PHILIPPINE JOURNAL OF OTOLARYNGOLOGY-HEAD AND NECK SURGERY VOL. 41 NO. 2 JULY – DECEMBER 2026

Robotic Excision of a Parapharyngeal Pleomorphic Adenoma: Pushing the Limits of Size

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ABSTRACT

Objective: To describe transoral robotic approach (TORS) as a paradigm-changing means of surgical management of a large (> 6 cm) parapharyngeal space (PPS) pleomorphic adenoma beyond the conventional tumor size limitations of the approach.

Methods:

Design: Case Report
Setting: Tertiary National University Hospital
Patient: One

Results: A 34-year-old man with a progressively enlarging oropharyngeal mass over two years was ultimately diagnosed with a 7 × 4.8 × 5.7 cm pleomorphic adenoma of the right PPS. He underwent resection via a transoral robotic approach using the da Vinci Si® surgical system. Preoperative imaging showed a well-circumscribed tumor without neurovascular invasion, allowing for safe robotic dissection. Complete tumor excision was achieved without capsular rupture or postoperative complications. This case demonstrates that TORS can be effectively employed in select cases involving large PPS tumors, provided careful preoperative assessment and surgical planning are performed.

Conclusion: This case supports the expanding indications for TORS in the management of PPS tumors beyond the previous conventional 6 cm threshold. Favorable tumor characteristics, multidisciplinary planning, and familiarity with PPS anatomy are essential for optimizing outcomes. TORS, when applied judiciously, allows for better visualization and dissection with excellent cosmetic and functional results even for large tumors, challenging traditional surgical paradigms.

Keywords: *robotic surgery; parapharyngeal mass; pleomorphic adenoma; minimally invasive head and neck surgery*

Parapharyngeal space (PPS) tumors are rare benign masses, accounting for approximately 0.5% of all head and neck neoplasms.[1] Traditionally, these have been removed by transcervical, transparotid, or transmandibular approaches or a combination of these external surgical approaches resulting in varied degrees of negative cosmetic and/or functional outcomes.[2]

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Disclosures: The authors signed a disclosure that there are no financial or other (including personal) relationship, intellectual passion, political or religious beliefs, and institutional affiliations that might lead to a conflict of interest. No financial or funding support was obtained for this study.

Use of Artificial Intelligence: The authors used ChatGPT (OpenAI) solely to edit author-written text for grammar, clarity, readability, and conciseness. No AI-assisted technologies were used during revisions nor to generate scientific content, analyze or interpret data, perform statistical analyses, generate tables or figures, or write computer code. All scientific content and the final manuscript were reviewed and approved by the authors, who accept full responsibility for the work.

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Philipp J Otolaryngol Head Neck Surg 2026; 41 (2) 67-72

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Figure 1. Head and neck patient photos: **A.** pre- and **B.** post-tracheostomy, showing a bulge (dotted circle) in the right level IB and level II areas. Photos published with permission.

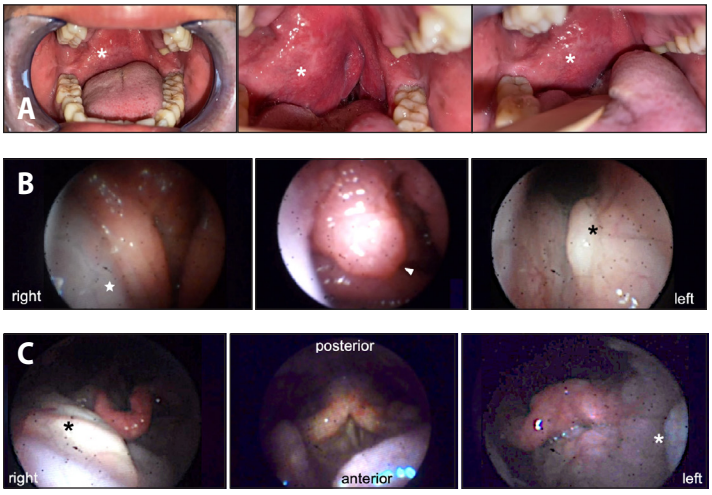


Figure 2. Oropharyngeal mass: **A.** oral cavity showing a 4 x 3 cm fleshy, pink, smooth bulge seemingly centered on the right soft palate (asterisk) causing near total occlusion of the oropharyngeal airway; **B.** nasolaryngsocopy showing enlarged adenoid (arrowhead) and a pink fleshy bulge (asterisk) seemingly originating from the submucosa of the right soft palate area extending posteriorly and superiorly, causing difficult insinuation of the scope in the R nasopharyngeal area (star); and **C.** soft tissue bulging (asterisk), seemingly contiguous with the soft palate bulge on the right; no overlying obstruction of laryngeal complex.

