS in the treatment of OPSCC are well described in the literature and may likely be extrapolated to OPSGC [8, 31, 42]. Lee et al. reported a more rapid recovery of swallowing, shorter hospitalization, and operation time after TORS versus conventional lateral oropharyngectomy [41]. In the ORATOR study comparing RT versus TORS for OPSCC, Nichols et al. reported no clinically meaningful difference in the swallowing-related quality of life score 1 year after treatment [41]. Some authors reported that patients treated for OPSCC with TORS return to baseline functional status and overall quality of life at 12 months, with a modest impact on speech at 6 and 12 months post-surgery [47]. Dziegielwski et al., on a large series of OPSCC who underwent TORS, reported older age, more extensive resection, and higher pathologic T stage to be associated with increased risk of gastrostomy tube dependency [48]. In our TORS-group, the two patients (11.8%) who required a gastrostomy had it removed during follow-up.

### Limitations of the study

Among the limitations of this study are its relatively small sample size, because BOT SGC are rare and TORS is not yet widespread in France. Therefore, only descriptive analyses were performed. We did not directly compare the TORS-group and OA-group because they lacked comparability, i.e., tumors of the OA-group were more often advanced, high-grade, or involving the floor of the mouth. Indeed, all these factors significantly influence the extent of surgery as well as functional and oncologic outcomes, which implies a major bias. The retrospective and multicentric nature of the study was associated with some missing data. While the histologies were heterogeneous, their management and prognosis mainly varied according to tumor grade and location, which justifies studying them together. The strengths of our study

include the homogeneity of patient management thanks to national REFCOR recommendations and national multidisciplinary meetings as well as the homogeneity of tumor location, which poses specific challenges.

### Conclusion

TORS is an acceptable minimally invasive option for BOT SGC. It may provide good functional and oncological outcomes in selected cases, despite a high rate of close margins. TORS may help to reduce morbidity by avoiding an OA. Further studies are needed to define the best therapeutic strategy according to each histology or grade.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s11701-025-02332-2>.

**Acknowledgement** We thank the French National Cancer Institute (INCa) for their financial support to the REFCOR, and all REFCOR members for their collaboration.

**Author contributions** Conceptualization: SV; data curation: VP; formal analysis: BS; funding acquisition: not applicable; investigation: SV, EC, VP; methodology: SV, BS; project administration: SV; resources: SV, PG, SW, RG, CF, RK, EdeM, FJ, PS, DC, RB, DE, MG, SM, HM, CR, SD, JPM, BG, SA, EB, CB, PC, KA, XD, PG, VB; software: BS; supervision: SV, EC; validation: SV, EC; visualization: SV, EC, EU-C; writing—original draft: VP; writing—review and editing: SV, EC, EU-C, PG, SW, RG, CF, RK, EdeM, FJ, PS, DC, RB, DE, MG, SM, HM, CR, SD, JPM, BG, SA, EB, CB, PC, KA, XD, PG, VB.

**Funding** The authors did not receive support from any organization for the submitted work.

**Data availability** All data generated or analyzed during this study are included in this published article (and its supplementary information files).

### Declarations

**Competing interest** The authors have no relevant financial or non-financial interests to disclose.

**Ethical approval** All the clinical data needed for the study were recorded in an anonymized computerized database after approval by the local research committee under the reference number RnIPH 2023-11. This study was performed in accordance with the Declaration of Helsinki.

**Patient consent** Informed consent was obtained for each patient at the start of his or her care, when he or she was included in the REFCOR database.

