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Transoral Robotic Nasopharyngectomy: A Novel Approach for Nasopharyngeal Lesions

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INTRODUCTION

The nasopharynx has traditionally been accepted to be an inapproachable, complicated site where complete surgical resections are often impossible to achieve. In the last few decades, several different approaches for nasopharyngectomy have been described. These include the infratemporal fossa, anterolateral disassembly, and maxillary and mandibular swing approaches.[1–5] As their names imply, the major disadvantages of these approaches are their complexity and high morbidities. The literature and the clinical applications are lacking a large number of case series to standardize any of the above approaches. Although recent anecdotal studies have described the use of the transnasal endoscope for nasopharyngectomies, minimally invasive techniques need to be refined for this specific anatomic location.[6,7]

Robotic assisted surgeries have gained popularity in variety of surgical fields like urology, gynecology, and cardiac surgery in the last decade but the use of robotic technology in otolaryngology has only recently been described and studied.[8,9] An obvious advantage of the transoral robotic approach to the upper aerodigestive tract is that the normal body cavity is used as the surgical field without external incisions.

Challenges and limitations related to the standard approaches and surgeries of the nasopharynx motivated us to explore the use of robotic assisted surgery for nasopharyngeal lesions, which has not been previously described. In this preclinical investigation, we aimed to demonstrate the feasibility of a novel robotic transoral approach to the nasopharynx without making any external incisions.

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METHODS AND SURGICAL TECHNIQUE

This study was planned and performed at the Robotic Training Laboratory of the Center for Minimally Invasive Surgery at The Ohio State University. The dissection was performed on a fresh-frozen, edentulous, female cadaver. The da Vinci surgical robot (Intuitive Surgical, Sunnyvale, CA) was positioned at the head of the operating table. The cadaver's head and neck region were positioned parallel to the central camera arm of the robot. Next, a Dingman mouth gag was inserted into the cadaver's mouth and opened. All the robotic arms, including the fourth arm, were then positioned transorally through the Dingman mouth gag. No external incisions were required. We found visualization was improved with the operating table in the Trendelenburg position, with minimal head extension.

The soft palate was incised to the left of midline and freed from the pharyngeal and hard palate attachments. The fourth arm of the robot grasped the uvula and was used to retract the soft palate to the right (Fig. 1). Perfect exposure of the entire nasopharynx was achieved with the use of the 30° dual-channel, upward-facing camera (Fig. 2). The nasopharyngectomy was then performed using the remaining two arms of the robot.

Starting from the inferior nasopharynx, tissues were excised using the monopolar cautery scissors and robotic DeBakey forceps (Fig. 3). The resection included the tissues adjacent to the Eustachian tube and Rosenmuller fossa (Figs. 4 and 5). Dissection and clear visualization of the internal carotid artery was achieved at the lateral aspect of the nasopharyngectomy (Fig. 6). Then the resection was completed with the inclusion of tissues overlying the clival region. A layered closure of the previously made 3-cm soft palate incision was then performed using the robot (Fig. 7).

RESULTS

Perfect exposure of all the nasopharyngeal sites was achieved with this minimally invasive transoral robotic-assisted surgical approach, without the need for any external incisions. The entire nasopharyx was exposed, including bilateral Eustachian tubes and Rosenmuller's fossae, and the clivus and choana (Fig. 2). Localization

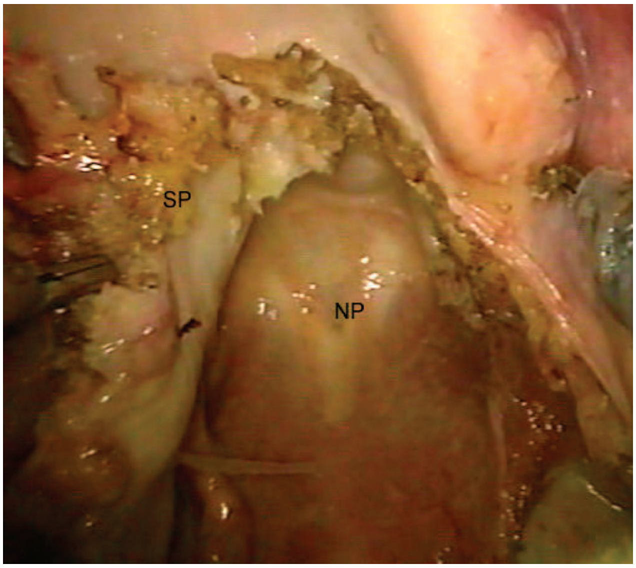

Fig. 1. The division and retraction of the hemi-soft palate (SP) to expose the entire nasopharynx (NP).