The introduction of TransOral Robotic Surgery (TORS) for the removal of parapharyngeal space tumors offers enhanced precision, 3D visualization, and a high degree of dexterity, which makes it ideal for complex surgeries in confined spaces. However, there are limitations to TORS, particularly with tumors greater than 6 cm or those deeply embedded within surrounding tissues.[3] We describe a paradigm-changing successful TORS removal of a large (> 6 cm) PPS pleomorphic adenoma beyond the conventional tumor size limitations of the approach.

CASE REPORT

A 34-year-old man was referred to the University of the Philippines - Philippine General Hospital (UP-PGH) for a gradually enlarging right oropharyngeal bulge at the soft palate and peritonsillar area. Three years prior to his initial consult, he reported pain in his second and third right mandibular molars, with appreciation of a flesh-colored bulging mass in the right peritonsillar area with no discharge. He reported no associated symptoms of jaw pain, dysphagia, hoarseness. The patient had an unremarkable past medical, personal and social, and family medical history.

In the interim, he noticed gradual enlargement of the oropharyngeal bulge with associated dysarthria and occasional throat pain. Further enlargement led to gradual development of a hot potato voice prompting consultation at another institution where significant narrowing of his airway was noted. He was referred to our institution for further management and was admitted at the Emergency Room. *(Figure 1)* Near total occlusion of the oropharyngeal airway was noted due to the size of the bulge. He underwent tracheostomy and biopsy of the PPS bulge, which revealed findings consistent with pleomorphic adenoma.

Physical examination of the oral cavity revealed a 4 x 3 cm fleshy, pink, smooth submucosal bulge seemingly centered on the right soft palate causing near total occlusion of the oropharyngeal airway and a left-sided deviation of the uvula. *(Figure 2A)* The hard palate, left soft palate, bilateral retromolar trigone, and buccal mucosa were not involved. On endoscopy, the same pink fleshy bulge was noted to originate from the right palatal area extending posteriorly and superiorly into the right nasopharynx. *(Figure 2B)* The laryngopharynx is free of the mass, and the vocal folds were noted to be fully mobile. *(Figure 2C)*

Contrast-enhanced computed-tomography (CECT) imaging studies were done post-tracheostomy to assess the present condition and extent of the mass. *(Figure 3)* Spiral multiaxial and coronal scans of the paranasal sinuses showed a right oropharyngeal mass extending to the nasopharynx and beyond the oropharyngeal mucosa, exhibiting slight inhomogeneous enhancement, measuring about 7x4.8x5.7cm, causing marked narrowing of the oropharyngeal orifice obscuring the palatine tonsil and uvula.

A robotic excision of the parapharyngeal pleomorphic adenoma via transoral endoscopic approach with possible trans mandibular approach/mandibular swing was planned. The following concerns with the treatment plan were raised at the tumor board conference:

First, there was a need for complete excision of the pleomorphic adenoma tumor as there is a cure rate of 95%. Second, not only was complete excision vital but the capsule should not be violated as recurrence rate with capsule rupture was as high as 45%.[4] Third, the endoscopic approach was conventionally limited to tumors less than 6 cm in size. There was evidence that with bigger tumors there were higher rates of incomplete resection and conversion to an open approach.[1,5,6] Vigilance must be exercised especially that the lesion had extended superiorly abutting the pterygoids and the nasopharyngeal area. However, with theoretically better 3D field visualization, exceptional instrumentation and improved dexterity, the tumor board approved this robotic procedure. The team also prepared a standby set-up for open surgery.

