Accepted Manuscript online: 2025-01-13 Article published online: 2025-01-27

A Novel Technique for Nasopharyngeal Stenosis Repair: Combined Transoral Robotic and Endonasal Approaches for Enhanced Visualization and Surgical Precision

Russel T. Wagner[1] Sammy Khalili[1] Blake Henning[1] Neil S. Mundi[1]

[1] Intent Medical Group, Department of Neurosciences, Northwest Community Hospital, Part of Endeavor Health, Arlington Heights, Illinois, United States

J Neurol Surg Rep 2025;86:e14–e18.

Address for correspondence Russel T. Wagner, BS, Intent Medical Group, Department of Neurosciences, Northwest Community Hospital, Part of Endeavor Health, 880 W Central Rd Suite 7200, Arlington Heights, IL 60005-2392, United States (e-mail: rwagner1@nch.org).

Abstract

Nasopharyngeal stenosis is a challenging condition characterized by a narrowed nasopharynx, leading to nasal congestion, impaired breathing, and recurrent sinus issues. In this report, we present a unique surgical approach that combines the use of both the Da Vinci Xi robot and a 70-degree nasal endoscope in a patient with a type II stenosis of the nasopharynx. The benefits of improved visualization, maneuverability, and precision of this novel combined approach are highlighted. It also highlights the benefit of using mitomycin C in minimizing the risk of re-stenosis. This previously undescribed technique can not only improve patient outcomes, but it also paves the way for future advancements and broader applications in robotically assisted procedures involving the skull base and oropharynx.

Keywords

- nasopharyngeal stenosis
- robotic-assisted surgery
- Da Vinci Xi
- robot endoscopic surgery
- transoral robotic surgery (TORS)
- skull base surgery
- nasal endoscope
- mitomycin C
- ENT surgery
- head and neck surgery

Introduction

Nasopharyngeal stenosis is commonly iatrogenic and is the result of procedures performed in or around the nasopharynx which can include surgery and radiation therapy. It can also be the sequela of infectious disease such as diphtheria, rhinoscleroma, tuberculosis, and syphilis.[1] The symptoms of nasopharyngeal stenosis usually include dysphagia, hyponasal speech, nasal obstruction, and difficulty sleeping.

In prior nasopharyngeal stenosis repairs, various surgical techniques have been employed. Each has its own advantages and limitations depending on the severity and etiology of the stenosis. Traditional approaches have included the use of mucosal flaps, such as the laterally based pharyngeal flap,

received August 14, 2024
accepted November 11, 2024
accepted manuscript online January 13, 2025

DOI https://doi.org/10.1055/a-2466-7414.
ISSN 2193-6358.

and the transposition of local tissue flaps to restore nasopharyngeal patency.[1] For example, to address both nasopharyngeal stenosis and tonsillar pillar adhesions in a single-stage operation, a palatal eversion technique could be employed where the soft palate is divided and repositioned to separate scarred tissue.[2] This approach was particularly useful in cases of post-adenotonsillectomy scarring where fibrosis caused significant airway obstruction. Similarly, another case described the excision of dense, avascular fibrotic tissue, followed by reconstruction using split-thickness skin grafts to prevent re-stenosis.[1] Although these techniques have demonstrated efficacy, challenges such as restenosis, scarring, and incomplete resolution remain, necessitating innovative approaches like the dual robotic and endonasal method described in this report.

We present the case of a patient with severe nasopharyngeal stenosis caused by the use of hydrogen peroxide irrigations which he had been doing for approximately 2 years following functional endoscopic sinus surgery (FESS) for chronic sinus disease. A combined transoral and transnasal surgical approach with a robotically trained head and neck surgeon and rhinologist was devised to improve field visualization and surgical maneuverability.

