The combined endonasal and transoral approach for the management of skull base and nasopharyngeal pathology: a case series

SATYAN B. SREENATH, B.S.,1 ROUNAK B. RAWAL, M.D.,1 AND ADAM M. ZANATION, M.D.1,2
1Department of Otolaryngology—Head and Neck Surgery, and 2Department of Neurosurgery, University of North Carolina at Chapel Hill, North Carolina

The posterior skull base and the nasopharynx have historically represented technically difficult regions to approach surgically given their central anatomical locations. Through continued improvements in endoscopic instrumentation and technology, the expanded endonasal approach (EEA) has introduced a new array of surgical options in the management of pathology involving these anatomically complex areas. Similarly, the transoral robotic surgical (TORS) approach was introduced as a minimally invasive surgical option to approach tongue base, nasopharyngeal, parapharyngeal, and laryngeal lesions. Although both the EEA and the TORS approach have been extensively described as viable surgical options in managing nasopharyngeal and centrally located head and neck pathology, both endonasal and transoral techniques have inherent limitations. Given these limitations, several institutions have published feasibility studies with the combined EEA and TORS approaches for a variety of skull base and nasopharyngeal pathologies. In this article, the authors present their clinical experience with the combined endonasal and transoral approach through a case series presentation, and discuss advantages and limitations of this approach for surgical management of the middle and posterior skull base and nasopharynx. In addition, a presentation is included of a unique, simultaneous endonasal and transoral dissection of the nasopharynx through an innovative intraoperative setup.

(https://thejns.org/doi/abs/10.3171/2014.7.FOCUS14353)

Key Words • combined endoscopic transoral approach • robotic • endonasal • skull base • nasopharynx

Abbreviations used in this paper: CVJ = costovertebral junction; EEA = expanded endonasal approach; ICA = internal carotid artery; TORS = transoral robotic surgery.

The posterior skull base and the nasopharynx have historically represented technically difficult regions to approach surgically given their central anatomical locations. Traditional approaches to this region include creation of an anterior transfacial corridor (Le Fort I osteotomy, maxillary swing, and midface degloving), lateral transcranial corridor (pre- and postauricular infratemporal fossa and subtemporal approaches), and inferior oral or cervical corridor (transcervical–transmandibular or transpalatal approaches).2,6,15,18,21,30,37 Although these approaches were previously frequently used, they were also associated with high clinical morbidity and less than ideal cosmetic outcomes, which has greatly decreased their use since the advent of the endoscopic, minimally invasive era.5,18,23,27,32,35,36

Through continued improvements in the Hopkins rod-lens endoscope (Karl Storz) and endoscopic instrumentation, the expanded endonasal approach (EEA) introduced a new array of surgical options in the management of pathology involving this anatomically complex area. Neoplastic lesions of this area have been successfully resected with favorable outcomes and adherence to oncological principles.1,7,8,32 However, the pure endonasal route can be inadequate for surgical management of pathology extending beyond the anatomical boundaries, such as for extension below the level of the soft palate in the oropharynx (Table 1). Given these limitations, several institutions initially published studies on their clinical and laboratory experience of combining both the EEA and nonrobotic transoral approach for a variety of pathological processes.10,12,14,16,17

In our initial experience with this combined technique, we successfully repaired oronasal fistulas and surgically managed chronic granulomatous disease, both of which required surgical access through the endonasal and transoral corridors. By combining these windows, a larger operating corridor may be established to obtain surgical margins during resection of neoplastic lesions, while minimizing displacement or dissection of normal tissue in the approach to the area of interest. Although
this original, combined technique offered many advantages to utilizing either surgical corridor separately, limitations included significant reduction in simultaneous maneuverability given difficult intraoperative positioning with reduced surgical manipulation and limited vision through the transoral route. These limitations were addressed with the introduction of the transoral robotic surgery (TORS) approach.

Transoral robotic surgery using the da Vinci surgical system (Intuitive Surgical, Inc.) has been extensively described in the literature for the management of middle cranial fossa skull base tumors, along with tongue base, nasopharyngeal, parapharyngeal, and laryngeal lesions. Advantages of TORS include superior 3D visualization, increased instrument access, precise and tremor-free 3-handed surgery, and elimination of external incisions, while limitations include the lack of bone-drilling equipment, relatively bulky instrumentation, and a steep initial learning curve. TORS has been shown to be highly effective in obtaining a direct, illuminated surgical window into the nasopharynx, allowing for surgical management of nasopharyngeal carcinomas and performance of complete nasopharyngectomy. However, without the capacity for bone resection via drilling instrumentation, the pure TORS approach is limited to dissection of soft tissue and may be inadequate to manage involvement of the skull base at the basiocciput region superiorly or medial pterygoid laterally (Table 1). Thus, the next logical step was to combine the EEA and the TORS approach for the greatest possible surgical window with the greatest degree of surgical manipulation (Fig. 1).

