Robotic Management of Salivary Glands

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KEYWORDS

• Transoral robotic surgery • Robotic surgery • Salivary gland disease • Sialadenitis • Salivary gland tumors • Parapharyngeal space • Minor salivary glands • Sialolithiasis

KEY POINTS

- Robotic surgery for salivary gland diseases can be performed transorally or transcervically.
- Transoral robotic surgery is primarily indicated for neoplasms of the oropharynx, including minor salivary gland tumors of the pharynx, base of tongue, and palate.
- Transoral robotic surgery can be combined with other approaches for resection of nasopharyngeal salivary gland malignancies.
- Transoral robotic surgery is helpful for inflammatory diseases of the submandibular gland and sublingual gland such as sialoliths and ranula.
- Transoral robotic surgery and retroauricular robotic surgery are alternatives to conventional transcervical approaches for removal of the submandibular gland.

INTRODUCTION

There are several ways to use robotics in the management of salivary gland disease. These include transoral robotic surgical resection of benign and malignant minor salivary gland tumors in the oropharynx, which are performed with classic operations such as radical tonsillectomy and base of tongue resections. Transoral approach and excision of parapharyngeal space minor salivary gland tumors have been employed successfully also. Transoral robotic surgery (TORS)-assisted submandibular gland excision and TORS-assisted combined approaches for submandibular stones are presented. Finally, unusual applications such as nasopharyngectomy, soft palate resection and reconstruction, sublingual gland excision, and resection of congenital anomalies such as salivary duct remnants in the oropharynx represent innovations that are also of interest (**Table 1**). Although the use of the robot for some of these indications is technically off label, this is explained to patients who agree to its use.

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Table 1
Robotic salivary gland surgery overview

		Indication				
		Pharyngeal Minor Salivary Gland Neoplasms	**Parapharyngeal Space (PPS) Neoplasms**	**Submandibular Gland (SMG) Pathology**	**Other TORS**	**Retroauricular Robotic Surgery**
Frequency of use at our institution	Most common	TORS posterior hemiglossectomy	TORS PPS space resection	TORS-Sialo		
	More common	TORS radical tonsillectomy		TORS SMG excision		
	Less common	TORS palatectomy with local flap reconstruction			Sublingual gland excision	
	Rare	TORS-assisted Nasopharyngectomy	TORS PPS resection combined with open approach		Congenital salivary fistula	
	Not performed					SMG excision

DISCUSSION

Transoral Robotic Surgical Resection of the Base of Tongue (Posterior Hemiglossectomy)

Background

Transoral robotic surgery was initially developed for the surgical management of squamous cell carcinoma (SCC) of the base of tongue (BOT) and tonsil.[1,2] Based on its significant success with this pathology and subsites, the technology was quickly extended to additional pathology and subsites, as will be discussed here. Early on, it was most easily extended to additional BOT neoplasms (**Fig. 1**). To study the efficacy of TORS for non-SCC pathology at the base of tongue, Schoppy and colleagues reviewed 20 patients managed with endoscopic approaches, either TORS or transoral laser microsurgery (TLM). Eighty percent of cases were minor salivary gland tumors, the most common of which was adenoid cystic carcinoma.[3] Notably, 75% of cases were BOT neoplasms, 10 of which underwent TORS followed by adjuvant radiation therapy. Only 1 of 20 patients had recurrence and underwent salvage TORS with good outcome. One patient underwent elective bilateral neck dissection because of pathology showing myoepithelial carcinoma.