### References

1. Devaraju R, Gantala R, Aitha H, Gotoor SG (2014) Mucoepidermoid carcinoma. *BMJ Case Rep.* <https://doi.org/10.1136/BCR-2013-202776>

2. Strick MJ, Kelly C, Soames JV, McLean NR (2004) Malignant tumours of the minor salivary glands—a 20 year review. *Br J Plast Surg* 57:624–631. <https://doi.org/10.1016/J.BJPS.2004.04.017>
3. Goel AN, Badran KW, Braun APG, Garrett AM, Long JL (2018) Minor salivary gland carcinoma of the oropharynx: a population-based analysis of 1426 patients. *Otolaryngol Head Neck Surg* 158:287–294. <https://doi.org/10.1177/0194599817735309>
4. Spiro RH (1986) Salivary neoplasms: overview of a 35-year experience with 2,807 patients. *Head Neck Surg* 8:177–184. <https://doi.org/10.1002/HED.2890080309>
5. Iyer NG, Kim L, Nixon JJ, Palmer F, Kraus D, Shaha AR et al (2010) Factors predicting outcome in malignant minor salivary gland tumors of the oropharynx. *Arch Otolaryngol Head Neck Surg* 136:1240–1247. <https://doi.org/10.1001/ARCHOTO.2010.213>
6. Silverman DA, Carlson TP, Khuntia D, Bergstrom RT, Saxton J, Esclamado RM (2004) Role for postoperative radiation therapy in adenoid cystic carcinoma of the head and neck. *Laryngoscope* 114:1194–1199. <https://doi.org/10.1097/00005537-200407000-00012>
7. Vergez S, Fakhry N (2022) Réseau d'Expertise Français sur les Cancers ORL Rares Tumeurs malignes primitives des glandes salivaires. *Recommandations Par Consensus Formalisé*
8. Llerena P, Wang K, Puram SV, Pipkorn PJ, Jackson RS, Bollig CA (2022) National analysis of positive surgical margins in oropharyngeal salivary gland malignancies. *Am J Otolaryngol*. <https://doi.org/10.1016/J.AMJOTO.2022.103527>
9. Mella MH, Chabrilac E, Dupret-Bories A, Mirallie M, Vergez S (2023) Transoral robotic surgery for head and neck cancer: advances and residual knowledge gaps. *J Clin Med*. <https://doi.org/10.3390/JCM12062303>
10. Weinstein GS, O'Malley BW, Magnuson JS, Carroll WR, Olsen KD, Daio L et al (2012) Transoral robotic surgery: a multicenter study to assess feasibility, safety, and surgical margins. *Laryngoscope* 122:1701–1707. <https://doi.org/10.1002/LARY.23294>
11. Jefferson GD, Frey H (2020) Open versus robotic surgery for oropharyngeal cancer. *Otolaryngol Clin North Am* 53:995–1003. <https://doi.org/10.1016/J.OTC.2020.07.010>
12. Lawrence I, Goldblatt GLE (1987) Salivary gland tumors of the tongue. *Cancer*. [https://doi.org/10.1002/1097-0142\(19870701\)60:1%3c74::aid-cnrc2820600113%3e3.0.co;2-b](https://doi.org/10.1002/1097-0142(19870701)60:1%3c74::aid-cnrc2820600113%3e3.0.co;2-b)
13. National Comprehensive Cancer Network (2020) NCCN Clinical practice guidelines in oncology: head and neck cancer. Version 2
14. Bollig CA, Wang K, Llerena P, Puram SV, Pipkorn PJ, Jackson RS et al (2022) National analysis of oropharyngeal salivary gland malignancies treated with transoral robotic surgery. *Otolaryngol Head Neck Surg* 166:886–893. <https://doi.org/10.1177/01945998211031161>
15. Berg M, Adnan A, Högmo A, Sjödin H, Gebre-Medhin M, Laurell G et al (2021) A national study of health-related quality of life in patients with cancer of the base of the tongue compared to the general population and to patients with tonsillar carcinoma. *Head Neck* 43:3843–3856. <https://doi.org/10.1002/HED.26882>
16. Matthew H (2021) Rigby BHHSMT. *Reconstruction of the Oropharynx*. vol 98
17. Sayin I, Fakhoury R, Prasad VMN, Remacle M, Lawson G (2015) Transoral robotic surgery for base of tongue neoplasms. *B-ENT* 24:45–50
18. Holsinger FC, Laccourreye OWR (2005) Surgical approaches to the oropharynx. *Oper Tech Otolaryngol Head Neck Surg* 16:40–48
19. White H, Ford S, Bush B, Holsinger FC, Moore E, Ghanem T et al (2013) Salvage surgery for recurrent cancers of the oropharynx: comparing TORS with standard open surgical approaches. *JAMA Otolaryngol Head Neck Surg* 139:773–778. <https://doi.org/10.1001/JAMAOTO.2013.3866>
