Initial Multi-institutional Experience with Transoral Robotic Surgery
Sebastien Vergez, Benjamin Lallemant, Philippe Ceruse, Sylvain Moriniere, Karine Aubry, Erwan De Mones, Adil
Benlyazid and Yann Mallet
Otolaryngology -- Head and Neck Surgery 2012 147: 475 originally published online 3 April 2012
DOI: 10.1177/0194599812443221
The online version of this article can be found at:
http://oto.sagepub.com/content/147/3/475

Published by:
SAGE
http://www.sagepublications.com

On behalf of:
American Academy of Otolaryngology- Head and Neck Surgery

Additional services and information for Otolaryngology -- Head and Neck Surgery can be found at:

Email Alerts: http://oto.sagepub.com/cgi/alerts
Subscriptions: http://oto.sagepub.com/subscriptions
Reprints: http://www.sagepub.com/journalsReprints.nav
Permissions: http://www.sagepub.com/journalsPermissions.nav

>> Version of Record - Aug 29, 2012
OnlineFirst Version of Record - Apr 3, 2012
What is This?
Initial Multi-institutional Experience with Transoral Robotic Surgery

Sebastien Vergez, MD, PhD¹, Benjamin Lallemant, MD, PhD², Philippe Ceruse, MD, PhD³, Sylvain Moriniere, MD, PhD⁴, Karine Aubry, MD, PhD⁵, Erwan De Mones, MD⁶, Adil Benlyazid, MD⁷, and Yann Mallet, MD, PhD⁸

No sponsorships or competing interests have been disclosed for this article.

Abstract

Objective. To assess the initial experience for transoral robotic surgery (TORS), as observed in the French TORS group.


Setting. Seven tertiary referral centers.

Subjects and Methods. One hundred thirty consecutive patients who were scheduled for a TORS between October 2008 and March 2011 were included. The operative times, conversion rates, morbidity, and alternatives were described. The serious adverse effects encountered were analyzed, and recommendations for avoiding them are specified.

Results. Most of the patients (65%) had a laryngeal (supraglottic) and/or hypopharyngeal resection. Thirty-nine of the 130 patients receiving TORS would have had a transoral laser resection as their alternative surgery. The tumor exposure was suboptimal in 26% of the cases. Six of the 130 patients needed conversion to an open approach. There were 15 postoperative hemorrhages and 2 deaths due to posthemorrhage complications in patients with significant comorbidities at 9 and 18 days after the surgery. The median setup and procedure times were 52 ± 46 and 90 ± 92 minutes, respectively. The learning curve was characterized by better selection and management of potential patients.

Conclusion. The visualization offered by the robotic assistance allowed transoral resections of tumors that were difficult to resect or unresectable by laser surgery. Self-assessment of surgical exposure and a decrease in the need to convert to an open procedure over time suggested improvement in TORS-related surgical skills. Nevertheless, strict patient selection is essential. Even with a minimally invasive approach, some patients will need a tracheostomy for safety reasons.

Keywords
transoral robotic surgery, learning curve, squamous cell carcinoma, hypopharyngeal tumor, oropharyngeal tumor, laryngeal tumor

Minimally invasive head and neck surgery has experienced a major advance in recent years with the development of transoral robotic surgery (TORS). Preclinical and clinical studies by a team at the University of Pennsylvania have demonstrated the feasibility and safety of transoral resections with the assistance of the Da Vinci surgical robot (Intuitive Surgical, Inc, Sunnyvale, California).¹,² Multiple case series have examined using TORS for resecting oropharyngeal,³−⁵ laryngeal,⁶ and hypopharyngeal⁷−⁸ tumors. The Food and Drug Administration approved TORS for tumors of mouth, pharynx, and larynx in 2009.⁹

In France, the first TORS took place in 2008. From the beginning, the groups who introduced the approach worked together to create a national organization (French Robotic Surgery Group) for performing multicenter research studies to evaluate robotic assistance and its indications.¹⁰

Received September 1, 2011; revised February 27, 2012; accepted March 5, 2012.