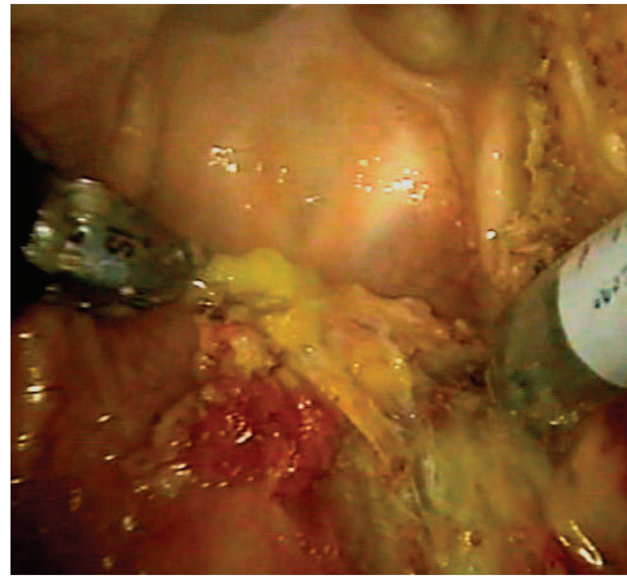

Fig. 3. The nasopharyngectomy was started from inferior to superior direction.

and dissection of the internal carotid artery was straightforward and easily performed without apparent injury to the vessel.

The setup time for positioning of the cadaver and robot was 25 minutes. The entire procedure, including division of the soft palate, carotid artery dissection, nasopharyngectomy, and closure of the soft palate, was performed in 45 minutes.

COMMENT

The nasopharynx is one of the most challenging areas of the head and neck to reach and resect. For this reason, the nasopharynx had been thought of as an inoperable site in the past. Approaches described in the last few decades were complicated, disfiguring surgeries with high morbidity.[1–5] Very recently, a few case series with a limited number of patients showed the feasibility of minimally invasive endoscopic approaches for nasopharyngectomy.[6,7] We expect the use of transoral robotic assisted surgery, to contribute toward refining minimally invasive nasopharyngectomies in the future.

Transoral robotic surgeries were introduced in the last few years and further investigations are needed to describe the appropriate use of this technology in otolaryngology. The *da Vinci*® Robotic Surgical System (Intuitive Surgical, Sunnyvale, CA) consists of a master-control and a remote-manipulator station in which there is a surgeon's console and a robotic cart next to the patient with three or four arms, two placed laterally for the instruments and the middle one for the three-dimensional endoscopic camera. Well-established advantages of the da Vinci ro-

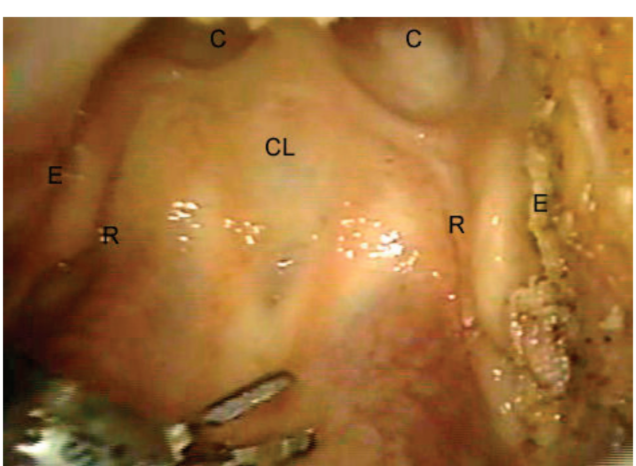

Fig. 2. The entire nasopharynx was exposed including bilateral Eustachian tubes (E), Rosenmuller fossa (R), clivus (CL), and the choana (C).

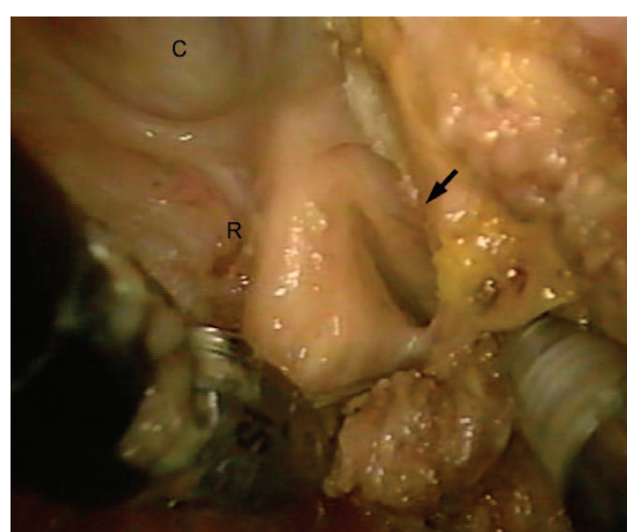

Fig. 4. Resection around the left eusthachian tube (arrow).

