Transoral Robotic Surgery Using an Image Guidance System

Shaun C. Desai, BA; Chih-Kwang Sung, MD; Eric M. Genden, MD, FACS

INTRODUCTION

Access to the oropharynx and parapharyngeal space often require a labiotoromy with midline mandibulotomy for resection of tumors located in these areas. Transoral robotic surgery (TORS) provides a minimally invasive method to access these areas without the morbidity associated with the traditional external approach. However, the TORS approach requires a unique perspective of the anatomy that is different from the open approach, because the surgeon approaches the space from the lumen of the pharynx. This may result in disorientation with regard to the position of the great vessels. In this pilot study, we describe the use of two novel technological advances, the real-time image guidance system (IGS) (BrainLAB AG, Feldkirchen, Germany) and the daVinci Surgical Robotic System (Sunnyvale, CA) in an effort to improve safety and facilitate tumor dissection during TORS surgery.

OBJECTIVES: To describe a novel technique using the image guidance system for transoral robotic surgery of the pharyngeal and parapharyngeal spaces.

STUDY DESIGN: Case series presentation.

METHODS: Three cases of oropharyngeal and pharyngeal space lesions are reviewed for presentation, workup, and original management.

RESULTS: Final pathology of a vascular malformation, an acinic cell adenocarcinoma, and a squamous cell carcinoma were located and minimally invasively removed by a transoral robotic approach with the aid of image guidance. No complications or recurrences were observed on an average of 7 month follow-up.

CONCLUSIONS: Transoral robotic surgery using an image guidance system seems safe and effective in assisting dissection.


MATERIALS AND METHODS/RESULTS

Case 1

A 68-year-old woman presented with an 8-month history of eustachian tube dysfunction and serous otitis media. The workup, including computed tomography (CT) and magnetic resonance imaging, revealed a left parapharyngeal space mass. Two needle biopsies performed under CT guidance were inconclusive. The patient was counseled regarding the options of a transmandibular approach through a midline mandibulotomy, a transcervical approach, or a transoral approach using the daVinci surgical system (Sunnyvale, CA). The patient refused the two open surgical options but agreed to the Institutional Review Board-approved transoral robotic approach with image guidance.

The patient was taken to the operating room and induced with general anesthesia and intubated. A Crowe-Davis retractor was used to gain exposure to the pharynx. The daVinci robotic arms and three-dimensional endoscope were placed transorally. The IGS was then positioned and calibrated to the bony landmarks in standard fashion. VectorVision navigation software in “ENT mode” was used to view the real-time images (Fig. 1). After precisely marking the location, a 3.0 cm incision was made through the mucosa in the area overlying with the IGS. Dissection of the infratemporal fossa using the IGS revealed a large vascular malformation. Immediately post-terolateral to the lesion was the carotid artery, which was dissected free from the vascular mass and its tributary vessels. The stereotactic system was used again to ensure that the lesion was completely visualized and the great vessels were adequately protected. Using the medial aspect of the mandible, the tuberosity of the maxilla, and the bony skull base anatomy, the IGS proved useful in assessing the anatomy during the dissection. The tributary vessels were ligated using titanium vascular clips and the tumor was carefully dissected and extirpated. The defect was closed using 2-0 Vicryl sutures with the robotic arms. The patient awakened.

The patient tolerated the procedure without complications and began clear liquids on postoperative day 1. The patient was discharged on day 2 after eating a soft diet. On 1-month follow up, the patient was asymptomatic and the serous otitis media had resolved.

Final pathology revealed a benign vascular malformation (Table I).

Case 2

A 73-year-old woman presented with a history of new onset snoring and difficulty breathing at night. On physical examination, a 3.0 × 3.0 cm painless, well-circumscribed, oropharyngeal mass was observed on the upper left side of the palate extending inferior to the palatine tonsil. Fine needle aspiration of the mass revealed a diagnosis of polymorphous low-grade adenocarcinoma vs. adenoid cystic carcinoma. Contrast enhanced CT and positron emission tomography scan of the neck confirmed a hypermetabolic...
left oropharyngeal mass that extended into the parapharyngeal space with no evidence of metastatic disease.

After obtaining consent, the patient was endotracheally intubated. After achieving adequate exposure with a Crowe-Davis retractor, the robotic arms were placed in the oral cavity (Fig. 2). The stereotactic IGS was then tested and configured to ensure anatomic calibration to the patient. After the mucosal incisions, the IGS was used to assist in dissection of the parapharyngeal space as the tumor was dissected from the carotid artery and lateral pharyngeal wall. The IGS provided guidance and localization of the carotid artery during the course of the dissection. Tumor-free margins were obtained by frozen section analysis. A pharyngoplasty and closure of the defect was then performed also using the robot. Final pathology revealed an acinic cell adenocarcinoma, predominately of the papillary-cystic variant with no perineural or vascular invasion. The patient declined adjuvant radiation therapy, and has been disease free on 9-month follow up.