¹Otolaryngology, Head and Neck Surgery Department, University Hospital Rangueil-Larrey, Toulouse, France
²Otolaryngology, Head and Neck Surgery Department, University Hospital Caremeau, Nîmes, France
³Otolaryngology, Head and Neck Surgery Department, University Hospital Lyon Sud, Lyon, France
⁴Otolaryngology, Head and Neck Surgery Department, University Hospital Bretonneau, Tours, France
⁵Otolaryngology, Head and Neck Surgery Department, University Hospital Dupuytren, Limoges, France
⁶Otolaryngology, Head and Neck Surgery Department, University Hospital Pellegrin, Bordeaux, France
⁷Surgical Oncology Department, Claudius Regaud Institute, Toulouse, France
⁸Surgical Oncology, Head and Neck Surgery Department, Oscar Lambret Center, Lille, France

This article was presented at the 2011 AAO-HNSF Annual Meeting & OTO EXPO; September 11-14, 2011; San Francisco, California.

Corresponding Author:
Sebastien Vergez, MD, PhD, Otolaryngology, Head and Neck Surgery Department, University Hospital Rangueil-Larrey, 24 chemin de Pouvourville, 31059 Toulouse cedex 9, France
Email: vergez.s@chu-toulouse.fr
The goal of this study was to describe the learning process of 7 separate surgical teams who began using TORS. The advantages provided by the surgical robot and the difficulties associated with it were examined. The essential criteria for using TORS under good conditions were identified. The oncological and functional outcomes are not reported in this study.

Subjects and Methods
The study was a prospective multi-institutional cohort study examining the learning curves of 7 surgical teams. From October 2008 to March 2011, all candidates for TORS from the 7 participating tertiary referral centers were entered into a secure online database (Capture system, CNIL agreement [Commission nationale de l’informatique et des libertés]). The study was approved by the institutional review board of the sponsoring center (Oscar Lambret Center, Lille, France). A data manager and biostatistician have overseen intermediate and final analyses (at 34, 76, and 130 patients).

The predefined selection criteria were small benign/malignant lesions, located in the oropharynx and/or larynx-hypopharynx, and without any deep involvement in the endoscopic and radiologic assessments (Tis/T1/T2) and accessible for a TORS for the trained senior surgeon. Carotid or osseous involvement (mandible, hyoid) was the exclusion criterion. In each case, the decision to use robotic assistance was approved by a multidisciplinary board following an endoscopic examination under general anesthesia and the acquisition of a computed tomography (CT) scan with or without magnetic resonance imaging (MRI). All the patients provided informed consent.

Transoral robotic surgery was initiated by the head and neck surgical teams between October 2008 and April 2010, and each team recruited 6 to 33 patients (median: 17 patients/center). Ten senior surgeons who had undergone theoretical and practical training on animal and/or cadaveric models performed the procedures from the surgical console. A second surgeon was placed at the head of the patient. This surgeon provided continuous aspiration and valuable dissection assistance and managed bleeding (using surgical clips and bipolar electrocautery). In 44% of the cases, the second surgeon was also a senior trained in TORS.

The robot and the operation room were configured as previously described.4 The intervention was performed under general anesthesia, with orotracheal or nasotracheal intubation. A tracheostomy was necessary in 19 patients. Surgical exposure was ensured by a Crowe-Davis or Feyh-Kastenbauer (FK; Gyrus-Medical, Tuttlingen, Germany) retractor. One surgical team did not have an FK retractor available at the time of the study. Depending on the team and the tumor location, an 8.5-mm or 12-mm endoscope at 0° or 30° was used, with two 5-mm or 8-mm Endowrist (Intuitive Surgical, Inc) surgical instruments. These instruments were typically a forceps (Maryland, DeBakey) and a bovie electrocautery spatula. Frozen sections were an option for all surgical teams.

Seventy-five patients required neck dissection. The dissection was performed during the initial procedure for the majority of patients, with the remaining patients undergoing neck dissection during a second procedure at a later date.

For each case, the perceived advantages of this technique and its surgical alternatives were noted by the surgeons. The clinical, endoscopic imaging data; rate of conversion to open surgery; surgical outcomes; morbidity; and the time required for the operative planning, setup, and surgery were recorded. Any adverse events were noted and discussed in a national morbidity-mortality conference organized by the French Robotic Surgery Group. Recommendations on how to prevent them were advanced.