Surgical Technique

With the patient under general endotracheal anesthesia and mechanical ventilation, the da Vinci Si® surgical system (Intuitive Surgical Inc., Sunnyvale, CA, USA) was docked above the patient's head. With a Crowe-Davis mouth gag retractor inserted, a 0° 8 mm HD telescopic camera (Intuitive Surgical Inc., Sunnyvale, CA, USA) was placed on the center arm of the robot patient cart and docked inside the mouth opening. On the right arm of the robot, a 5 mm EndoWrist® monopolar cautery instrument (Intuitive Surgical Inc., Sunnyvale, CA, USA) was attached and an 8mm Da Vinci S/Si 420344 Curved Bipolar Forcep (Intuitive Surgical Inc., Sunnyvale, CA, USA) was placed on the left arm of the robot. A curvilinear transverse incision halfway to the right soft palate up to just beyond the midline was made. *(Figure 4)* The parapharyngeal space was dissected and the tumor capsule identified. *(Figure 4A)* During the tumor dissection, the BrainLab Curve Neuronavigation 17700 (BrainLab SE, Munich, Germany) and a Minidop ES-100VX ultrasound endoscopic doppler (Hadeco Inc., Arima, Miyamae-ku Kawasaki, Japan) were used to identify the neovascular structures deep in the PPS. Dissection of the periphery of the tumor was done using the robotic system until the capsule was free from all surrounding tissue aside from the posterior attechment. *(Figure 4B-C)* To dissect the remaining posterior tumor margins, the technique was briefly converted into a non-robotic endoscopic transoral approach. This was done because the firm consistency and size of the tumor made the posterior attachment difficult to visualize. The tumor had to be manually retracted to visualize and dissect its posterior attachment. After this, surgery shifted back to a transoral robotic endoscopic approach allowing less invasive, focused and precise excision with better 3D depth perception to achieve complete resection. *(Figure 4D)* No conversion to an open approach involving a mandibulectomy or a neck incision to access the PPS was needed. Hemostatis was achieved and surgicel™ was left in the mucosal bed. *(Figure 4E)* The incision at the soft palate was closed with a simple interrupted suturing using a vicryl 4-0 suture. *(Figure 4F)* Complete tumor resection was achieved without any break in the capsule or tumor spillage, as evident in the grossly excised mass. *(Figure 4G)* Oral Feeding was resumed the day after surgery, and he was discharged two days after surgery without any postoperative complications.

Post-operatively, the soft palate was symmetrical, with good mobility. *(Figure 5A)* The tracheostomy tube was removed 45 days post-surgery with no untoward incidents. *(Figure 5B)* The patient had several bi-monthly outpatient consults until 4 months post-surgery with no clinical or radiological evidence of tumor recurrence on repeat nasopharyngeal CECT. *(Figure 6)*