The Da Vinci surgical robot has progressively translated its applications in general surgery, urology, gynecology, cardiothoracic, pediatrics, and ENT surgery. The surgical system has four EndoWrist robotic arms that offer enhanced manual dexterity and a three-dimensional magnified image for improved visualization.[3,4] Traditional transoral approaches to the oropharynx have several existing limitations. Specifically, there is a confined operative field, limited range of instrument motion, and optical concerns such as reduced line of sight and depth perception. Other areas of ENT surgery including endoscopic thyroid and parathyroid also have inherent limitations such as video camera platform instability, restricted motion of straight endoscopic instruments, two-dimensional imaging, and suboptimal operator ergonomics.[5] Applications of the Da Vinci robot as well as combined surgical technologies may prove to solve these issues in the future upon further development and integration.

Nasopharyngeal Stenosis Classifications

Nasopharyngeal stenosis can be categorized into types I, II, and III, with each having different degrees of severity. Type I is a mild grade where the lateral aspects of the palate adhere to the posterior pharyngeal wall. Type II is a moderate grade characterized by circumferential scarring, resulting in a small central opening of the soft palate measuring 1 to 2 cm in diameter. Type III is a severe grade identified by the complete fusion of the entire palate with the posterior and lateral palatal wall, leaving a residual opening of less than 1 cm.[6]

Case Presentation

A 67-year-old male presented with nasal congestion, frequent, thick mucus drainage, and sores in his nostrils. He had a history of chronic sinus disease and had undergone balloon sinuplasty at an outside institution, as well as two other surgeries in the past to help manage it. He was then instructed to use hydrogen peroxide sinus rinses, which was a regimen he continued for approximately 2 years. This ultimately led to the stenosis of his nasopharynx.

Despite previous surgical interventions including an FESS, the patient's symptoms worsened over time, particularly the nasal obstruction, sores, and drainage, none of which improved with antibiotic treatments. Imaging studies showed that while CT scans demonstrated some improvement from the earlier surgeries, an MRI revealed a Tornwaldt cyst, mucosal thickening in the left nasopharynx, and bilateral maxillary and ethmoid thickening.

During a follow-up visit, the patient reported that his nasal obstruction was progressively worsening. In-office nasal and oral endoscopy (►**Fig. 1A, B**) revealed type II nasopharyngeal stenosis, likely resulting from prolonged hydrogen peroxide irrigation. Based on these findings, further surgical intervention was deemed necessary to address the stenosis and restore airway patency (►**Fig. 2A, B**).

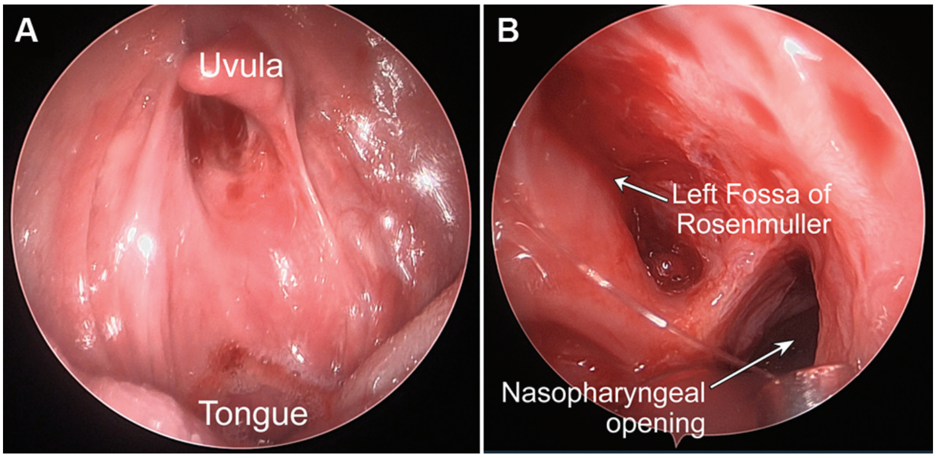

Fig. 1 (A) Preoperative oral view of the enclosed nasopharynx using the endoscope. (B) Preoperative endonasal view of the enclosed nasopharynx using the endoscope.