Results
Demographic Data
One hundred thirty patients were scheduled for TORS, with a male-to-female ratio of 5:1 and an average age of 60 ± 9 years. The comorbidities are summarized in Table 1. Nine of the 130 patients had a benign lesion: lingual tonsillar hypertrophy (n = 1), cysts (n = 3), schwannomas (n = 1), papillomatosis (n = 2), and other benign tumors (n = 2). One hundred twenty-one patients had malignant tumors, 97% of which were squamous cell carcinomas (SCC). The tumor stages seen in the patients presenting with SCC were pTis, 42pT1, 63pT2, 6pT3, and 3pT4. Of the 121 SCC, 99 were pT1/pT2 tumors without any deep infiltration.

The sites of the tumors were supraglottic and hypopharyngeal, laryngeal, lateral oropharyngeal, inferior oropharyngeal,
and oral in 51%, 14%, 10%, 24%, and 1% of the cases, respectively (Table 2).

The senior surgeons appreciated the operative comfort provided by the new surgical tool. The range of instrument movement within the depths of the upper aerodigestive tract and the high-definition, 3-dimensional images allowed recommendations in favor of TORS for the majority of the patients in our series, and only 39 of the 130 patients would have been able to receive a transoral laser microsurgery as an alternative therapy. In the complete sample, the other alternatives proposed were partial laryngectomy and/or pharyngectomy, radiotherapy, mandibular swing, and total laryngectomy in 46%, 16%, 5%, and 5% of the cases, respectively. Partial laryngectomies would be supraglottic laryngectomies, supracricoid laryngectomies, frontolateral laryngectomies, or supracricoid hemipharyngolaryngectomy.

### Table 2. Tumor Location and Resection Performed (126 Patients Fully Operated by Transoral Robotic Surgery)

<table>
<thead>
<tr>
<th>Main Location</th>
<th>Extension and Subsites Resected</th>
<th>No. Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraglottic/hypopharynx</td>
<td></td>
<td>64</td>
</tr>
<tr>
<td>Epiglottis</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>Pharyngoepiglottic fold</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>Aryepiglottic fold</td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>Ventricular folds (unilateral/bilateral)</td>
<td></td>
<td>22/5</td>
</tr>
<tr>
<td>Glottis (unilateral/bilateral/anterior commissure)</td>
<td></td>
<td>9/13/16</td>
</tr>
<tr>
<td>Arytenoid (partial/complete)</td>
<td></td>
<td>10/12</td>
</tr>
<tr>
<td>Subglottis</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Pharyngolaryngeal wall</td>
<td></td>
<td>27</td>
</tr>
<tr>
<td>Anterior pyriform sinus</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>Posterior pharyngeal wall</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Lateral pharyngeal wall</td>
<td></td>
<td>23</td>
</tr>
<tr>
<td><strong>Inferior oropharynx</strong></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Base of tongue</td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>Vallecula</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Epiglottis</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Pharyngoepiglottic folds</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Tonsilla</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Glossotonsillar sulcus</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Posterior pelvis and oral tongue</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>Endolarynx</strong></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Vocal cords (unilateral/bilateral)</td>
<td></td>
<td>4/6</td>
</tr>
<tr>
<td>Anterior commissure</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Ventricular folds (unilateral/bilateral)</td>
<td></td>
<td>7/2</td>
</tr>
<tr>
<td>Arytenoid (partial/total)</td>
<td></td>
<td>7/3</td>
</tr>
<tr>
<td>Epiglottis</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Subglottis</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Aryepiglottic, pharyngoepligotic folds</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td><strong>Lateral oropharynx</strong></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Tonsilla</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Glossotonsillar sulcus</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Soft palate</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Base of tongue</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>Oral cavity</strong></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>126</td>
</tr>
</tbody>
</table>
other). In the complete sample, the average interval between the multidisciplinary board and the TORS was 18 ± 10 days.

We have routinely performed en bloc resections (116/126). A piecemeal resection was necessary for large tumors (9 SCC and 1 schwannoma).