Procedure

Exposure of the BOT is achieved using the Feyh-Kastenbauer retractor. A 5 mm spatula-tip cautery is used, with the goal of achieving grossly negative margins. Intraoperative frozen sections are performed to confirm adequacy of resection.[3] Based on patient factors (eg, body mass index [BMI] and medical comorbidities) and extent of resection, tracheostomy and feeding tube placement can be considered

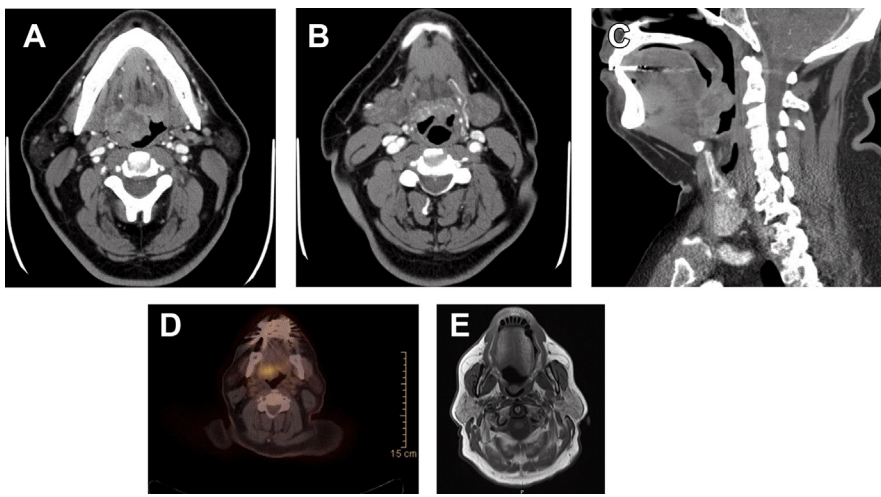

Fig. 1. Imaging of a minor salivary gland carcinoma of the base of tongue. (*A*) Axial computed tomography (CT) scan with contrast demonstrating right BOT mass. (*B*) Axial CT scan also shows multiple pathologic ipsilateral nodes. (*C*) Sagittal CT showing that tumor has both exophytic and submucosal components. (*D*) Positron emission tomography (PET) scan showing avidity (biopsy showed high-grade mucoepidermoid carcinoma). The patient underwent TORS, neck dissection, and postoperative radiation. (*E*) MRI 8 years after TORS showing no recurrence at the primary site but a new contralateral deep lobe parotid tumor that was not felt to be amenable to TORS. It was resected with a parotidectomy approach and was found to be a low-grade hyalinizing clear cell carcinoma.

intraoperatively at the discretion of the treating surgeon. In contrast to the primary indication for TORS posterior hemiglossectomy, chemoradiation is much less effective, so that surgery is almost always preferred for salivary pathology.

Advantages

Benefits of the TORS approach for minor salivary gland neoplasms of the BOT are those that have been described in the literature as general advantages of robotic surgery. These include enhanced magnification, 3-dimensional optics affording greatly improved visualization, improved manual dexterity, and the ability to better utilize a bedside assistant allowing for 4-handed surgery in tandem with the surgeon at the console. The assistant provides feedback to the console surgeon and helps with retraction, suction, and clipping of vessels. These all enhance the adequacy of resection and reduce the risk of hemorrhage. By avoiding large open approaches for access such as mandibulotomy, lingual-mandibular release, and suprahyoid pharyngotomy, tracheotomy can usually be avoided. Additionally, there can be a decreased rate of need for prolonged enteral access, and better short- and long-term swallowing outcomes can be achieved.

Disadvantages

As with TORS for SCC, the risk of post-TORS hemorrhage in the management of minor salivary gland neoplasms of the BOT remains the most significant risk. This is estimated at approximately 10% based on a variety of studies.[4] This risk can be minimized by performing neck dissection before the resection with ligation of the facial, lingual, and superior laryngeal arteries.[5] In some cases, a large resection of the tongue base is required, which necessitates a free flap reconstruction.

Transoral Robotic Surgery for Other Oropharyngeal Cancers, Palate Cancers and Reconstruction

Background

Although the BOT is the predominant oropharyngeal site for minor salivary gland malignancies, tumors of the tonsil and glossotonsillar sulcus also occur. These tumors may require a radical tonsillectomy in addition to a TORS BOT resection.[3] The most common site for minor salivary glands is the hard palate, but many of these tumors may involve the soft palate and other oropharyngeal and nasopharyngeal sites also. The soft palate represents an anatomically difficult location to access, making it ripe for the application of TORS to enable visualization.