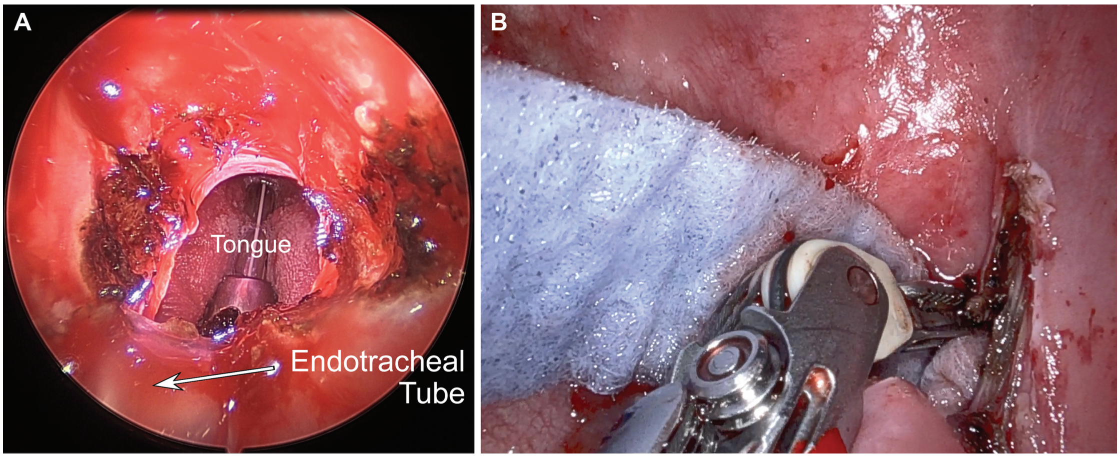

Fig. 2 (A) Endonasal view of the nasopharynx after it had been opened up by the robot. (B) Oral view from the Point of view of the robot as it applies topical mitomycin C.

Surgical Procedure

To improve visualization of the surgical field and surgical dexterity, the senior authors employed a novel approach, utilizing both the Da Vinci Xi robot (with a 30-degree endoscope) and a 70-degree nasal endoscope. The surgical robot was equipped with Maryland bipolar forceps and a cautery spatula. The robotic surgeon was positioned at the robot console while the endonasal surgeon was positioned at the head of the operating room table; the latter acting as the assistant for the transoral robotic surgeon while visualizing the nasopharynx from above. This setup was employed to view the nasopharynx and soft palate from both inferior and superior simultaneously. The room setup is demonstrated in ►**Fig. 3A, B**.

The surgery began with the robot incising the scar band present between the soft palate and posterior pharyngeal wall in the oropharynx. Once the soft palate had been released, the upper limit of the field of view of the surgical robot was reached. Further division of scar tissue was performed from inferior to superior along the posterior pharyngeal wall using the robotic instruments under the guidance of the endonasal surgeon who was visualizing the nasopharynx from above. Dissection continued from medial to lateral on both sides to recreate the fossa of Rosenmuller that had been scarred due to hydrogen peroxide irrigations (►**Fig. 2A**). Once the soft tissue dissection was complete, mitomycin C was applied topically to the raw edges of the field to aid in preventing scar reformation postoperatively (►**Fig. 2B**). Two nasal trumpets were placed into the nasal cavity and through the stenosis site to retain airway patency in recovery and were sewn to the nasal septum.

Postoperative Course

In the days following the surgery, the patient utilized nasal saline sprays as prescribed. On postoperative day 8, the patient presented with intolerance of the nasal trumpets and these were removed without incident. He continued to use the nasal saline spray once the trumpets were removed.

At 3 weeks into his recovery, the patient reported a substantial improvement in nasal breathing with no nasal regurgitation of solids or liquids. His speech was mildly hypernasal but the patient did not report any difficulty with speech intelligibility. Diagnostic nasal endoscopy revealed an expanded nasopharyngeal opening and minimal excess scarring, signifying effective healing (►**Fig. 4A**).