Case 3

A 61-year old man with a history of liver failure and thrombocytopenia presented with a 2-month history of a left neck mass that had grown in size. CT-scan of the neck revealed a tonsillar lesion and a biopsy confirmed squamous cell carcinoma with a single metastasis to the ipsilateral neck. After receiving consent, the patient was brought to the operating room and endotracheally intubated. The Crowe-Davis retractor was once again used for adequate exposure to the oral cavity, and the stereotactic IGS was calibrated to the patient’s anatomy. The robotic arms were then placed intraorally and a left lateral pharyngectomy was performed, removing both the left tonsil and adjacent pharyngeal musculature. The IGS was used to guide the deep lateral dissection by helping to identify the carotid artery. Bony landmarks such as the maxillary tuberosity and the styloid tip were helpful in guiding the dissection. Negative margins were achieved on frozen section. A lateral pharyngeal wall musculo-mucosal flap was raised and used to close the defect. After completing the resection of the primary cancer, a left selective neck dissection was performed. The patient went on to receive postoperative chemoradiation, and has been tumor free for the past 11 months.

DISCUSSION

Robotic surgical technology has found growing applications and increasing acceptance in thoracic and abdominopelvic

<table>
<thead>
<tr>
<th>Age (Yr)</th>
<th>Sex</th>
<th>Tumor Location</th>
<th>Reconstruction</th>
<th>EBL (cc)</th>
<th>Final Pathology</th>
<th>Stage (AJCC)</th>
<th>Hospital Stay (D)</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>F</td>
<td>Parapharyngeal space</td>
<td>None</td>
<td>30</td>
<td>Vascular malformation</td>
<td>n/a</td>
<td>2</td>
<td>None</td>
</tr>
<tr>
<td>73</td>
<td>F</td>
<td>Oropharynx</td>
<td>Pharyngoplasty</td>
<td>10</td>
<td>Adeno-cystic</td>
<td>T2N0M0</td>
<td>4</td>
<td>None</td>
</tr>
<tr>
<td>61</td>
<td>M</td>
<td>Oropharynx</td>
<td>Pharyngeal wall musculo-mucosal flap</td>
<td>80</td>
<td>SCC</td>
<td>T1N2aM0</td>
<td>3</td>
<td>None</td>
</tr>
</tbody>
</table>

EBL = estimated blood loss; AJCC = American Joint Committee Cancer; n/a = not applicable; Adeno-cystic = acinic cell adenocarcinoma, papillary-cystic variant; SCC = squamous cell carcinoma.
surgery with robot-assisted prostatectomies and mitral valve surgery becoming common practice in some institutions. However, TORS has only recently been used for resection of cancers of the base of tongue and supraglottic larynx. Early adaptation of this technology to head and neck surgery is limited, however, shows great potential. Technical advantages to this minimally invasive approach include magnified three-dimensional imaging, improved fine motor control with a tremor filter, articulated instruments, and the ability to perform two-handed surgery through small openings.

Anecdotal experience with the robotic system suggests that most patients experienced less pain, fewer blood transfusions, and shorter hospital stays, however, definitive data has not yet been published. In this subset of three patients, we were able to access the lesion transorally and spared the group a more morbid open approach. When the robotic system was coupled with the image guided system, it provided a safe and controlled approach to the parapharyngeal space. The IGS has become more popular in head and neck surgery in recent years and has been mainly used for transnasal functional endoscopic sinus surgery. Only one report has thus far described the use of the image guided system for aiding in a transoral approach, and this was to access an inferior based benign cyst in the pterygopalatine fossa. However, no group has described the combined use of the image guided system and the daVinci Surgical Robot to access and remove oropharyngeal and parapharyngeal space lesions. The combination of these technologies allows the surgeon to intraoperatively mark the exact location of the oropharyngeal incision and localize the great vessels using the bony landmarks of the skull base for reference. There are however, limitations to using the IGS for this technique. Because the IGS provides guidance based on the bony landmarks, it is important to make sure that manipulation of the patient to gain access to the tumor with the robot does not change the soft tissue anatomy and the relationship of the tumor and the bony landmarks. Although this did not present a problem in this small case series, one could anticipate that the carotid artery may shift if the patient were aggressively repositioned. Although there is no substitute for an intimate knowledge of the anatomy, the transoral approach can be disorienting. The IGS provided a reliable method to assess the surgeon’s position throughout the procedure. It is important to note that the bony landmarks remain constant, and therefore can be reliably used to evaluate the surgeon’s position, in contrast to the soft tissue and great vessels which are generally manipulated through the course of surgery. Similarly, the position of the mandible will change as the preoperative scan is performed in a mouth-closed position while the surgery is performed in a mouth-open position. This highlights the importance of using the bony anatomy of the skull base rather than the mandible as a fixed landmark.

CONCLUSION

Our experience would suggest that the combination of the transoral robotic surgical approach with a real-time integrated navigation system is a safe and feasible technique to aid in the dissection of the deep pharyngeal and parapharyngeal spaces. Long-term prospective studies are currently underway at our institution using this technology.

BIBLIOGRAPHY