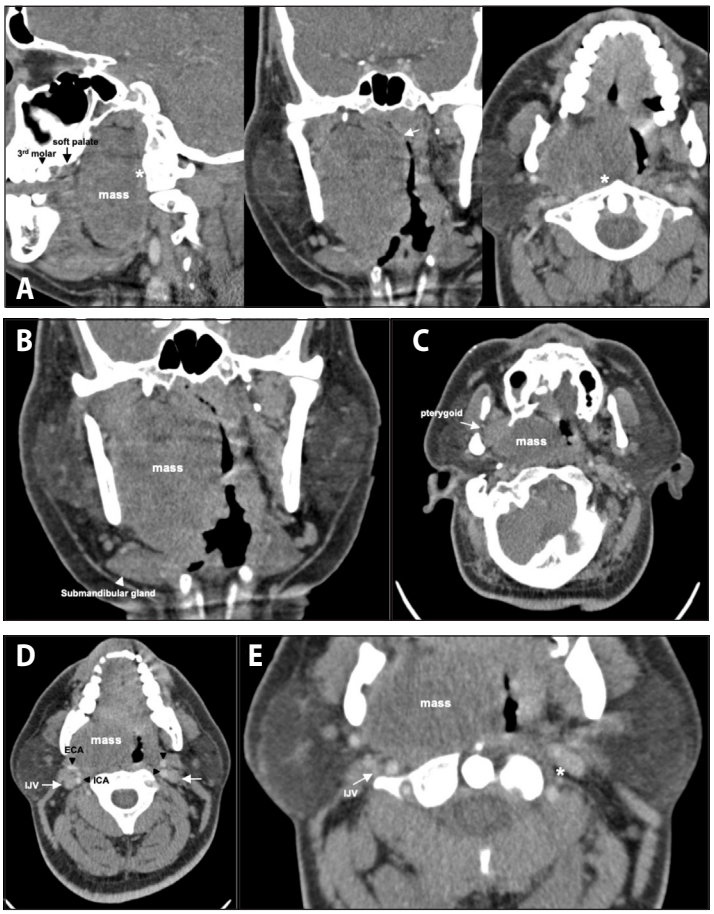


Figure 3. Representative cuts of CECT of the paranasal sinuses (05/01/2024) revealing a heterogeneously enhancing mass centered in the right parapharyngeal space extending to the right pharyngeal mucosal space measuring 7 x 4.8 x 5.7 cm. **A.** sagittal, coronal, axial views showing anterior extension to the soft palate (arrow), abutting the posterior aspect of the right maxillary 3rd molar (arrowhead); and posterior compression of the prevertebral space (asterisk); **B.** Inferior compression of the right submandibular gland at the level of C3 vertebral body (arrowhead); **C.** Superior extension to the level of the right pterygoid fossa (arrow); **D.** coronal section showing bilateral external/internal carotid arteries (E/ICA; arrowhead) and internal jugular veins (IJV; arrow) are not involved; and **E.** Medial displacement of the right pharyngeal mucosal space to the left. The right fossa of Rosenmuller is obliterated (left with asterisk), and the right IJV is compressed (arrow).

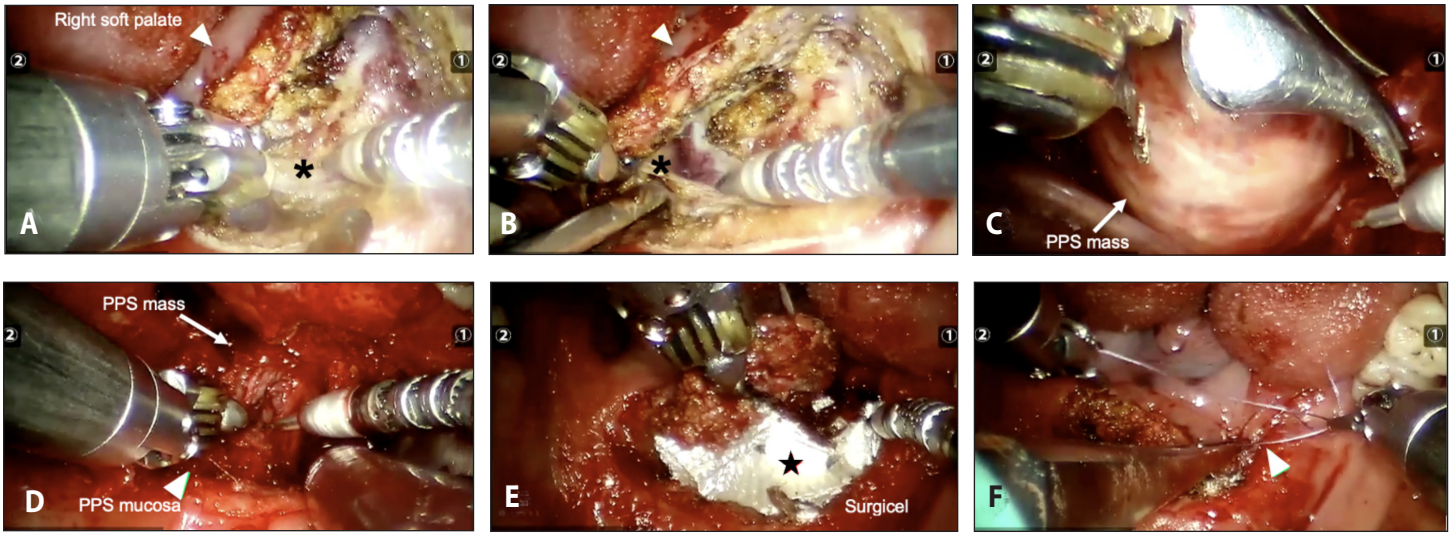


Figure 4. Images from the TransOral robotic surgery approach: **A.** Soft palate (arrowhead) incision and opening of the mass capsule (asterisk); **B.** freeing up the peripheral margins of the mass capsule (asterisk); **C.** freeing up the encapsulated parapharyngeal space mass (PPS, arrow); **D.** ligating and separating from the posterior attachment from the mucosa (arrowhead); **E.** packing with Surgicel™ (star) after removal of tumor residuals and hemostasis; **F.** suturing of the parapharyngeal space mucosa; and **G.** excised PPS mass