At 1 year following his surgery, nasal endoscopy shows a maintained opening of the nasopharynx with minimal scarring (►**Fig. 4B**).

Discussion

The utilization of a dual approach combining the Da Vinci Xi robot and the nasal endoscope in nasopharyngeal stenosis repair represents a pioneering advancement in the field of robotic-assisted surgery. This novel combination offers a multitude of benefits that synergistically enhances the surgeons' capabilities, improves visualization, and increases precision during the surgical procedure.

One of the major advantages of this dual approach is the ability to access and navigate small and challenging anatomical spaces with greater ease as seen in ►**Fig. 5A, B**. The Da Vinci Xi robotic arms equipped with EndoWrist instruments provide the surgeon with enhanced dexterity and a wider range of motion, allowing delicate maneuvers within confined areas of the nasopharynx.[7] The nasal endoscope further complements these capabilities by providing top-down visualization of the surgical site, especially in areas such as the nasopharynx that are difficult to visualize with the robotic endoscope when it is positioned in the oral cavity. The integration of these technologies facilitates improved maneuverability, granting the surgeons greater control and finesse in navigating intricate anatomical structures utilizing the robotic instruments while having a 360-degree view of the surgical field. Alone, neither the transoral robotic nor endonasal approach to nasopharyngeal stenosis can accomplish this.

Moreover, this dual approach has the potential to lead to improved surgical outcomes for future procedures. The

