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Guillermo Maza and Arun Sharma

Robotic-assisted surgery embodies the latest in technological advancement and is being applied to operative management of patients. The current concept of robotic surgery involves performance of surgical procedures by using small wristed instruments attached to a robotic arm. Its extension to otolaryngology is only natural, because it allows for precise surgery through anatomic orifices, often allowing for preservation of critical anatomic structures and functions. Transoral robotic surgery is an effective and safe tool for head and neck surgeons. Its speed of recent growth and the imminent addition of innovative technology could signal the advent of a new era in surgery.

History and Acceptance of Transoral Robotic Surgery	943
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Erica R. Thaler

The development and acceptance of transoral robotic surgery from an experimental procedure to widespread acceptance in the management of head and neck cancers and other disease states occurred over the course of about a decade, from 2005 to 2015. Transoral robotic surgery has cemented its place in the treatment of pharyngeal and laryngeal cancer. Education and training was key to broad use and acceptance. This article traces the history and evolution of transoral robotic surgery to its current practice. The process of surgical innovation in this arena is followed from early cadaveric studies to recent large systemic reviews of outcomes.

Current Indications for Transoral Robotic Surgery in Oropharyngeal Cancer	949
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Harman S. Parhar, Christina M. Yver, and Robert M. Brody



Video content accompanies this article at <http://www.oto.theclinics.com>.

The incidence of oropharyngeal squamous cell carcinoma (OPSCC) is increasing dramatically and is conclusively linked to increasing rates of human papillomavirus (HPV) infection. HPV-related oropharyngeal cancers have been shown to occur in a unique demographic group and show favorable oncologic outcomes compared with HPV-negative OPSCC. There has been a paradigm shift in the treatment of early-stage OPSCC, with most patients now undergoing primary surgery in

the United States. Transoral robotic surgery is associated with excellent oncologic and functional outcomes in the treatment of OPSCC and is increasingly being used for a broader range of oropharyngeal indications.	
Role of Transoral Robotic Surgery in the Work-up of the Unknown Primary	965
John R. de Almeida	
Unknown primary squamous cell carcinoma metastatic to cervical lymph nodes is a relatively rare tumor presentation, although the incidence may be increasing along with the rising incidence of human papilloma virus-mediated oropharyngeal cancers. Traditional diagnostic methods with palatine tonsillectomy and panendoscopy may identify the minority of primary tumors. The addition of a transoral lingual tonsillectomy may improve the diagnostic yield of identifying a primary tumor. Incorporation of transoral robotic surgery may be used for diagnostic purposes to identify a primary site and also for therapeutic purposes, whereby a primary tumor may be completely resected and combined with a neck dissection.	
Transoral Robotic Surgery and De-escalation of Cancer Treatment	981
Benjamin Wahle and Jose Zevallos	
This article outlines the ways that transoral robotic surgery and transoral laser microsurgery relate to treatment de-escalation in the treatment of head and neck cancer. Treatment de-escalation has particular importance in context of human papillomavirus-related oropharynx squamous cell carcinoma, which responds well to therapy but leaves many survivors with decades of treatment-related sequelae. We compare these less invasive transoral approaches with previously used open approaches to the oropharynx. We discuss the topic of treatment de-escalation in human papillomavirus-related disease and outline completed and ongoing clinical trials investigating the choice of primary treatment modality and de-escalation of adjuvant therapy.	
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Transoral robotic surgery is a useful minimally invasive technique in the treatment of oropharyngeal squamous cell carcinoma, both human papilloma virus (HPV)-positive and HPV-negative patients in certain instances. This treatment modality often has proven useful for certain tumor persistences or recurrences. Good outcomes are possible given appropriate patient selection, both oncologically and functionally.	
Robotics in Pediatric Otolaryngology-Head and Neck Surgery and Advanced Surgical Planning	1005
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Robotic surgery has been shown to be feasible and successful in several areas of pediatric head and neck surgery. However, adoption has been limited. Robotic surgery may be better integrated into practice	

with advanced preoperative surgical planning and the design of new robotic platforms with instrumentation specific for the application. With continued investigations, computer-aided surgical planning techniques including three-dimensional printing, virtual reality, multiobjective cost function for optimization of approach, mirror image overlay, and flexible robotic instruments may demonstrate value and utility over current practice.