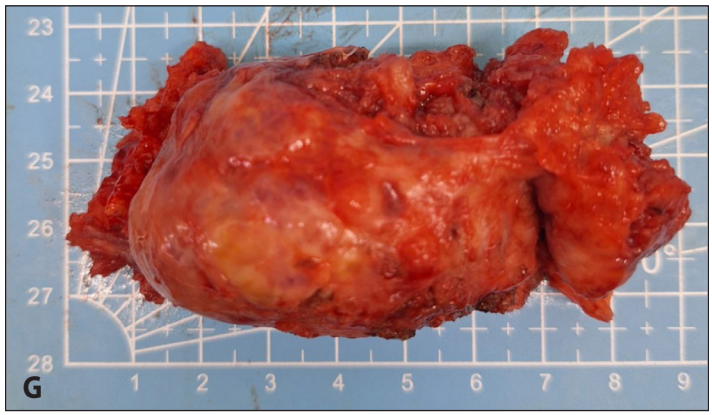




Figure 5. Post-operative oral cavity and neck showing: **A.** successful removal of right parapharyngeal mass using transoral robotic surgery leading to **B.** decannulation

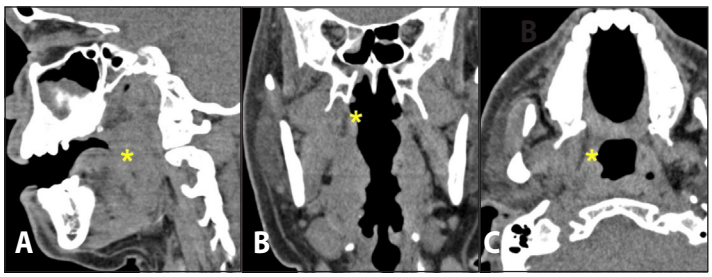


Figure 6. Postoperative CECT of the paranasal sinuses (10/05/2024), representative **A.** sagittal, **B.** coronal, and **C.** axial cuts revealing no residual right parapharyngeal space mass post-operatively (asterisks – previous location of mass)

DISCUSSION

Our case highlights the successful resection of a large pleomorphic adenoma via primarily TORS approach despite exceeding the previously reported 6 cm size threshold. No break in the capsule, tumor spillage, post-operative complication and tumor recurrence occurred. Key factors contributing to surgical success included favorable tumor characteristics (well-circumscribed, non-invasive), benign histopathology, detailed preoperative imaging, use of the intraoperative navigation system and vascular doppler, dual surgical set-up for an open approach, and surgeon understanding of complex PPS anatomy. These factors allowed for a safe and successful large PPS tumor excision using the TORS, which would otherwise have been approached via open surgery.

Traditionally, an open surgery via the transcervical approach was the most used technique as it offered good PPS exposure with minimal morbidity. With larger PPS masses, the combined transcervical and trans mandibular approaches provided better exposure but had higher morbidity from splitting the mandible.[7] Other approaches were also available but involve extensive dissections.

TransOral Robotic Surgery (TORS) as an approach to parapharyngeal masses is a relatively new way to resect masses in small and hard to access spaces such as the PPS. It offers a minimally invasive option of excising transoral masses compared to other open approaches. However, critics do not favor its usage in anatomically complex regions such as PPS because of limited exposure for larger tumors with risks

for tumor spillage, infection and neurovascular injury. Therefore, the indications for TORS have remained conventionally for resection of well-circumscribed, medially located, benign PPS tumors like pleomorphic adenoma.[8]

Generally, the surgical approach depends on tumor localization, size, initial biopsy results and compromise of adjacent structures. Good TORS candidates include those with adequate mouth opening enough to accommodate the robotic instruments and masses that are well-circumscribed regardless of proximity to crucial adjacent structures such as the internal carotid artery, although most surgeons would opt not to use this technique for cases with masses closely abutting it.[8,9] Radiological studies aid in determining resectability of the mass. Both CT and Magnetic Resonance Imaging (MRI) can identify the tumor origin, extension, and relationship between the prestyloid fat pad and the direction of vessel displacement. In our case, the paranasal sinus CECT allowed visualization of an enlarged right oropharyngeal mass with well-circumscribed appearance, albeit enlarged (> 6 cm), suggesting resectability through TORS. However, due to its large size exceeding previous conventional threshold, a double set-up was prepared in case an open approach would be needed, which proved to be unnecessary. Utilization of an intraoperative navigation system and vascular doppler together with TORS further enhance safety by providing anatomical guidance for real-time decision making in surgeries involving this deep and complex space. These highlight the importance of the surgeon's good grasp of the anatomy of the PPS, and innovative peri-operative and intraoperative imaging set-ups, to perform a safe TORS procedure and be able to decide when to shift approaches, if necessary, in order to maximize the advantages of TORS in minimizing the external incisions and dissection of unaffected anatomical structures without compromising tumor excision.[10]