A lack of surgical exposure with a conflict between surgical instruments rendered robotically assisted dissection impossible in 2 cases. A lack of exposure was noted in 4 additional patients, for a total of 6 conversions to open surgery due to lack of exposure in our series. It is interesting to note that these exposure failures all occurred in 5 centers during the first half of the study period. These difficulties occurred before the senior surgeon, who was trained in TORS, has systematically repeated the endoscopy with the adapted retractor.

The surgical exposure was rated as optimal in 74% of the cases. For the other 33 patients, the exposure challenges were often multifactorial, with the cause being anatomic (issues with a small oral opening, dentition, and the base of the tongue volume) in 10 patients and oncologic (related to tumor volume and a lower pole) in 6 patients. Suboptimal exposure was seen in 10 of the 18 patients presenting with a glottic tumor and was principally linked to a narrow channel and difficulty accessing the anterior commissure with the instruments. In the complete sample, 41 of 130 patients were edentulous. The teams that had not yet been equipped with an FK retractor did not perform resections beyond the oropharynx. Challenges also resulted from using the 8-mm instruments.

No major complications occurred during the TORS. The setup and operative times were difficult to interpret, given the increasing complexity of the procedures performed by the surgical teams. In addition, the frequent addition of a neck dissection to the procedure and the need to combine a cervical procedure with the transoral procedure in several cases made it challenging to determine the total times for the robotic and cervical surgeries. The average setup time (operation room setup, calibration of the endoscope, surgical exposure, and instrument setup) was 52 ± 46 minutes, with a surgical time of 90 ± 92 minutes. In the learning process, each surgeon reported a rapid improvement in his setup, exposure, and dissection abilities, but no significant decrease in these times could be observed.

**Follow-up**

The postoperative course was simple for 84% of the patients (Table 3). Minor complications linked to the exposures were identified, including injuries, hematomas, and edema of the tongue and oral cavity. Three patients experienced infections at their operative sites.

All the patients were systematically extubated in the operating room immediately after the procedure, even after a long surgery and an associated neck dissection. No patient required persistent intubation and an intensive care unit stay following the surgery. Nineteen patients received tracheostomies. Two of them were performed emergently because of postoperative dyspnea (Table 3).

A patient presented with a massive pulmonary embolism and died 10 days after the TORS. Fifteen patients had secondary bleeding, and 14 required reoperation. There were 2 deaths due to posthemorrhage in patients with a World Health Organization (WHO) status of 2 to 3 and significant comorbidities. The first of these patients presented with profound aftereffect from cerebrovascular accident and cardiac insufficiency and was receiving anticoagulants. Nine days following an extended cordectomy (type IV), the patient had a small paraglottic hemorrhage that led to serious cardiorespiratory decompensation during sleep. The second of these patients died from inhalational pneumonitis several days after a secondary hemorrhage. The serious adverse events were analyzed in our multicentric morbidity-mortality conference. In our experience, the expected improvement in the functional course observed led us to recommend TORS to patients who were in poor health and needed their procedures to be as minimally invasive as possible. The presence of a coagulopathy (due to anticoagulation or thrombocytopenia or cirrhosis), prior cervical radiation therapy, cardiorespiratory insufficiency, and a WHO performance status greater than 1 was linked to hemorrhagic complications, aspirations, and a delayed return to oral nutrition. In such situations, we strongly recommend a tracheostomy. With these recommendations, decided after an intermediate analysis (76 patients), we have limited the occurrence of serious adverse events.

**Discussion**

We present here a large multi-institutional consecutive series with data collected in a prospective fashion. To our knowledge, it is one of the few TORS reports that include primarily laryngeal and hypopharyngeal lesions.

The study surgeons believed that TORS permitted them to perform resections with unequalled visual and instrumental comfort. As previously reported, there was a clear distinction between TORS and transoral laser microsurgery (TLM) using magnified direct visualization and rigid