Procedure

Basic patient positioning is as described previously with exposure typically achieved with a modified Crow Davis mouth gag A 70° endoscope with a 45° angled monopolar cautery is set-up on the robot. Bipolar cautery is additionally available, which provides optimized hemostasis in the right circumstances.

Advantages

The advantages of TORS for BOT resection are applicable to radical tonsillectomy and palate resection also. In addition, robotically assisted elevation of the buccinators myomucosal flap and buccal fat pad flap enhances visualization and 4-handed surgery for the reconstruction. These procedures can be hybrid (partially nonrobotic) in nature.

Disadvantages

Although there is a theoretic risk of velopalatal insufficiency with soft palate resection, there is no clear evidence showing an increased risk with TORS-assisted soft palate

resection. One can argue that this surgery can be done without robot; however, this has been argued for many of the indications, and the authors believe that TORS adds value for all of these resections, as it does for the BOT.

Transoral Robotic Surgery Approach to the Parapharyngeal Space for Salivary Gland Tumors

Background

The parapharyngeal space is divided anatomically into the pre- and poststyloid parapharyngeal space (PPS) based on the relative location to the styloid process. Salivary gland tumors arise in the prestyloid parapharyngeal space, which contains the deep lobe of the parotid gland and minor salivary glands. Most (70%–80%) of parapharyngeal space masses are benign, most commonly pleomorphic adenoma (**Figs. 2** and **3**).[6,7] Because of this, it is important to perform preoperative work-up with fine needle aspiration, as transoral resection is relatively contraindicated in malignancy. In addition, tumors that minimally involve the deep lobe of parotid gland may be resectable transorally, but those that approach or traverse the stylomandibular tunnel require an alternate approach externally.

A retrospective review and systematic review both previously confirmed the safety and feasibility of TORS for PPS tumors. TORS is primarily indicated for benign tumors of the PPS as previously mentioned, but if malignancy is identified at the time of final pathology, radiation or additional surgery is not precluded.[8,9] O'Malley and colleagues performed a prospective study of well-defined PPS tumors. Ten patients were enrolled, with TORS completed in 9 of 10 patients.[10] There were no significant complications, and in patients with pleomorphic adenomas, local control was 100%.

Procedure

Technical details are reviewed elsewhere, with an approach similar to that of a radical tonsillectomy, with division of the medial pterygoid and blunt dissection.[11]

Fig. 2. T2-weighted axial MRI of a prestyloid parapharyngeal space pleomorphic adenoma that underwent TORS with good results.

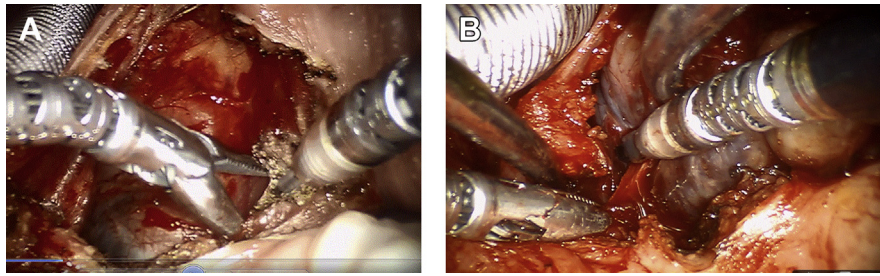

Fig. 3. TORS approach to the parapharyngeal space for a benign tumor. (*A*) Approach and exposure of prestyloid PPS tumor with division of medial pterygoid muscle to improve access. (*B*) 4-handed dissection of prestyloid PPS tumor.