In this case series, we present our clinical experience with the combined endonasal and transoral approach and discuss its advantages, limitations, and possible future prospects. We also include presentation of a unique, simultaneous endonasal and transoral dissection of the nasopharynx through an innovative intraoperative setup of the endoscopic endonasal and robotic surgical equipment.

**Methods**

After Institutional Review Board approval, a retrospective, consecutive review was performed to identify patients who underwent the combined endoscopic endonasal and transoral robotic approaches for surgical management of disease, which yielded 3 patients. All 3 patients exhibited distinct nasopharyngeal and skull base pathology. Data were collected regarding patient history, surgical indications, operative technique, and postoperative outcomes. All surgical procedures were performed by the senior author (A.M.Z.).

**Case Reports**

**Case 1**

**History and Presentation.** A 35-year-old woman with a history of papillary thyroid carcinoma status post, fol-

---

**TABLE 1: Advantages and limitations of the EEA and TORS approaches to the nasopharynx and skull base**

<table>
<thead>
<tr>
<th>Approach</th>
<th>Advantages</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEA</td>
<td>improved cosmetic outcomes, direct visualization &amp; minimal tissue displacement, angled endoscopic cameras &amp; instrumentation</td>
<td>limited access below the soft palate, 2D endoscopic view, limited lateral mobility &amp; access</td>
</tr>
<tr>
<td>TORS</td>
<td>3D imaging, increased articulation with 3–4 robotic arms, ability to suture within the operative field</td>
<td>lack of bone-drilling equipment, bulky robotic instrumentation, steep learning curve</td>
</tr>
</tbody>
</table>

---

**Fig. 1.** Illustration of the anatomical corridor and boundaries in the EEA (blue triangle) and the TORS approach (yellow triangle) to the nasopharynx.
Combined endonasal and transoral approach

Following total thyroidectomy with left neck dissection, presented with a metastatic 1.5 cm × 2.5-cm retropharyngeal space lesion on routine surveillance MRI with contrast administration. It was also noted on MRI that the internal carotid artery (ICA) was inferior and lateral to the mass, demonstrating the superomedial location of the mass in the parapharyngeal space, abutting the nasopharyngeal region (Fig. 2). Given the extent and location of the tumor, it was determined that the mass would be resected via the combined endonasal and transoral approach, as exposure of the superolateral portion of the mass would not be feasible through a purely transoral route.

**Intraoperative Technique.** Intraoperatively, the CT-MRI guidance system was used for constant stereotactic localization of the parapharyngeal lesion. Once the nasal cavity was decongested with Afrin pledgets and the oral cavity was opened with the use of the McIvor mouth gag, a radical tonsillectomy was performed with exposure of the peritonsillar region. With the use of electrocautery and blunt dissection through the transoral route, a lateral pharyngectomy was performed with dissection of the pharyngeal constrictor muscles for adequate exposure. Through the endonasal route, the superolateral extensions of the lesion were exposed through superior incisions in the lateral nasopharyngeal region, abutting the parapharyngeal recess.

Once exposure was adequately achieved, the da Vinci surgical system was used in the transoral route for the resection portion of the procedure. With the robot positioned at the head of the bed, the articulating arms were fixed with a 30° endoscope, Maryland forceps, and monopolar electrocautery (Fig. 3). With the use of the angled endoscope, the surgical view through the robotic system was directly over the lateral pharyngeal recess and parapharyngeal space with minimal tissue and palatal retraction. The remainder of the excision of the skull base proceeded through the TORS approach, which was advantageous in meticulously dissecting the lesion away from the ICA. Upon completion of the resection, the tonsillar and pharyngeal mucosa were reapproximated using vicryl sutures to ensure closure of the parapharyngeal space and ensure its integrity from the nasopharyngeal region, to minimize any postoperative complications.

**Postoperative Course.** At her immediate postoperative visit, the patient exhibited temporary trismus, but no evidence of neuropathy, velopharyngeal insufficiency, or swallowing issues. At a 2-year routine clinical and radiological follow-up visit, she remained free of complications and has experienced no recurrence of disease.