The Rise of Upper Airway Stimulation in the Era of Transoral Robotic Surgery for Obstructive Sleep Apnea

1017

Kevin J. Kovatch, Syed Ahmed Ali, and Paul T. Hoff

Introduced in 2010, transoral robotic surgery (TORS) is recognized as an effective treatment of moderate to severe obstructive sleep apnea (OSA) in the setting of lymphoid and muscular tongue base hypertrophy. Upper airway stimulation (UAS) or hypoglossal nerve stimulation has emerged as a promising treatment of patients with moderate to severe OSA who have failed continuous positive airway pressure. UAS has shown favorable success rates and low morbidity compared with traditional soft tissue and skeletal framework surgery. UAS is in its infancy as a surgical procedure and concerns exist regarding narrow candidacy criteria, postimplant device titration, and durability of treatment response.

Robotic Thyroidectomy: Past, Future, and Current Perspectives

1031

Emad Kandil, Abdallah S. Attia, Deena Hadedeya, Areej Shihabi, and Ahmad Elnahla

Through the past decades, there was a tremendous revolution in the surgical approaches for thyroidectomy. Remote access approaches (RAA) use the axillary approach, the axillary-bilateral breast approach, the bilateral axilla-breast approach, the retroauricular approach, and the transoral approach. The installation of the robotic system in surgery overcomes many limitations of the RAA. Although there are various types of robotic thyroidectomy by far, transaxillary is the commonly used approach. Moreover, the transoral approach is the most novel approach. In this article, the authors demonstrate the benefits and the constraints of each method and future directions of robotic thyroidectomy.

Robotic Neck Dissection

1041

Neal Rajan Godse, Toby Shen Zhu, and Umamaheswar Duvvuri

Management of head and neck squamous cell carcinoma necessitates a multimodal approach. The neck dissection has evolved over many years but is well established as the key surgical intervention for management of nodal disease in the neck. The open neck dissection has many varieties based on location and degree of disease but is the gold standard surgical technique. Robot-assisted neck dissections have emerged in recent years as an alternative. More research is required to establish long-term oncologic outcomes achieved with robot-assisted surgery and to assess whether cost and operative times decrease with experience.

Robotic Management of Salivary Glands **1051**

Jennifer E. Douglas, Christopher Z. Wen, and Christopher H. Rassekh

There are numerous salivary gland pathologies for which robotic surgery can provide benefit. This article reviews the primary indications for use of transoral robotic surgery for salivary gland neoplasms. It also discusses transoral and retroauricular robotic approaches for pathology of the sub-mandibular gland and prestyloid parapharyngeal space. These approaches have the advantage of avoiding a visible scar and are additionally minimally invasive in other ways as well. Robotic surgery offers advantages in several different modules of salivary gland surgery, similar to those it offers for oropharyngeal cancer, including improved optics, manual dexterity, and teamwork.

Robotic Ear Surgery **1065**

Katherine E. Riojas and Robert F. Labadie

Robots under research and development for otology can be classified as collaborative (intervention is constrained by the robot but surgeon directly actuates the end-effector), teleoperated (surgeon remotely controls a tool with modification [eg, tremor reduction] by the robot), or autonomous (surgeon monitors the robot performing a task). Current clinical trials focus on more accurate stapes surgery, minimally invasive access to the cochlea, and less traumatic insertion of cochlear implant electrode arrays. Autonomous approaches to major aspects of surgical interventions (eg, mastoidectomy) will likely be late entries to clinical use, given higher cost of regulatory approval and disruption of existing workflow.

Robotic Skull Base Surgery **1077**

Mitchell Heuermann, Alex P. Michael, and Dana L. Crosby

Robotic surgery has become more common in otolaryngologic surgery since the introduction of the da Vinci robotic system, but has played a limited role in anterior and central skull base surgery, largely because of technical limitations of existing robots. Current robotic technology has been used in creative ways to access the skull base, but was not designed to navigate these complex anatomic constraints. Novel robots should target many of the limitations of current robotic technology, such as maneuverability, inability to suture, lack of haptic feedback, and absent integration with image guidance.

Transoral Robotic Surgery for Residual and Recurrent Oropharyngeal Cancers **1091**

Vinidh Paleri, John Hardman, Grainne Brady, Ajith George, and Cyrus Kerawala

Transoral robotic surgery (TORS) is a well-established treatment option for treatment-naïve oropharyngeal cancer. For residual, recurrent, and new primary oropharyngeal tumors emerging in previously irradiated fields, the global experience of management with TORS is limited. This article discusses current concepts on this topic, offers a deeper insight into the transoral anatomy for these cases, and covers the specific complexities of resections in the various subsites of the oropharynx. It provides practical tips on reconstruction, recovery, and rehabilitation as well as offering a synthesis of the current evidence and exploring future trends.