20. Hedayat F, Htwe KK, Vassiliou LV, Kyzas P (2022) Morbidity related to the lip-split mandibulotomy approach: a systematic and narrative review. *Br J Oral Maxillofac Surg* 60:430–436. <https://doi.org/10.1016/J.BJOMS.2021.09.019>
21. Vergez S, Lallemand B, Ceruse P, Moriniere S, Aubry K, De Mones E et al (2012) Initial multi-institutional experience with transoral robotic surgery. *Otolaryngol Head Neck Surg* 147:475–481. <https://doi.org/10.1177/0194599812443221>
22. Razafindranaly V, Lallemand B, Aubry K, Moriniere S, Vergez S, De ME et al (2016) Clinical outcomes with transoral robotic surgery for supraglottic squamous cell carcinoma: experience of a French evaluation cooperative subgroup of GETTEC. *Head Neck* 38(Suppl 1):E1097–E1101. <https://doi.org/10.1002/HED.24163>
23. Jamie RO, Michael JP, Binhuan W, Umamaheswar D, Neil DG, Alec EV, Luc GT, Morris BG (2022) Transoral robotic surgery adoption and safety in treatment of oropharyngeal cancers. *Cancer* 128(4):685–696. <https://doi.org/10.1002/cncr.33995>
24. Van Abel KM, Quick MH, Graner DE, Lohse CM, Price DL, Price KAR et al (2019) Outcomes following TORS for HPV-positive oropharyngeal carcinoma: PEGs, tracheostomies, and beyond. *Am J Otolaryngol Head Neck Med Surg* 40:729–734. <https://doi.org/10.1016/j.amjoto.2019.07.003>
25. Parhar HS, Yver CM, Brody RM (2020) Current indications for transoral robotic surgery in oropharyngeal cancer. *Otolaryngol Clin North Am* 53:949–964. <https://doi.org/10.1016/J.OTC.2020.07.007>
26. Villanueva NL, De Almeida JR, Sikora AG, Miles BA, Genden EM (2014) Transoral robotic surgery for the management of oropharyngeal minor salivary gland tumors. *Head Neck* 36:28–33. <https://doi.org/10.1002/HED.23258>
27. Schoppy DW, Kupferman ME, Hessel AC, Bell DM, Garland EM, Damrose EJ et al (2017) Transoral endoscopic head and neck surgery (eHNS) for minor salivary gland tumors of the oropharynx. *Cancers Head Neck*. <https://doi.org/10.1186/S41199-017-0024-2>
28. Lee SY, Park YM, Byeon HK, Choi EC, Kim SH (2014) Comparison of oncologic and functional outcomes after transoral robotic lateral oropharyngectomy versus conventional surgery for T1 to T3 tonsillar cancer. *Head Neck* 36:1138–1145. <https://doi.org/10.1002/HED.23424>
29. Matsuba HM, Simpson JR, Mauney M, Thawley SE (1986) Adenoid cystic salivary gland carcinoma: a clinicopathologic correlation. *Head Neck Surg* 8:200–204. <https://doi.org/10.1002/hed.2890080312>
30. Liu F, Chu Y, Zheng Q, Hu Y, Wang Y, Qin L et al (2025) Major and minor perineural invasion in salivary gland cancer. *Front Oncol*. <https://doi.org/10.3389/FONC.2024.1466196>
31. Achim V, Bolognone RK, Palmer AD, Graville DJ, Light TJ, Li R et al (2018) Long-term functional and quality-of-life outcomes after transoral robotic surgery in patients with oropharyngeal cancer. *JAMA Otolaryngol Head Neck Surg* 144:18–27. <https://doi.org/10.1001/JAMAOTO.2017.1790>
32. Thariat J, Ferrand FR, Fakhry N, Even C, Vergez S, Chabrilac E et al (2023) Radiotherapy for salivary gland cancer: REFCOR recommendations by the formal consensus method. *Eur Ann Otorhinolaryngol Head Neck Dis*. <https://doi.org/10.1016/J.ANORL.2023.11.006>
33. Hacioglu MB, Erdogan B, Bardakci M, Algin E, Gulbagci B, Hacibekiroglu I et al (2023) Major and minor salivary gland cancers: a multicenter retrospective study. *Head Neck* 45:1643–1653. <https://doi.org/10.1002/HED.27376>
34. Kirke DN, Chitguppi C, Rubin SJ, Truong MT, Jalisi S (2017) Adenoid cystic carcinoma of the base of tongue: a population-based study. *Am J Otolaryngol* 38:279–284. <https://doi.org/10.1016/J.AMJOTO.2017.01.010>
35. Vander Poorten VLM, Balm AJM, Hilgers FJM, Tan IB, Keus RB, Hart AAM (2000) Stage as major long term outcome predictor in