**Case 2**

**History and Presentation.** An 87-year-old woman was referred to our institution for management of a nasopharyngeal mass, previously identified as a mucosal melanoma on biopsy at an outside institution. On imaging

![Fig. 2. Case 1. Pre- and postoperative MRI of retropharyngeal metastasis of a papillary thyroid carcinoma. A and B: Preoperative sagittal and axial images show a retropharyngeal metastatic mass involving the nasopharynx. The blue rectangles demonstrate the extent of the lesion and proximity to the skull base. C and D: Postoperative sagittal and axial images demonstrate complete resection of the lesion with the combined approach.](image-url)
review of the lesion, MRI demonstrated a 1.5 cm × 2 cm mass just right of the midline in the nasopharyngeal region, with involvement of the torus tubarius and posterior pharyngeal wall (Fig. 4). Given the borders of the tumor with superior and inferior extensions to the skull base and the oropharynx, respectively, and in consideration of the required surgical margins, a decision was made to surgically manage this lesion through the combined endonasal and transoral approach with use of the da Vinci surgical system.

**Intraoperative Technique.** First, exposure in the endonasal corridor was obtained on the right side with a total ethmoidectomy and a complete middle turbinate resection. Upon exposure, a 0° endoscope was used to visualize the lesion, which was just posterior to the nasopharyngeal orifice of the Eustachian tube. Attention was then turned to the TORS approach, which began with placement of the McIvor mouth gag retractor and use of a rubber catheter through the contralateral nasal passage to assist in retraction of the soft palate. Again, the robot was stationed at the head of the bed with the articulating arms positioned parallel to the patient’s head. In this case, this operating setup allowed for a second surgeon to be positioned at the patient’s side for simultaneous endonasal work as needed (Fig. 5). A 30° endoscope, Bovie electrocautery, and Maryland retractor were affixed to the robotic arms, and a right radial tonsillectomy with a small, lateral palatal incision was performed through the transoral corridor for adequate exposure. Given the extensions of the tumor into the fossa of Rosenmüller and parapharyngeal space, a radical resection of the lateral pharyngeal wall was performed with robotic assistance, with surgical margins obtained from all mucosal margins. The parapharyngeal extent of the tumor was dissected in an en bloc fashion in the transoral window.

Attention was then returned to the nasal cavity for resection of the nasopharyngeal and skull base component of the lesion. Initially, the torus tubarius was cut on its posterior aspect for surgical margins and the tumor was debulked in an en bloc fashion again. For the posteroinferior extension in the nasopharyngeal space, a modified “2-surgeon, 4-handed” technique was employed, where an additional Hopkins rod-lens endoscope was operated manually through the endonasal route while the robotic instruments were used in the transoral corridor to allow full dissection from the nasopharynx down to the oropharynx (Fig. 5). This 2-surgeon technique allows a full range of visualization of the region from both corridors, which affords an increased level of safety during the nasopharyngectomy. The mass was resected in its entirety while obtaining adequate surgical margins for staging purposes.

**Postoperative Course.** Postoperatively, the patient did quite well with no evidence of velopharyngeal insufficiency, weak phonation, or dysphagia. From a surgical standpoint, the combined endonasal and transoral approach was highly effective in managing the patient’s anatomically complex nasopharyngeal lesion.

**Case 3**

**History and Presentation.** A 39-year-old man with a longstanding history of intranasal narcotics and cocaine abuse presented with complaints of significant nasal congestion, chronic nasal drainage, and difficulty passing air through his nose. On sinonasal endoscopy, he was noted to have a persistent, large septal perforation. Additionally, from the posterior ledge of the soft palate to the posterior nasopharyngeal wall, there was diffuse scarring resulting in complete nasopharyngeal obstruction and obliteration, believed to be due to intranasal drug abuse (Fig. 6A). Advancing the endoscope into the oropharyngeal space, further scar tissue was noted surrounding the tonsillar pillars. Given these findings, the patient was deemed an ideal candidate for the combined endonasal and transoral approach.