Advantages

Advantages of the TORS approach for PPS tumors include enhanced visualization, avoidance of an external scar, reduced operative time, and the possibility of 4-handed surgery, all while offering comparable return to oral intake times.[10,12] A major advantage of this approach is avoidance of major external approaches such as described for oropharyngeal cancer and parotidectomy or other approaches that require dissection or retraction of the facial nerve. In addition, the risk of first-bite syndrome has been found to be virtually nonexistent, whereas it is a rather frequent occurrence in external approaches.[13]

Disadvantages

The use of the robot increases the cost and technical skill required for the procedure. There is also concern for the risk of tumor spillage, particularly with pathology such as pleomorphic adenoma. However, the open approach literature suggests that tumor rupture can occur even with open approaches and that even with tumor capsule rupture, the risk of recurrence is low.[11] With transoral approaches, there is risk of pharyngeal dehiscence, although this can be avoided by meticulous closure with horizontal mattress sutures.

Transoral Robotic Surgery-Assisted Resection of Nasopharyngeal Salivary Gland Tumors

Traditional approaches to the nasopharynx and infratemporal fossa overlap with those used for the parapharyngeal space.[14,15] TORS has been employed for nasopharyngeal malignancy combined with endoscopic endonasal or transpalatal approaches.[14,16] The robot provides an additional level of visualization and dexterity as it does for many TORS applications.[16,17]

Transoral Robotic Surgery Approach to the Parapharyngeal Space for Submandibular Gland Excision

Background

Transoral excision of the SMG via the PPS was first demonstrated in 2005 by Terris and colleagues[18] and has been reviewed in various publications since, but has never been widely adopted because of the technical difficulty of a predominantly anterior transoral approach.[19] Kauffman and colleagues[20] performed a retrospective review of 9 patients over 10 years, showing its application for the management of chronic sialadenitis (n = 6) and benign cystic lesions (n = 3). There are isolated case reports of TORS SMG excision,[19,21,22] and in their institution, the authors have been working

on refining the technical details of a TORS parapharyngeal space approach to make transoral SMG excision safer.

Procedure

The procedure is the most challenging of all TORS procedures in the authors' experience. However, their technical refinements have resulted in successful removal of benign neoplasms and selected glands with chronic sialadenitis. The technique involves a combination of the Crow Davis mouth gag and Jennings mouth gag with tongue retractor and cheek retractor using dual side arms (Fig. 4). The dissection is done inside out, so steps that are generally carried out late in the transcervical SMG excision are done earlier. For example, identification and mobilization of the lingual nerve is done immediately after making an incision that is much like that used for PPS tumors but extending further onto the floor of the mouth. The mylohyoid muscle and digastric muscle are identified, and it is critical to ligate the facial vessels. The duct may be used as a handle. The operation is often a hybrid procedure with some of the dissection done under direct vision with loupe magnification. A third assistant may provide upward pressure on the gland to deliver it into the oral cavity. Care is taken to avoid damage to the tumor capsule, as the operation is most commonly performed for pleomorphic adenoma.

Advantages

Transoral removal of the SMG avoids the visible scar inherent with the transcervical approach and also minimizes risk to the marginal mandibular nerve. If required, the transcervical approach can always be employed should transoral resection fail.

Disadvantages

A TORS transoral approach requires a more challenging and complex dissection that leads to longer operative times and increased risk of tumor rupture, vascular complications like critical hemorrhage, and lingual nerve injury. It also requires the patient to