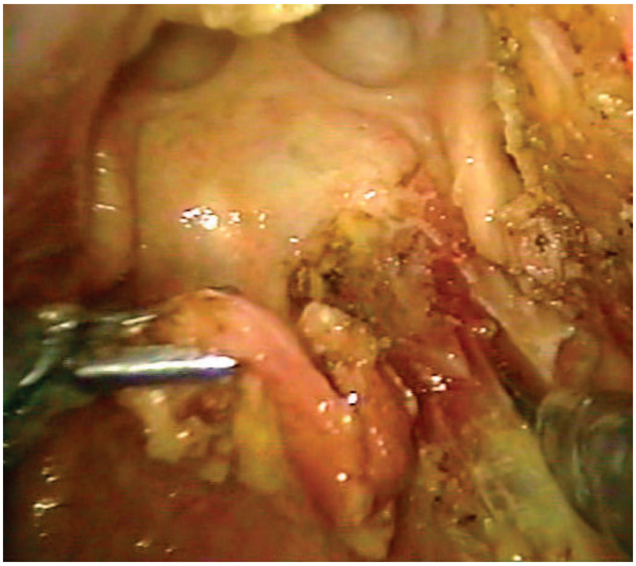

Fig. 5. The nasopharyngectomy specimen.

botic surgical system include excellent, magnified, three-dimensional visualization, with precise, tremor-free, and "wrist-like" manipulation, and the opportunity for three-handed surgery.[8,9] In comparison, traditional endoscopic surgeries are performed under two-dimensional visualization, with limited manipulation of the end-effector of the endoscopic instruments. In addition, endoscopic surgeons are limited to one-handed surgery, unless an assistant or a mechanical scope holder are used.

In this preclinical study, we have shown feasibility of the transoral robotic approach to perform a complete nasopharyngectomy, including clival resection and internal carotid artery dissection. We were able to complete this procedure without the use of external incisions. Through the use of proper positioning and division of the soft palate, exposure of the entire nasopharynx was achieved. All four arms of the robot were placed transorally; we noted only minimal interference between the four arms, the Dingman mouth gag, or the cadaver's gums, and hard palate. This short 45-minute procedure was achieved without needing any type of mandibular or maxillary osteotomies, and bony reconstructions that are usually needed in the minimally disfiguring approaches like Lefort I or maxillary removal and reinsertion.

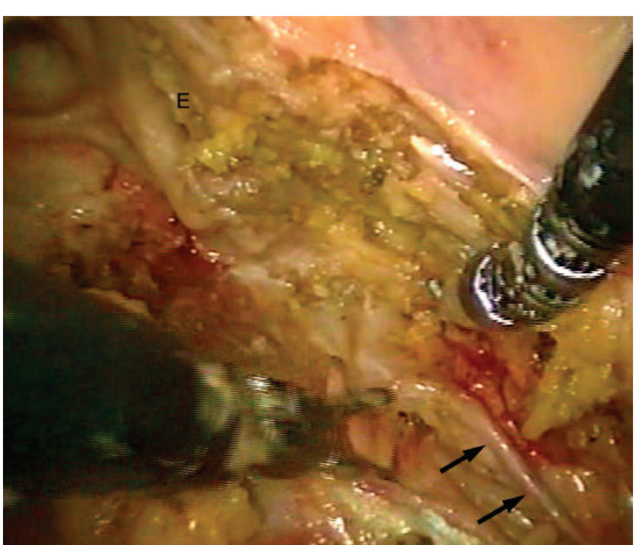

Fig. 6. Dissection of the left internal carotid artery (arrows) and its relation to the nasopharyngectomy.

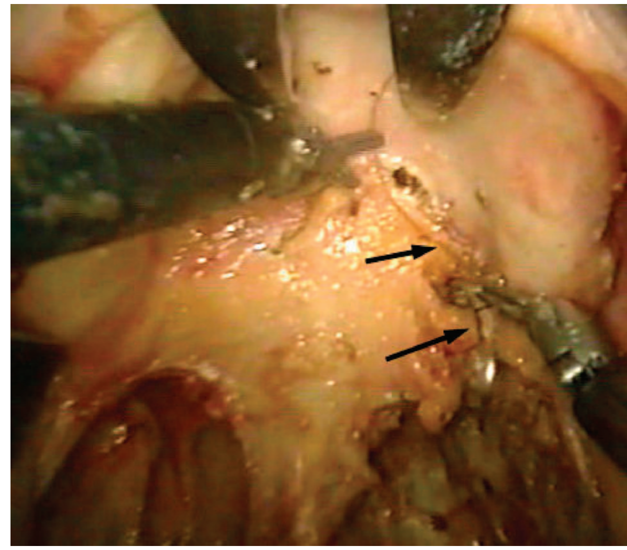

Fig. 7. Robotic closure of the soft palate incision (arrows).

Areas for future improvement for robotic assisted surgery include the innovation of finer, smaller diameter instruments, and instruments for bony resection. Finer instrumentation will improve the precision of microsurgeries in confined areas like the nasopharynx and laryngopharynx. Without bone-cutting instruments, lesions involving the bony boundaries of the nasopharynx will prove difficult to resect. With current technology, bony resection will require transoral or transnasal placement of endoscopic drills or rongeurs.

In conclusion, this is the first study to describe a transoral robotic approach to the nasopharynx. In this preclinical investigation, we have shown this novel approach to be feasible for nasopharyngeal lesions. In addition to the advantages of endoscopic minimally invasive surgeries, the robotic system provides three-dimensional visualization and the ability to perform multihanded and tremor-free surgery. Refinement of the robotic instruments for the particular anatomic sites and future preclinical and clinical studies are needed to further demonstrate the feasibility and effectiveness of robotic surgical systems to treat benign and malignant lesions of the head and neck.

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