- minor salivary gland carcinoma. *Cancer* 89:1195–1204. [https://doi.org/10.1002/1097-0142\(20000915\)89:6%3c1195::aid-cncr2%3e3.3.co;2-a](https://doi.org/10.1002/1097-0142(20000915)89:6%3c1195::aid-cncr2%3e3.3.co;2-a)
36. Baskin RM, Boyce BJ, Amdur R, Mendenhall WM, Hitchcock K, Silver N et al (2018) Transoral robotic surgery for oropharyngeal cancer: patient selection and special considerations. *Cancer Manag Res* 10:839–846. <https://doi.org/10.2147/CMAR.S118891>
  37. Barrette LX, De Ravin E, Carey RM, Mady LJ, Cannady SB, Brody RM (2022) Reconstruction following transoral robotic surgery for head and neck cancer: systematic review. *Head Neck* 44:1246–1254. <https://doi.org/10.1002/HED.26998>
  38. Weinstein GS, O'Malley BW, Rinaldo A, Silver CE, Werner JA, Ferlito A (2015) Understanding contraindications for transoral robotic surgery (TORS) for oropharyngeal cancer. *Eur Arch Otorhinolaryngol* 272:1551–1552. <https://doi.org/10.1007/S00405-014-3331-9>
  39. Gaino F, Gorphe P, Vander Poorten V, Holsinger FC, Lira RB, Duvvuri U et al (2021) Preoperative predictors of difficult oropharyngeal exposure for transoral robotic surgery: the Pharyngo-score. *Head Neck* 43:3010–3021. <https://doi.org/10.1002/HED.26792>
  40. Gleysteen J, Troob S, Light T, Brickman D, Clayburgh D, Andersen P et al (2017) The impact of prophylactic external carotid artery ligation on postoperative bleeding after transoral robotic surgery (TORS) for oropharyngeal squamous cell carcinoma. *Oral Oncol* 70:1–6. <https://doi.org/10.1016/J.ORALO.NCOLOGY.2017.04.014>
  41. Nichols AC, Theurer J, Prisman E, Read N, Berthelet E, Tran E et al (2019) Radiotherapy versus transoral robotic surgery and neck dissection for oropharyngeal squamous cell carcinoma (ORATOR): an open-label, phase 2, randomised trial. *Lancet Oncol* 20:1349–1359. [https://doi.org/10.1016/S1470-2045\(19\)30410-3](https://doi.org/10.1016/S1470-2045(19)30410-3)
  42. Sethia R, Yumusakhuyly AC, Ozbay I, Diavolisits V, Brown NV, Zhao S et al (2018) Quality of life outcomes of transoral robotic surgery with or without adjuvant therapy for oropharyngeal cancer. *Laryngoscope* 128:403–411. <https://doi.org/10.1002/LARY.26796>
  43. Poissonnet V, Chabrillac E, Schultz P, Morinière S, Gorphe P, Baujat B et al (2022) Airway management during transoral robotic surgery for head and neck cancers: a French GETTEC group survey. *Eur Arch Otorhinolaryngol* 279:3619–3627. <https://doi.org/10.1007/S00405-021-07188-4>
  44. Jeyarajah J, Ahmad I, Jacovou E (2018) Anaesthesia and perioperative care for transoral robotic surgery. *ORL J Otorhinolaryngol Relat Spec* 80:125–133. <https://doi.org/10.1159/000490598>
  45. William S, Jad R, Georges L, Robert F, Ferris L, Floyd CH, Meghan TTM (2020) Bleeding complications after transoral robotic surgery: a meta-analysis and systematic review. *Laryngoscope*. <https://doi.org/10.1002/lary.28580>
  46. Mandal R, Duvvuri U, Ferris RL, Kaffenberger TM, Choby GW, Kim S (2016) Analysis of post-transoral robotic-assisted surgery hemorrhage: Frequency, outcomes, and prevention. *Head Neck* 38(Suppl 1):E776–E782. <https://doi.org/10.1002/HED.24101>
  47. Leonhardt FD, Quon H, Abrahão M, O'Malley BW, Weinstein GS (2012) Transoral robotic surgery for oropharyngeal carcinoma and its impact on patient-reported quality of life and function. *Head Neck* 34:146–154. <https://doi.org/10.1002/HED.21688>
  48. Dziegielewski PT, Teknos TN, Durmus K, Old M, Agrawal A, Kakarala K et al (2013) Transoral robotic surgery for oropharyngeal cancer: long-term quality of life and functional outcomes. *JAMA Otolaryngol Head Neck Surg* 139:1099–1108. <https://doi.org/10.1001/JAMAOTO.2013.2747>