Studies on the resection of large parapharyngeal space mass (> 6 cm) using TORS are currently limited.[6,8] There have been reported cases, but these are few. A recent systematic review by Chiari *et al.* reported the use of TORS for PPS tumors with an overall mean tumor diameter of 4.18 cm, mean operative time of 93.20 minutes, mean interval to oral intake resumption of 1.8 days, and mean discharge interval of 3.6 days.[6] Our case aligns with these findings with an operative time of 135 minutes for a 7cm tumor, 1 day to resumption of oral feeding, and 2 days to discharge. The review included cases with tumor diameters of 7.0, 8.5 and 8.6 cm excised via TORS. Like our case, the large tumors reported in the review were well-encapsulated benign pleomorphic adenoma, pre-styloid in location making them good candidates for TORS.[2,11,12] However, conferring with the systematic review results where TORS-only approach was successfully applied for tumors with mean diameter of 38.3 mm, the cases of large tumors were excised in combination with an open approach such as transparotid modified facelift incision.[6] This is unlike our case that successfully excised a large tumor (7cm) with TORS alone. Another interesting case reported was a large 7.1cm retrostyloid benign nerve sheath tumor that was excised via TORS-only approach. Although the location and histopathology are different, the tumor was benign, well encapsulated, and with a well-documented pre-operative imaging similar to our case which allowed for an adequate pre-operative planning and uncomplicated robotic surgery despite tumor size.[13] Overall, these reflect the relative novelty of the technique and restrictions posed by its critics, making our case relevant for surgical advancement. On the other hand, several studies demonstrated successful parapharyngeal mass excision using the closely related but less technologically advanced non-robotic transoral endoscopic technique[3,14] such as that of the pioneering 2024 study of Chen *et al.* with an average mass size of >5 cm, (range 4 x 4 to 7 x 7 cm).[5] More recently, another group reviewed 95 reports of PPS tumors removed endoscopically, with 93.8% primary PPS masses, 97.4% benign, and with an average of 5 cm mass size of which 6.17% were converted into an open approach.[1] The overall complication rate (endoscopic and endoscopic with open approach) was 27.4% with complications such as pharyngeal dehiscence, tumor fragmentation, laryngeal palsy, Horner syndrome, lip/tongue numbness, and mouth-opening limitation.

Reporting cases in series, the same group successfully excised 10 PPS tumors with an average tumor size of 5.9 × 3.7 cm, and the largest tumor at 8.0 × 6.0 cm, using the endoscopic approach without conversion to open surgery.[1] Endoscopically assisted approaches eliminate the need for external incisions, result in short hospital stays, minimal blood loss, and little postoperative pain. However, illumination is poor, rendering maneuverability difficult.[1] Overall, it is still recommended that non-robotic endoscopic surgery be used for smaller (<4–5 cm), medial PPS lesions only. On the other hand, TORS offers wider 3-dimension near-field visualization, better image quality and subsequently better degree of freedom of movement which is particularly useful when access is limited therefore currently recommended for deep to medial PPS masses of 6 cm size thresholds.[15,16] In the case of our patient these advantages of TORS led to complete tumor resection and good post-operative outcomes. This is consistent with another case of a 5.1 × 7.1 × 6.5 cm PPS prestyloid mass excised using TORS reporting similar excellent post-surgical outcomes.[12] This suggests that the endoscopic approach in general, and TORS in particular, can be developed as a technique to excise larger parapharyngeal tumors with minimal invasiveness, resulting in less intraoperative complications, and higher rates of success.

In conclusion, our case highlights Transoral Robotic Surgery (TORS) as an emerging viable and minimally invasive alternative for resecting tumors in the PPS without capsule break or tumor spillage, including larger lesions previously thought unsuitable for this approach. With careful patient selection, advanced imaging support, and appropriate surgical expertise, TORS offers a minimally invasive approach reducing morbidities otherwise associated with an open surgery, changing the paradigm of PPS mass excision.

ACKNOWLEDGEMENTS

The authors would like to express our deepest gratitude to Dr. Jose Florencio F. Lapeña Jr, Dr. Martin Jacinto, and Dr. Matthew Hernandez for their contributions to this case report.

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