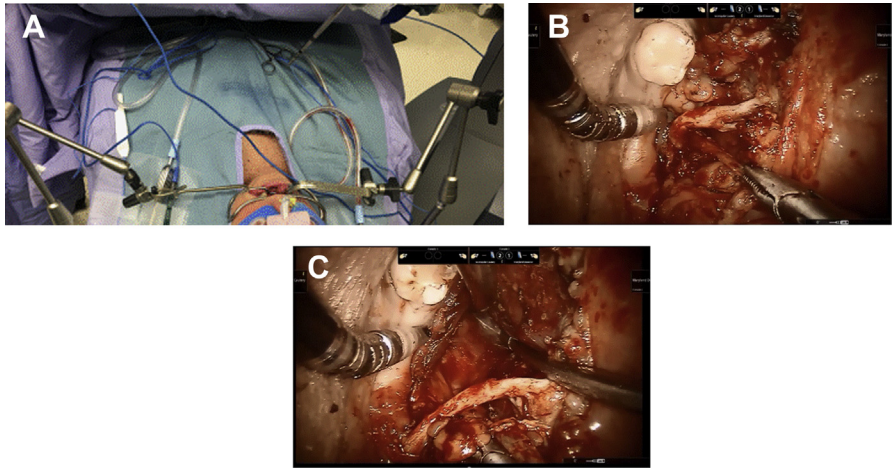

Fig. 4. TORS approach for submandibular gland excision. (*A*) Set-up for TORS SMG excision with Jennings mouth gag and dual side arms; the gland excision is often started with the Crow Davis mouth gag to get the parapharyngeal space exposure first. The same set-up as is shown is used for TORS-Sialendoscopy (*B*) TORS SMG excision-using duct as handle and showing lingual nerve. (*C*) Exposure of very large SMG pleomorphic adenoma with blunt dissection from mylohyoid after division of SMG ganglion.

be on a modified diet. Because of these significant disadvantages, it is generally suitable for patients with keloid potential or those who want to avoid a visible scar. Additionally, because of the operative difficulty, this operation should only be done by centers with extraordinarily high volume of TORS experience with standard modules and ideally in centers that have successfully incorporated TORS PPS resection into their practice. It should also be avoided when gland excision is caused by sialolithiasis, as such cases usually have severe chronic inflammation that makes the procedure dangerous.

Transoral Robotic Surgery Resection of Sublingual Gland for Ranula

Background

Ranulas are salivary gland-associated pseudocysts, typically arising from the sublingual gland (SLG), which are either congenital or acquired in the setting of intraoral trauma.[23] Simple ranulas may require minimal intervention, whereas plunging ranulas involving the musculature of the floor of the mouth may need a more comprehensive resection. At a minimum, removal of the associated salivary gland is necessary for adequate resection. For SLG-associated ranulas, management is typically with standard transoral excision. However, the authors have employed TORS combined with sialendoscopy, which allows improved visualization of the lingual nerve and can be used for cases where the submandibular duct is also abnormal.[24] This minimizes risk of injury to the surrounding neurovasculature and maximizes resection to limit risk of recurrence.[19,24,25] The 2 case reports in the literature detail the approach.[24,25]

Procedure

The procedure is done with the same incision as without the robot, but the magnification improves visualization of the lingual nerve and the extent of the SLG. The authors use a Jennings mouth gag for this operation. Sialendoscopy of the submandibular duct can be used to visualize the sublingual and submandibular ducts and facilitate leaving a stent to aid in localization and limit risk of duct injury. The zero-degree robotic endoscope, monopolar cautery, and Maryland dissector are used for the dissection. An incision is made over the mass, and blunt dissection through the floor of mouth is performed, ensuring safe dissection of the lingual nerve. After identifying sublingual gland, ranula, and the portion of the ranula that extends beyond the sublingual space, the ranula and associated sublingual gland are excised. Postexcision sialendoscopy can be performed to ensure the submandibular duct is intact and entry of the sublingual duct is adequately ligated. The wound is closed with simple interrupted 3-0 Vicryl sutures.

Advantages

Advantages for the technique for SLG resection in cases of ranula are similar to that of TORS used in the oropharynx as previously discussed.

Disadvantage

The primary disadvantage is the complexity of set-up and cost. As such, this technique should be used in very select cases.