Complications of Transoral Robotic Surgery**1109**

Rosh K.V. Sethi, Michelle M. Chen, and Kelly M. Malloy

This article summarizes major and minor complications following transoral robotic surgery in the head and neck. Overall, transoral robotic surgery is extremely safe; however, surgeons must recognize inherent risks associated with major and severe bleeding, dysphagia, and minor complications, including injury to nerves, mucosal surfaces, teeth, and the eyes. This article briefly discusses prevention and management strategies for common complications.

Quality of Life Implications After Transoral Robotic Surgery for Oropharyngeal Cancers**1117**

Christopher M.K.L. Yao and Katherine A. Hutcheson

Oropharyngeal cancers and their treatment can exquisitely affect a patient's quality of life and functional outcome. Transoral robotic surgery offers a minimally invasive surgical approach that mitigates injury from traditional open surgical approaches and offers a treatment more likely to have short-term side effects compared with nonsurgical treatment. Feeding tube dependence, oral intake, and swallowing questionnaires, in addition to swallowing evaluations provide a snapshot of a patient's current swallowing function. Investigation of patient-reported quality-of-life outcomes allows for understanding of their symptomatology and the comparison of different treatment strategies.

Cost Considerations for Robotic Surgery**1131**

James Kenneth Byrd and Rebecca Paquin

Transoral robotic surgery (TORS) is a rapidly growing diagnostic and therapeutic modality in otolaryngology–head and neck surgery, having already made a large impact in the short time since its inception. Cost-effectiveness analysis is complex, and a thorough cost-effectiveness inquiry should analyze not only financial consequences but also impact on the health state of the patient. The cost-effectiveness of TORS is still under scrutiny, but the early data suggest that TORS is a cost-effective method compared with other available options when used in appropriately selected patients.

Special Article Series: Otolaryngology in COVID-19

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Coronavirus Disease-19 and Rhinology/Facial Plastics	1139
Morgan E. Davis and Carol H. Yan	

This review summarizes the challenges and adaptations that have taken place in rhinology and facial plastics in response to the ongoing coronavirus disease-19 pandemic. In particular, the prolonged exposure and manipulation of the nasal and oral cavities portend a high risk of viral transmission. We discuss evidence-based recommendations to mitigate the risk of viral transmission through novel techniques and device implementation as well as increasing conservative management of certain pathologies.

Coronavirus Disease-19 and Otology/Neurotology	1153
Esther X. Vivas	

The severe acute respiratory syndrome corona virus 2, responsible for the worldwide COVID-19 pandemic, has caused unprecedented changes to society as we know it. The effects have been particularly palpable in the practice of medicine. The field of otolaryngology has not been spared. We have had to significantly alter the way we provide care to patients, changes that are likely to become a new norm for the foreseeable future. This article highlights some of the changes as they apply to otology/neurotology. Although this is written from the perspective of an academic physician, it is also applicable to private practice colleagues.

Coronavirus Disease-19: Challenges Associated with the Treatment of Head and Neck Oncology and Laryngology Patients in the Coronavirus Disease-19 Era	1159
Brandon J. Baird and C. Kwang Sung	

This review explores the changes to practice associated with COVID-19 for providers treating patients with head and neck cancer and laryngeal pathology. The aim of the review is to highlight some of the challenges and considerations associated with treating this patient population during the pandemic. Additionally, it seeks to discuss some of the areas of concern related to ramping up clinical volume.

Pediatric Otolaryngology in the COVID-19 Era	1171
Steven E. Sobol, Diego Preciado, and Scott M. Rickert	

Although the majority of attention to the health care impact of COVID-19 has focused on adult first responders and critical care providers, the pandemic has had a profound effect on the entire health care industry,

including the pediatric otolaryngology community. This article highlights the unique ramifications of COVID-19 on pediatric otolaryngology, with a focus on the immediate and potential long-term shifts in practice. Specifically, the article is divided into 3 sections (care for the patient, care for the practitioner, and care for the practice) and details the unique effects of the pandemic on the pediatric otolaryngology specialty.