**Intraoperative Technique.** Once the nasal cavity was decongested with Afrin pleggets and the oral cavity was opened with the use of the McIvor mouth gag, the robot was docked at the head of the bed with articulating arms, parallel to the patient, fixed with a 30° endoscope. Maryland forceps, and monopolar electrocautery (Fig. 3). The transoral portion with robotic assistance proceeded first,
which consisted of using monopolar cautery to make incisions in the oropharyngeal aspect of the scar tissue bilaterally, allowing for removal of these scar bands (Fig. 6B). Once these initial incisions were made, the nasal corridor was addressed, which involved completing the nasopharyngectomy by extending the initial incisions superiorly (Fig. 6C). Scar bands posterior to the palatoglossal and palatopharyngeal arches were also incised posteriorly and superiorly to the nasopharyngeal wall, allowing mobility of the soft palate. Lastly, in the transoral corridor, the nasopharyngeal resection was carried slightly anteriorly with the use of the robot, by removing a portion of the soft palate and uvula involved by scar bands to maximize the nasopharyngeal opening. As this anterior resection was performed, the “2-surgeon” technique was employed with use of a Hopkins rod-lens through the nasal cavity, allowing for true simultaneous dissection through both corridors (Fig. 7). At the conclusion of the surgical procedure, 2 nasal trumpets were placed through the nasal cavity into the nasopharyngectomy site to ensure maintenance of patency while healing (Fig. 7).

Postoperative Course. Postoperatively, this patient did very well with only temporary velopharyngeal insufficiency noted at his initial postsurgical clinic visit, which was attributed to nasal trumpet placement. Otherwise, the patient demonstrated good air movement through his nose without further complications.

Discussion

With the advent of the endoscopic era and application of the da Vinci robotic technology in the realm of the head and neck, surgical management of the nasopharynx and posterior skull base is continually evolving (Fig. 8). In our clinical experience with the combined endonasal and transoral approach, we demonstrated successful surgical management of a variety of nasopharyngeal and posterior skull base pathologies. Based on postoperative outcomes, all 3 patients whose cases are reported in this paper experienced ideal postoperative courses with minimal morbidity, including few to no complications. In this primary series, we highlighted patient pathology that is highly suitable for the combined approach, while emphasizing innovative operative technique and clinical outcomes.

Relevant Anatomy in the Combined Endonasal and Transoral Approach

Resection into the posterior skull base and inferior nasopharynx requires detailed knowledge of the relevant anatomy. The nasopharynx is the most superior division of the pharynx and is closely associated with the nasal cavity and the skull base. The nasopharynx is a cuboi-
dal-shaped region that extends from the skull base to the inferior limit of the soft palate. Borders are important to remember to avoid violation into unwanted areas. Its anterior border opens to the sinonasal cavity via the choanae and its posteroinferior border opens to the oropharyngeal region directly. The torus tubarius, the terminal portion of the cartilaginous Eustachian tube in the nasopharyngeal region, defines the anterolateral border. The most posterolateral limit, composed of the buccopharyngeal fascia, extends to the medial edge of the medial pterygoid plates and defines the boundary between the nasopharynx and parapharyngeal space. In the anterolateral boundary, the salpingopharyngeus muscle and mucosal fold extend posteriorly from the torus tubarius and insert into the pharyngeal wall. Immediately posterior to the salpingopharyngeal fold sits the pharyngeal recess, or fossa of Rosenmüller, which is a slitlike space that is posterolaterally directed. Posteriorly, 4 layers compose the nasopharyngeal wall in the anteroposterior axis, including the mucous membrane, pharyngobasilar fascia, superior constrictor and longus colli muscles, and buccopharyngeal fascia. Importantly, the ICA, ascending within the parapharyngeal space, is separated from the buccopharyngeal fascia of the nasopharynx by a very thin layer of fibrofatty tissue, which demonstrates the intimate relationship of the ICA to the nasopharynx.

Current Perspectives of the Combined EEA and TORS Approach

Through a comprehensive review of the literature, to date we have found only 3 published studies addressing the application and feasibility of the combined endonasal...
Combined endonasal and transoral approach

In 2010, Yin Tsang et al. published an original case report on the resection of a recurrent nasopharyngeal carcinoma using the combined endonasal and transoral approach. In their experience, the combined endonasal and transoral approach was required given the close proximity of the lesion to the skull base, necessitating the use of an endoscopic drill for bone resection, a surgical element that is still not feasible in standard TORS. Additionally, in their report, a second surgeon worked subsequently in the nasal cavity, providing blood and smoke suction capacity and placing occasional traction on the lesion. Therefore, through combining the endoscopic and transoral robotic surgical approach for nasopharyngeal management, endonasal endoscopic imaging was routed as a secondary source to the robotic operator, allowing for the surgeon to simultaneously observe the endonasal surgery (lower row) and transoral surgery (upper row). This setup allows for the primary and assisting surgeons to operate together through the transoral and endonasal corridors. Intraoperative bleeding was controlled in a safe manner by visualizing critical nasopharyngeal structures through both corridors simultaneously (left). With the combined intraoperative view, nasal stents were inserted through the nasal cavity and sewn into place at the nasopharyngectomy site using the robotic instruments through the transoral corridor (right).