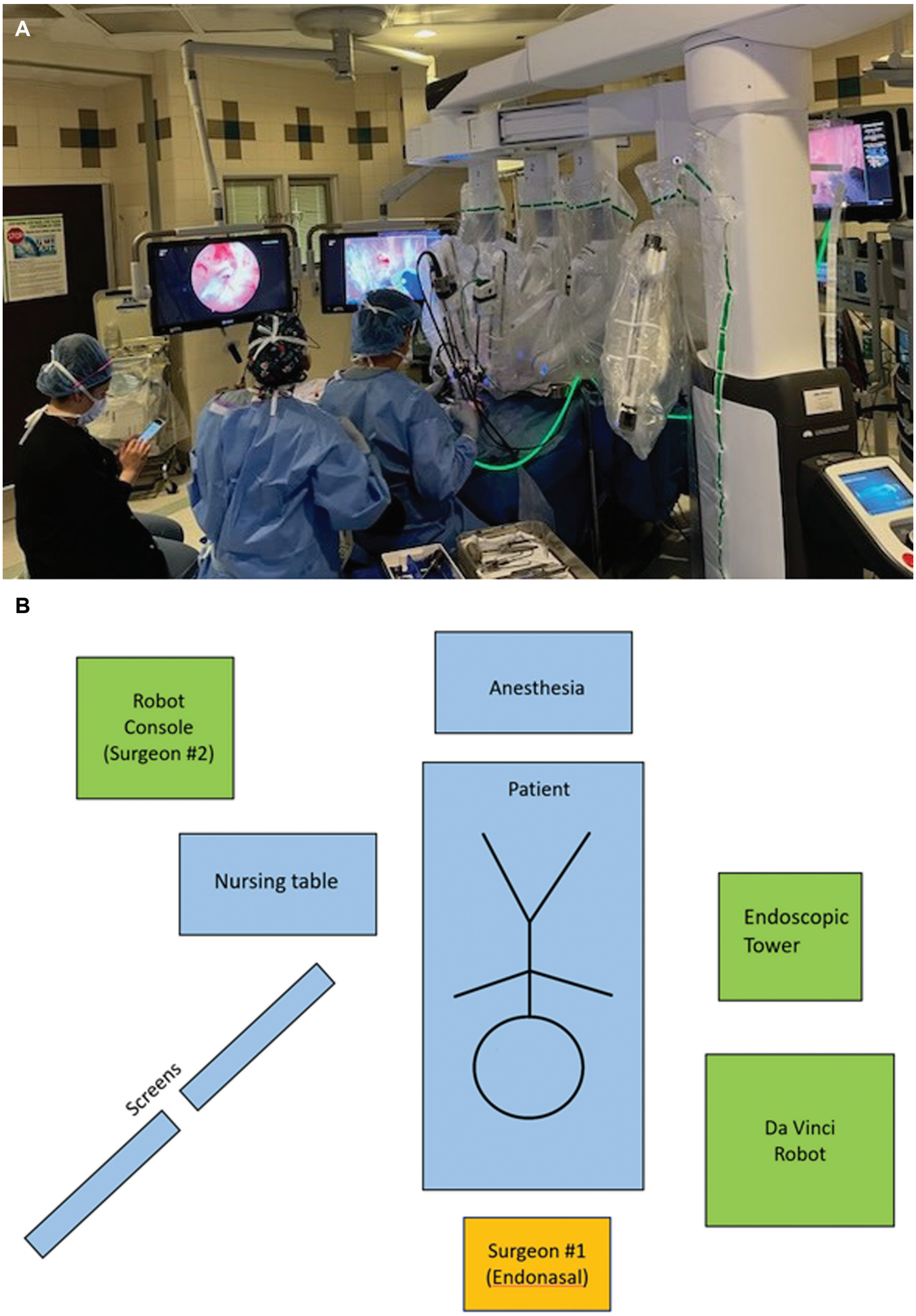

Fig. 3 (A) A real photo of surgical setup showcasing the intricate surgical setup during the nasopharyngeal stenosis repair procedure. The image captures the simultaneous utilization of the Da Vinci Xi robot and a reverse-posted nasal endoscope. (B) Animated diagram of an aerial view of the operating room (OR) setup offering a better visual representation of where the equipment and surgeons were strategically positioned.

enhanced visualization, precision, and maneuverability offered by both the robot and the endoscope may contribute to reduced surgical complications, preservation of vital structures, and overall patient safety. The successful application of this dual approach in nasopharyngeal stenosis repair opens the door to expanding applications in robotic-assisted surgeries. As surgeons gain experience and expertise with this novel technique, its potential may extend to other complex anatomical regions and surgical procedures. The combination of different surgical technologies may also inspire further research and innovation, leading to the development of new approaches and protocols for various medical conditions.

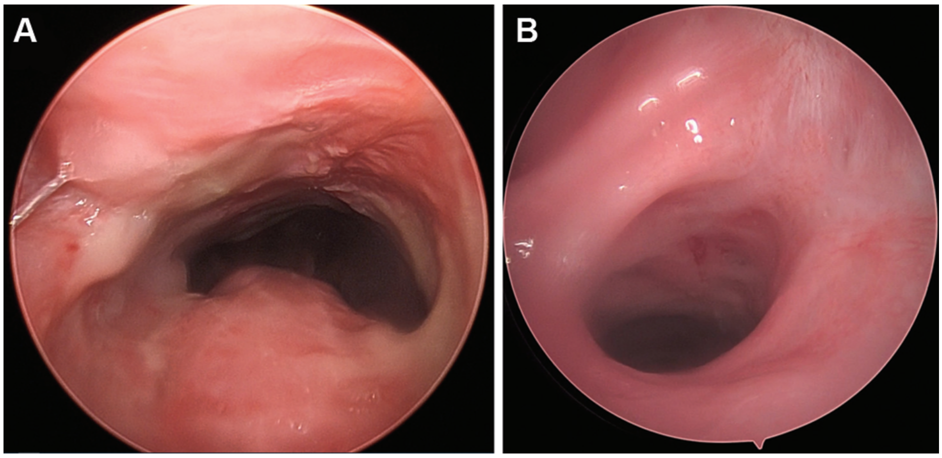

Fig. 4 (A) Nasal endoscopic view of the opened and healing nasopharynx at 3 weeks following surgery. (B) Nasal endoscopic view of the opened nasopharynx at 1 year following surgery.