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.

## Authors and Affiliations

Valentine Poissonnet<sup>1</sup> · Emilien Chabrillac<sup>1</sup> · Bertille Segier<sup>2</sup> · Philippe Gorphe<sup>3</sup> · Stéphanie Wong<sup>4</sup> · Renaud Garrel<sup>5</sup> · Christophe Ferron<sup>6</sup> · Rachid Kaci<sup>7</sup> · Erwan de Monès<sup>8</sup> · Franck Jegoux<sup>9</sup> · Philippe Schultz<sup>10</sup> · Dorian Culié<sup>11</sup> · Robin Baudouin<sup>12</sup> · Diane Evrard<sup>13</sup> · Maxime Goffinet<sup>14</sup> · Sylvain Morinière<sup>15</sup> · Haitham Mirghani<sup>16</sup> · Christian Righini<sup>17</sup> · Suzy Duflo<sup>18</sup> · Jean Paul Marie<sup>19</sup> · Bruno Guelfucci<sup>20</sup> · Sarah Atallah<sup>21</sup> · Esteban Brenet<sup>22</sup> · Chloé Bertolus<sup>23</sup> · Philippe Ceruse<sup>24</sup> · Karine Aubry<sup>25</sup> · Xavier Dufour<sup>26</sup> · Patrice Gallet<sup>27</sup> · Vianney Bastit<sup>28</sup> · Emmanuelle Uro-Coste<sup>29</sup> · Sébastien Vergez<sup>1</sup>

✉ Valentine Poissonnet  
valentine.poissonnet@gmail.com

<sup>1</sup> Otolaryngology, Head and Neck Surgery Department, University Cancer Institute Toulouse and Toulouse University Hospital, Larrey Hospital, 24 Chemin de Pourville, 31059, Cedex 9 Toulouse, France

<sup>2</sup> Statistical Department, Institut Claudius Régaud, University Institute of Cancer, 1 Avenue Irène Joliot-Curie, 31100 Toulouse, France

<sup>3</sup> Head and Neck Oncology Department, Gustave-Roussy Institute, 114 Rue Edouard Vaillant, 94800 Villejuif, France

<sup>4</sup> Department of Radiation Therapy, AP-HM, Aix-Marseille University, 264 Rue Saint Pierre, 13385 Marseille, France