Dallan and colleagues published a study on the cadaveric feasibility of a combined endonasal and transoral approach, and also compared their version of the combined approach to traditional TORS. However, Dallan et al. presented a modified combined approach, because their “combined” approach was performed entirely with the da Vinci surgical system, with a central, endoscopic robotic arm in the nasal cavity and the other 2 robotic arms inserted through small, transcervical paramandibular windows created by 5-mm paramandibular incisions. This placement method may also ease dissection of the basisphenoid and upper clivus at the skull base. However, given the additional external incisions required in this approach, further analysis of this technique may be required prior to clinical implementation, as Dallan and colleagues alluded to in their conclusion. Their study provided a novel and thought-provoking take on the combined endonasal and transoral approach to the nasopharynx in a cadaver model.

Lastly, Carrau et al. most recently presented their experience with the combined endonasal and transoral approach for the resection of various malignancies of the nasopharynx and skull base. In their study, they demonstrated the feasibility of the combined approach through cadaveric and clinical study to complete nasopharyngectomies with lateral and inferior extensions to the middle skull base and costovertebral junction (CVJ), respectively. Additionally, they presented their clinical experience with the combined endonasal and transoral approach for nasopharyngeal management.

![Combined intraoperative views from the robotic surgical console.](image1)

**Fig. 7.** Combined intraoperative views from the robotic surgical console. In these views, the endoscopic endonasal imaging was routed as a secondary source to the robotic operator, allowing for the surgeon to simultaneously observe the endonasal surgery (lower row) and transoral surgery (upper row). This setup allows for the primary and assisting surgeons to operate together through the transoral and endonasal corridors. Intraoperative bleeding was controlled in a safe manner by visualizing critical nasopharyngeal structures through both corridors simultaneously (left). With the combined intraoperative view, nasal stents were inserted through the nasal cavity and sewn into place at the nasopharyngectomy site using the robotic instruments through the transoral corridor (right).

![Photograph of the da Vinci robotic surgical system with the primary surgeon.](image2)

**Fig. 8.** Photograph of the da Vinci robotic surgical system with the primary surgeon. The primary surgeon is stationed within the operating theater at the robotic console and manipulates the robotic arms, while in consistent contact with his assisting surgeon at the patient bed. This intraoperative setup allows for a true “2-surgeon, 4-handed” technique.
experience with these techniques in the surgical management of a large adenoid cystic carcinoma with involvement of the middle cranial fossa, nasopharynx, clivus, and sphenoid sinus. By combining an EEA to the nasopharynx and middle cranial fossa with a TORS approach to the tonsillar fossa and pterygoid plates, they were able to successfully resect the tumor with adequate surgical margins. In their second case experience, Carrau and colleagues described their management of a large chordoma with extensions from the middle skull base to the CVJ, C-1 vertebra, and C-2 vertebra. Given the long features of this tumor, they again implemented the combined approach without complication and successfully resected a large majority of the tumor.

The combined endonasal and transoral approach allows for both EEA and TORS to complement each other regarding their unique advantages and decrease their combined limitations. The EEA allows for the ability to perform bone resection, achieve superolateral access in the nasopharyngeal region (as demonstrated in Case 2), and provide a large array of available instrumentation given its historic implementation in sinonasal surgery. In contrast, TORS creates the ability to approach the nasopharyngeal region below the soft palate while minimizing tissue displacement, perform a wide array of surgical maneuvers that are impossible in manual surgery in the narrow oral corridor, and achieve a 3D image of the operative field. Therefore, the combination of these techniques may become established as a viable surgical option for the skull base surgeon. In addition, while communication between surgeons was paramount during Cases 1 and 2, Case 3 allowed for the endoscopic endonasal image to be routed to the surgeon at the robotic console. The surgeon at the robotic console was therefore able to have the exact same visualization as the endonasal surgeon, thus allowing for true simultaneous dissection through both corridors. This has not been performed previously and represents a technological innovation that decreases the chance for any misconmunication between surgical teams.