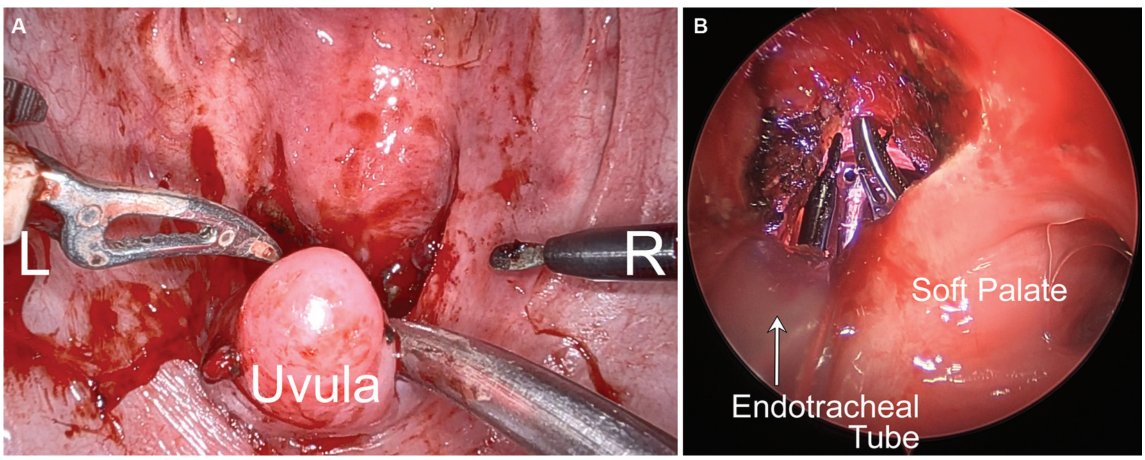

Fig. 5 (A) Oral view of the nasopharynx from the point of view of the robot during the operation. Note the difficult angle and view of the opening. Labels 'L' and 'R' indicate the left and right sides of the surgical field, respectively, for orientation. (B) Endonasal view of the opened nasopharynx from the point of view of the endoscope during the operation. Note the much clearer view of both the opening and walls of the nasopharynx.

Conclusion

This case report highlights an innovative combination of surgical approaches utilizing the Da Vinci Xi robot and a nasal endoscope in nasopharyngeal stenosis repair, offering improved visualization and surgical precision. This innovative technique not only benefits current patients by improving outcomes but also opens avenues for future advancements and expansion of applications in robotic-assisted surgical interventions for nasopharyngeal and skull base surgery. Continued research and exploration of this dual approach are critical to unlock its full potential and shape the future landscape of surgical practices.

Conflict of Interest
None declared.

References

1 Korkmaz H, Selcuk OT, Tatar EC, Saylam G, Ozdek A. Complete nasopharyngeal stenosis: presentation of a rare case. Eurasian J Med 2012;44(03):185–187
2 Abdel-Fattah G. Palatal eversion for the treatment of combined nasopharyngeal stenosis and tonsillar pillars adhesion. Int J Pediatr Otorhinolaryngol 2016;90:227–230
3 Ahmed K, Khan MS, Vats A, et al. Current status of robotic assisted pelvic surgery and future developments. Int J Surg 2009;7(05):431–440
4 Najmaldin A, Antao B. Early experience of tele-robotic surgery in children. Int J Med Robot 2007;3(03):199–202
5 Arora A, Cunningham A, Chawdhary G, et al. Clinical applications of Telerobotic ENT-Head and Neck surgery. Int J Surg 2011;9(04):277–284
6 Krespi YP, Kacker A. Management of nasopharyngeal stenosis after uvulopalatoplasty. Otolaryngol Head Neck Surg 2000;123(06):692–695
7 Ngu JC, Tsang CB, Koh DC. The da Vinci Xi: a review of its capabilities, versatility, and potential role in robotic colorectal surgery. Robot Surg 2017;4:77–85