---

**Table 3. Postoperative Course**

<table>
<thead>
<tr>
<th>Postoperative Course</th>
<th>No. Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>No complication</td>
<td>106</td>
</tr>
<tr>
<td>Major edema</td>
<td>3</td>
</tr>
<tr>
<td>Bleeding</td>
<td>15</td>
</tr>
<tr>
<td>Infection</td>
<td>3</td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>19</td>
</tr>
<tr>
<td>Planned tracheostomy</td>
<td>17</td>
</tr>
<tr>
<td>Tracheostomy for postoperative edema</td>
<td>2</td>
</tr>
<tr>
<td>Reoperations/bleeding</td>
<td>14</td>
</tr>
<tr>
<td>Intensive care unit admission</td>
<td>1 (postoperative edema) intubated 24 hours</td>
</tr>
<tr>
<td>Deaths (related to medical diseases)</td>
<td>3</td>
</tr>
</tbody>
</table>
instrumentation. Miniatrurized instrumentation with a 360° range of motion, combined with magnified vision in high definition and 3 dimensions, led to recommending transoral surgery in 91 of the patients in our series. Only 39 of our patients would have had TLM as an alternative. The potential alternative most frequently mentioned was partial laryngectomy or pharyngolaryngectomy, which is often performed by French teams. We recognize that some of these lesions may have been amenable to TLM by other surgical groups.

The absence of integrated suction and more complicated perioperative hemorrhage management are limitations of TORS. The presence of a second surgeon trained in TORS is a significant cost for ensuring the efficacy and safety of TORS. The benefits of having a second surgeon trained in robotic surgery near the patient during abdominal and thoracic surgery have been reported. Indeed, a significant improvement was seen in setup times (P = .05) and instrument change times (P = .0004) when the second surgeon was present. In our series, we observed that knowing how to perform a dissection from the console permitted the second surgeon to anticipate the senior surgeon’s needs and facilitate the dissection. The second surgeons could also compensate for the lack of opposing force in the robotic system. In addition, they managed bleeding and prevented conflicts between the surgical instruments and collateral injuries due to exposure and instrument movement.

The chief limitations of TORS are its cost and the scarcity of data on its oncological results. The justification for medical centers investing in a TORS program is provided by the satisfying functional results seen in 2 recent studies. In a cohort of 47 patients with advanced-stage oropharyngeal cancer, the locoregional disease control rates were better than those in a series of patients treated by chemotherapy (using intensity-modulated radiotherapy) with a longer average follow-up (26 months). Postoperative deintensification of chemotherapy or radiation with a selective neck dissection has been recommended following TORS.

In the setting of oropharyngeal tumor recurrence, gastrectomy dependence 6 months later was less for TORS than for open surgical salvage therapy (0% vs 43%, P = .06). Postoperative deintensification of chemotherapy or radiation with a selective neck dissection has been recommended following TORS.

In the literature, early resumption of oral feeding is reported, although a transitory impact is seen on patient quality of life, particularly with postoperative chemoradia-

tion. These results and the expected decreased need for postoperative therapy allow for new paradigms that combine good oncological and functional results.

Our learning curve was characterized by a progressive increase in the volume and difficulty of surgical resections. Some teams began with benign lesions, such as cysts or lingual tonsillar hypertrophy. Lesions classified T1 or small T2 are recommended during the learning curve. We all appreciated the robotic assistance for the supraglottic laryngectomies, routinely performed en bloc. This procedure, as a radical tonsillectomy, appeared easier than a resection of the base of the tongue or the glosso tonsillar sulcus, which was deeper and more difficult without opposing force. The resection of the epiglottis, the aryepiglottic folds, and pharyngolaryngeal wall was routinely performed en bloc (eventually helped by 30° endoscopes) but always needed an optimal surgical exposure.

Surgical exposure is another limitation of this technique. The surgical tool was not initially developed for transoral access, and accessibility and surgical exposure are as important for resections as tumor extent and margins. Failure of exposure was reported in 6 of 128 patients in our series and in 2 of 20, 8 of 62, and 7 of 36 patients in the literature. A link between tumor size (P = .01), dentition (P = .07), and degree of progression on the learning curve has been identified. In our series, 9 of 121 cancers were pT3 or pT4, and 65% of the tumors were laryngeal and/or hypopharyngeal. The endoscopy performed by the senior surgeon as part of the TORS evaluation allowed for better patient selection. In our series, glottic tumors were incompletely exposed in 56% of the cases (10/18). In this setting, the instrument encumbrance in the laryngeal cavity led us to prefer using a CO2 laser for the transoral resection of glottic and subglottic tumors. Using the 8-mm instruments and the absence of pharyngolaryngeal retractors were also limitations for some of the resections in our series. The availability of adapted instruments (a choice of retractors and 5-mm instruments) and a choice of a 0° or 30° endoscope, ideally 8.5 mm, place the surgical team in the best position for performing TORS.