Safety and Cost-Effectiveness of the Combined Endonasal and Transoral Approach and TORS

Although many of the advantages and disadvantages of combining these novel surgical techniques have been previously discussed above, the safety and cost-effectiveness of specifically the TORS approach requires further clarification. In 2012, a multicenter review by Weinstein et al. demonstrated the feasibility, safety, and effectiveness of TORS for selected head and neck tumors: 98.9% of their intent-to-treat population was successfully treated with TORS without needing any form of inoperative conversion to an open approach. Also, the adequacy of surgical margins achieved with TORS was comparable to those achieved with open approaches to the nasopharynx. Lastly, Weinstein et al. found that the incidences of wound dehiscence and postoperative bleeding requiring intervention associated with the TORS approach were overall lower than the incidences found with standard transoral approaches during management of neoplastic disease.

As discussed earlier, given the proximity of the ICA to the region of interest, visualization and proximal control of the ICA becomes critically important. Rates of ICA injury in TORS cases have been found to be lower than those noted in open procedures or radiation therapy, although this may be due to the lower absolute number of cases. If incurred, intraoperative ICA control may be indirectly achieved through the robotic arms given the surgical maneuverability and ability to suture with the use of the robotic arms.

Lastly, when considering cost-effectiveness, current literature offers conflicting evidence of TORS due to the high costs in purchasing the equipment but minimized costs in postoperative overall health care and hospital stay. Further data are necessary to definitively assess the costs of TORS singularly and in conjunction with EEA via the combined endonasal and transoral approach. Overall, each patient should be considered on a unique basis regarding the feasibility and applicability of the combined endonasal and transoral approach in the surgical management of his or her pathology.

Future Endeavors in the Combined Surgical Approach

As endoscopic and robotic technology continues to improve, the realm of clinical applications will continue to expand due to multiple factors, particularly when considering a combination of approaches. First, the application of bone-drilling technology in TORS will greatly expand the range of surgical possibilities, especially in the transoral approach to the CVJ and upper cervical vertebrae. Second, as demonstrated in Case 1 in our clinical experience, the application of image-based neuronavigation software, an established component of endoscopic endonasal surgery, to TORS specifically has the capacity to radically change current limitations in the transoral approach. Third, as described by Dallan et al., the possibility of utilizing transcervical ports in the transoral approach to the nasopharynx has unique implications in combined surgery, because it opens the possibility of minimizing complications associated with the purely transoral approach such as palatal or pharyngeal injury. Lastly, as described in our experience in Cases 2 and 3, we employed a “2-surgeon, 4-handed” technique, an established practice in endoscopic skull base surgery, as 1 surgeon performed minimal, manual dissection in the nose while the other surgeon was at the robotic console operating the robot in the transoral corridor. This was further modified in Case 3 through an innovative intraoperative setup in which available technology was used to allow for simultaneous visualization by the surgeon at the robotic helm of both the endonasal and transoral corridors. Communication between the operating surgeons was facilitated by merging the endoscopic imaging modalities, which minimized risks and complications in operating in both corridors simultaneously. As instrumentation and technology in robotic and endoscopic surgery improve with smaller-sized instruments and increased mobility, this true, 2-surgeon technique will allow for consistent, simultaneous surgical dissection.

S. B. Sreenath, R. B. Rawal, and A. M. Zanation

Neurosurg Focus / Volume 37 / October 2014
Combined endonasal and transoral approach

Conclusions

The combined endonasal endonasal and robotic transoral approach offers a unique surgical option for the management of a wide array of nasopharyngeal and skull base pathologies. Through presentation of our institution's experience with the combined endonasal and transoral approach we have demonstrated the feasibility, clinical applications, and preliminary outcomes of this relatively novel surgical technique. With the continual push for minimally invasive approaches and improvement in patient surgical outcomes, we believe that this combined surgical technique will continue to evolve and have widespread clinical applicability.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conceptuation and design: all authors. Acquisition of data: all authors. Analysis and interpretation of data: all authors. Drafting of the article: all authors. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Reviewed the final version of the manuscript on behalf of all authors: Zanation. Administrative/technical/material support: all authors. Study supervision: Zanation.

References

34. Tsang RK, To VS, Ho AC, Ho WK, Chan JY, Wei WI: Early results of robotic assisted nasopharyngectomy for recurrent nasopharyngeal carcinoma. Head Neck [epub ahead of print], 2014

Manuscript submitted June 15, 2014.
Accepted July 17, 2014.
Please include this information when citing this paper: DOI: 10.3171/2014.7.FOCUS14353.
Address correspondence to: Adam M. Zanation, M.D., Department of Otolaryngology—Head & Neck Surgery, University of North Carolina at Chapel Hill, 170 Manning Dr., CB #7070, Physician’s Office Building, Rm. G-190, Chapel Hill, NC 27599. email: adam_zanation@med.unc.edu.