<sup>5</sup> Otolaryngology, Head and Neck Surgery Department, University Hospital of Montpellier, 191 Avenue du Doyen Gaston Giraud, 34295 Montpellier, France

<sup>6</sup> Otolaryngology, Head and Neck Surgery Department, University Hospital of Nantes, 5 Allée de l'Île Gloriette, 44000 Nantes, France

<sup>7</sup> Pathology Department, AP-HP, Hôpital Lariboisière, 2 Rue Ambroise Paré, 75010 Paris, France

<sup>8</sup> Department of Otorhinolaryngology and Head and Neck Surgery, Bordeaux University Hospital-CHU, F-33000 Bordeaux, Place Amélie Raba Léon, 33000 Bordeaux, France

- 9 Otolaryngology, Head and Neck Surgery Department, University Hospital of Rennes, 2 Rue Henri le Guilloux 35000, Rennes, France
- 10 Otolaryngology, Head and Neck Surgery Department, University Hospital of Strasbourg, 1 Place de l'Hôpital, 67000 Strasbourg, France
- 11 Otolaryngology, Head and Neck Surgery Department, Head and Neck University Institute, 31 Avenue de Valombrose, 06100 Nice, France
- 12 Otolaryngology, Head and Neck Surgery Department, Foch Hospital, 40 Rue Worth, 92150 Suresnes, France
- 13 Otolaryngology, Head and Neck Surgery Department, Bichat Hospital, 46 Rue Henri Huchard, 75018 Paris, France
- 14 Head and Neck Surgery Department, CHU Sart Tilman, University Liege, 1 Avenue de l'Hôpital, 4000 Luik, Belgium
- 15 Otolaryngology, Head and Neck Surgery Department, University Hospital of Tours, 2 Boulevard Tonnellé, 37000 Tours, France
- 16 Otolaryngology, Head and Neck Surgery Department, George Pompidou European Hospital, 20 Rue Leblanc, 75015 Paris, France
- 17 Otolaryngology, Head and Neck Surgery Department, University Hospital of Grenoble, Avenue des Maquis du Grésivaudan, 38700 La Tronche, France
- 18 Otolaryngology, Head and Neck Surgery Department, University Hospital of Point-à-Pitre, Route de Chauvel, Les Abymes, 97142 Guadeloupe, France
- 19 Otolaryngology, Head and Neck Surgery Department, University Hospital of Rouen, 37 Boulevard Gambetta, 76000 Rouen, France
- 20 Otolaryngology, Head and Neck Surgery Department, Hospital of Toulon, 54 Rue Henri Sainte-Claire Deville, 83100 Toulon, France
- 21 Head and Neck Surgery Department, Tenon Hospital, APHP, Sorbonne University, 4 Rue de la Chine, 75020 Paris, France
- 22 Otolaryngology, Head and Neck Surgery Department, University Hospital of Reims, Rue du Général Koenig, 51100 Reims, France
- 23 Department of Oral and Maxillo-Facial Surgery, Pitié-Salpêtrière Hospital, APHP, Sorbonne Université, 47-83 Boulevard de l'Hôpital, 75013 Paris, France
- 24 Otolaryngology, Head and Neck Surgery Department, University Hospital of Lyon, 165 Chemin du Grand Revoyet, 69310 Pierre-Benite, France
- 25 Otolaryngology, Head and Neck Surgery Department, University Hospital of Limoges, 2 Avenue Martin Luther King, 87000 Limoges, France
- 26 Otolaryngology, Head and Neck Surgery Department, University Hospital of Poitiers, 2 Rue de la Milétrie, 86000 Poitiers, France
- 27 Otolaryngology, Head and Neck Surgery Department, University Hospital of Nancy, 20 Avenue du Maréchal de Lattre de Tassigny, 54000 Nancy, France
- 28 Otolaryngology, Head and Neck Surgery Department, University Hospital of Caen, Avenue de la Côte de Nacre CS 30001, 14000 Caen, France
- 29 Department of Anatomical Pathology, University Cancer Institute Toulouse, 1 avenue Irène Joliot-Curie, 31100 Toulouse, France