As has been described in the literature, the postoperative course was simple for the majority of the patients in our series, with early realimentation and short hospital stays. A significant increase in operative-site infections has been seen in robotic abdominal surgery, particularly (in descending order) during the learning process for gastrointestinal, gynecological, and urological surgery. This complication was rarely seen in our series or in the TORS literature. In the literature, wide exposure of the operative field has been reported as being responsible for minor local complications, and our series had similar findings. We now inform patients in advance about the possibility of injuries or ecchymoses involving the tongue and oral mucosa. The number of hemorrhagic complications in our series was higher than that seen in the literature: 3 of 54 and 2 of 29 patients. This complication led to the death of 2 patients in our cohort, both of whom had poor general status. Certainly, TORS simplifies the postoperative course in the majority of patients, but careful preoperative selection of candidates remains essential. Placing a prophylactic tracheostomy is recommended for large resections that result in an incompetent larynx. For example, we recommend associating tracheostomy for tongue base and epiglottis resections. We expanded the indications for tracheostomy to patients with poor overall health and to those patients with increased risks of postoperative hemorrhage (due to anticoagulants, antiplatelet medications, cirrhosis, thrombocytopenia) to protect the airway. Coverage with a local flap was performed to prevent hemorrhage. Finally, some of our groups also applied Tissucol (Baxter, Maurepas, France) in the resection cavity at the end of the...
procedure.¹² Nineteen of the patients in our series required tracheostomies. This procedure was justified by the comorbidities seen in our patients, with 12% having respiratory insufficiency and 24% having had prior cervical radiation (Table 1). In addition, 65% of the surgeries involved the larynx and/or hypopharynx. In some series, none of the patients received a tracheostomy.¹² Nevertheless, 27 of 47 and 7 of 29 patients remained intubated and ventilated at 24 and 48 hours postsurgery, and 3 of 47 and 1 of 29 patients underwent tracheostomy in the series of Weinstein et al¹⁸ and Iseli et al,²³ respectively. Adhering to the principal of minimally invasive surgery, TORS allows avoiding a tracheostomy in a significant majority of cases. However, we believe that placing a prophylactic tracheostomy is justified to avoid major complications in patients who are at risk.

The early constitution of our group of robotic surgeons, when the TORS was still not well described, helped us to improve our learning curve. This database, our regular meetings, and the multicentric morbidity mortality conference have changed our practices. Our French robotic surgery group is growing, and other multicentric studies evaluating TORS are ongoing. Such collaborative work is useful when we start an innovative activity.

In conclusion, we found that careful patient selection is necessary both in the preoperative evaluation (for the surgical exposure) and in the medical clearance (for placing a prophylactic tracheostomy). With optimal instrumentation and a pair of trained senior surgeons, rapid progression on the TORS learning curve is seen for setup, surgical exposure, dissection, and patient selection. The clear advantages of improved visual comfort and the operative comfort provided by the movement range of the microinstruments allow recommending TORS for patients who are less-than-suitable candidates for TLM. In light of our combined experience, however, we prefer TLM for glottic tumors with anterior and inferior extension.

Acknowledgments
Thanks to Jean-Pierre Meurant, Charles Fournier, and Sarah AlSheirri for their help.

Author Contributions
Sebastien Vergez, design and conception, acquisition of data and interpretation, draft, revision and final approval; Benjamin Lallemant, design and acquisition of data, revision and final approval; Philippe Ceruse, design and acquisition of data, draft, revision and final approval; Sylvain Moriniere, design and acquisition of data, revision and final approval; Karine Aubry, design and acquisition of data, revision and final approval; Erwan De Mones, design and acquisition of data, revision and final approval; Adil Benlyazid, design and acquisition of data, revision and final approval; Yann Mallet, design and conception, acquisition of data and interpretation, draft, revision and final approval.

Disclosures
Competing interests: None.
Sponsorships: None.
Funding source: None.

References