Transoral Robotic Surgery Combined Sialendoscopic Approaches to the Submandibular Hilum for Sialoliths

Background

Combining sialoendoscopic approaches with open approaches has shown great success in sialolith removal without the need for gland excision.[26] The combined transoral approach for SMG sialoliths avoids the external scar of traditional sialoadenectomy,

but 2% of cases still have postoperative lingual nerve damage.[27] This risk is higher with larger stones, which occur primarily at the hilum, where Wharton's duct is in close proximity to the lingual nerve.[28] The use of a TORS combined sialendoscopic approach to better protect the lingual nerve has been reported to reduce the risk of permanent lingual nerve injury and have a high gland preservation rate.[29,30]

Procedure

The patient is anesthetized and intubated with a nasotracheal tube, and the sialolith is localized with either palpation (large stones) or sialendoscopy and transillumination (nonpalpable or multiple stones). A Jennings mouth gag is used, and a tongue retractor/cheek retractor combination is used to remove the tongue from the surgical field and stabilize the head. The robot is docked, and low-setting monopolar cautery is used to make a mucosal incision over the stone. Blunt dissection is performed until the lingual nerve is identified, retracted, and protected. Wharton duct can then be found in a triangle between the lingual nerve, mylohyoid, and sublingual gland. Depending on the location of the sialolith, excision of part of or all of the sublingual gland may be necessary to visualize the relationship between the duct and nerve. After confirming the location of the sialolith, an incision is made in the duct, and the sialolith can be delivered (**Fig. 5**).[23] Sialendoscopy is performed after TORS to irrigate the duct, visualize patency, and ensure absence of retained sialoliths. The floor of mouth is then closed with 3-0 or 4-0 Vicryl sutures.

Advantages

The TORS combined sialendoscopic approach allows for safer dissection of the lingual nerve in a multitude of ways. The stereoscopic 3-dimensional magnified view and 6-handed surgical approach allow for finer motions, smaller incisions, and decreased tissue manipulation.[29,30] Decreasing crowding around the already small working space of the posterior floor of the mouth improves ease of access to the surgeon and assistants.[29] Finally, the flexibility this approach offers allows the surgeon to utilize a combination of the direct approach, endoscopic approach, and robotic approach for complex sialolithotomies. In this way, the benefits of TORS assistance allow for easy cases to be performed more quickly and difficult cases to be performed more safely.

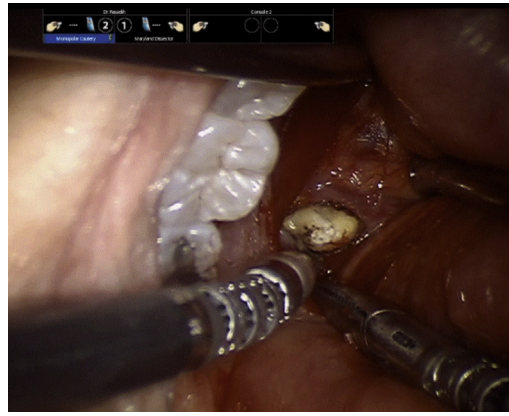

Fig. 5. TORS-sialo for left hilar SMG sialolith with stone shown in the opened duct in the triangle with sublingual gland anteriorly, mylohyoid laterally, and lingual nerve medially.

Disadvantages

Similar to other robotic procedures, a TORS-assisted sialendoscopic approach has increased cost but may not have increased operation duration.[31] Razavi and colleagues[30] reported a decreased operating time (67 vs 90 minutes) when compared with a nonrobotic combined approach, and operative times decreased with increased case experience. Furthermore, difficult cases are longer whether the robot is used or not.

Transoral Robotic Surgery Resection of Congenital Cervical Salivary Duct Fistulas

Congenital cervical salivary duct fistulas (CCSDF) are a rare cause of drainage from the anterolateral neck due primarily to heterotopic salivary gland tissue.[32] Because of the risk of malignancy, definitive treatment is complete excision of the fistula and surrounding salivary tissue.[33] Although uncomplicated cases are unlikely to benefit from robotic assistance, cases that present with tonsillar or posterior oropharyngeal involvement may.[32,34] The authors previously published the report of a patient who presented with asymptomatic bilateral CCSDFs with a tract extending to the posterior oropharynx. TORS direct pharyngolaryngoscopy was able to visualize the tract and demonstrate that the internal opening was not patent to the external opening. The external approach could not access the entire tract, as it narrowed significantly at the level of the digastric muscle. The final centimeters of dissection were completed with TORS and the entire tract delivered transorally. Given the narrow parapharyngeal space, a tonsillectomy would have been otherwise required had TORS not been used.[34] Those rare cases where the SMG is the origin of CCSDF drainage may also benefit from TORS assistance.[30,31,35]

RETROAURICULAR ROBOTIC SMG EXCISION

Retroauricular Approach

Background

The robot-assisted retroauricular approach to SMG excision was developed to avoid the cervical scars that result from a transcervical approach endoscopic-assisted retroauricular approach.[36] Although primarily developed in South Korea,[37,38] this approach has also been reported in India.[39] Robot-assisted approaches have similar safety and efficacy as endoscopic and transcervical approaches in small prospective studies.[40]

Procedure

The procedure begins with either a modified facelift incision or a retroauricular incision that extends posteriorly along the hairline.[41] The subplatysmal flap is raised anteriorly toward the midline about 10 cm, with care to identify and protect the great auricular nerve and external jugular vein.[31,41] A self-retaining retractor maintains the flap to create a working space.[41] The sternocleidomastoid muscle is retracted to reveal the SMG, and dissection begins at the lower border near the posterior belly of the digastric muscle.[31,39,41] Dissection proceeds in a subcapsular fashion with either Harmonic shears or monopolar cautery.[41] The facial artery is identified and ligated with clips or the Harmonic shears.[41] After retracting the mylohyoid and with traction on the SMG, the lingual nerve can be separated from the SMG ganglion, and Wharton duct can be divided.[31,40,41] The SMG can be released from the digastric and mylohyoid muscles and excised after ensuring the integrity of the hypoglossal nerve.[39,41]

Advantages

The primary advantage of this approach is the improved cosmesis.[37–40,42,43] In addition, the wider, 3-dimensional surgical field and improved instrument articulation allow

for finer surgical control and easy access to the superior and medial aspects of the SMG just inferior to the mandible, which are otherwise difficult to access with straight endoscopes.[37,42,43]

Disadvantages

As previously noted, similar concerns exist about cost and increased operative time, although this decreases with increased surgeon experience.[40,44] One study did note a greater incidence of transient marginal mandibular nerve paresis in the robot-assisted approach, which could be due in part to the large skin flap of the retroauricular approach.[40]

Transhairline Approach

A separate South Korean group advocates for a transhairline approach as an alternative to the retroauricular approach.[45] The procedural steps are similar, apart from a smaller (sub 5vcm) incision with the transhairline incision that can be hidden at the hairline.[45,46] This maximizes postoperative cosmesis and provides a favorable option for some patients. Without the postauricular limb, the resulting skin flap is much smaller, further limiting the working space but decreasing the risk of flap necrosis or injury to the auricular branches of sensory nerves.[46] If the working space is ultimately too limited, such as for patients with adhesion caused by chronic inflammation, the transhairline approach can easily be converted to the retroauricular approach.[46]

SUMMARY

TORS-assisted combined approaches allow for advanced approaches to multiple sites within the head and neck for management of inflammatory and neoplastic salivary gland disease. In addition to enhanced visualization and ease of dissection, robotic approaches enable improved surgeon posture, which likely decreases the likelihood of a work-related musculoskeletal disorder and may contribute to a longer active surgical career.[31] The authors put forth that the robot be considered as a helpful adjunct to the management of salivary gland disease in high-volume centers with experienced head and neck surgeons.

CLINICS CARE POINTS

TORS has proven benefits for oropharyngeal cancer. The lessons learned from management of oropharyngeal cancer can be applied to salivary gland diseases of the nasopharynx, parapharyngeal space, and the floor of mouth.

TORS allows for minimally invasive surgery to be performed safely. Alternate approaches such as retroauricular approach for submandibular gland excision can be done robotically also. Although some may say that robotic surgery is not needed, for salivary gland indications, the have chosen to be innovators and early adopters akin to the paradigm shift following the application of TORS for oropharyngeal carcinoma[1,47]

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DISCLOSURE

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