Keywords
Transoral robotic surgery (TORS); Oropharyngeal squamous cell carcinoma; Modular robotic system; Glossotonsillar sulcus; Lingual artery ligation.

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# Feasibility of Transoral Robotic Surgery with a Modular Multi-Arm Platform in Early Oropharyngeal Squamous Cell Carcinoma

**Abstract**

**Background:** Transoral robotic surgery (TORS) is an established minimally invasive approach for early-stage oropharyngeal squamous cell carcinoma (OPSCC), providing oncologic control while preserving function. Experience with newer modular multi-arm robotic platforms in TORS remains limited. The objective of this report was to describe the operative technique and evaluate the technical feasibility and early oncologic outcomes of TORS performed using a modular robotic platform.

**Methods:** A 38-year-old male with cT2N1M0 HPV-independent OPSCC of the right glossotonsillar sulcus underwent TORS using the MIZZO™ Endo 4000 system followed by modified neck dissection (levels II–V). Operative setup included 15–20° cervical extension, FK retractor exposure, 30° lateral cart angulation, and sequential endoscope-first docking to achieve stable triangulation. Circumferential mucosal incision and controlled submucosal dissection were performed under three-dimensional visualization with prophylactic ligation of the right lingual artery.

**Results:** Complete tumor excision with negative surgical margins (R0) was achieved. Final histopathology confirmed moderately differentiated squamous cell carcinoma with 29 lymph nodes negative for metastasis (pT2N0). Docking time was 15 minutes, console time 80 minutes, and total operative time approximately 200 minutes, with estimated blood loss <50 mL. No intraoperative complications, robotic malfunction, conversion, postoperative hemorrhage, airway compromise, or need for tracheostomy or enteral feeding occurred. The patient was discharged uneventfully.

**Conclusion:** TORS using a modular multi-arm robotic platform was technically feasible and achieved favourable early oncologic and perioperative outcomes. Larger prospective studies are required to validate reproducibility and long-term results.

## 1. INTRODUCTION

Transoral robotic surgery (TORS) has emerged as an important minimally invasive surgical approach for selected cases of oropharyngeal squamous cell carcinoma (OPSCC). Historically, open surgical approaches to the oropharynx were associated with significant morbidity and functional impairment, leading to increased interest in transoral access techniques that preserve speech and swallowing function. In early T-stage OPSCC, TORS has demonstrated favorable oncologic and functional outcomes, making it an accepted treatment modality in multidisciplinary care pathways 1.

Several large series and systematic reviews have reported that TORS results in comparable locoregional control and survival outcomes to traditional approaches, with the added benefits of reduced hospital stay and lower rates of tracheostomy and feeding tube dependence 1. Recent evidence also supports successful disease control with TORS combined with neck dissection in early OPSCC, even with limited application of adjuvant therapy in selected cohorts 2.

Technical considerations in TORS include stable intraoral exposure, surgeon familiarity with endoscopic visualisation, and careful alignment of robotic arms to enable effective instrument articulation within a confined operative corridor. Although most literature to date has described TORS using established robotic platforms. However, there is growing interest in alternative and modular robotic configurations that may facilitate similar technical goals 3.

The MIZZO™ Endo 4000 (Merai Newage Private Limited) is a modular, multi-arm robotic platform designed to provide wristed instrument articulation and three-dimensional visualization, principles that are foundational to effective TORS. A clear understanding of operative setup, docking strategy, and intraoperative ergonomics is critical for reproducible outcomes when utilizing any robotic system. There are currently limited published descriptions of the use of newer robotic platforms for TORS in oropharyngeal malignancy, particularly regarding docking and instrument configuration.

In this case report, we present early-stage OPSCC managed with TORS using the MIZZO™ Endo 4000, with emphasis on operative setup, docking considerations, and early clinical outcomes relevant to minimally invasive robotic head and neck surgery.

## 2. CASE PRESENTATION

A 38-year-old male presented with a one-month history of a non-healing ulcer over the right glossotonsillar sulcus associated with mild odynophagia. There were no significant past medical history or known comorbidities. Clinical examination revealed an ulceroinfiltrative lesion involving the right anterior tonsillar pillar extending to the glossotonsillar sulcus, with a palpable right level IB cervical lymph node.

Positron emission tomography–computed tomography (PET-CT) demonstrated an FDG-avid primary lesion (SUVmax 12.4) in the right glossotonsillar region (2.1 x 1.8 cm) with ipsilateral level IB nodal uptake (SUVmax 4.2, 1.2 cm short axis); no distant metastasis. Incisional biopsy confirmed moderately differentiated squamous cell carcinoma (HPV-independent). Disease staged as cT2N1M0 (AJCC 8th edition)

The case was discussed in a multidisciplinary tumor board, which recommended primary surgical management. The patient underwent transoral robotic surgery (TORS) using the MIZZO™ Endo 4000 platform for wide local excision of the right glossotonsillar lesion, followed by modified neck dissection (MND, levels II–V). Intraoperatively, circumferential mucosal incision was performed under magnified three-dimensional visualization, with controlled submucosal dissection along the tumor capsule to achieve oncologic clearance. The right lingual artery was identified and ligated prophylactically, and the specimen was retrieved transorally intact for pathological assessment.

The postoperative course was uneventful. Final histopathological examination confirmed moderately differentiated squamous cell carcinoma with negative surgical margins. A total of 29 lymph nodes were harvested, all negative for metastasis (0/29). The final pathological stage was pT2N0. The patient was discharged in stable condition and remains under follow-up without evidence of early recurrence.

## 3. ROBOTIC OPERATIVE TECHNIQUE

Following induction of general anaesthesia and nasotracheal intubation, the patient was positioned supine with approximately 15–20° cervical extension using a shoulder roll while maintaining neutral head alignment. The head was secured to prevent intraoperative movement. A self-retaining transoral retractor system (FK retractor) was applied to achieve stable exposure of the right glossotonsillar sulcus and anterior tonsillar pillar. Adequate visualization of the tumor margins and surrounding musculature was confirmed prior to robotic docking (Fig. 1).

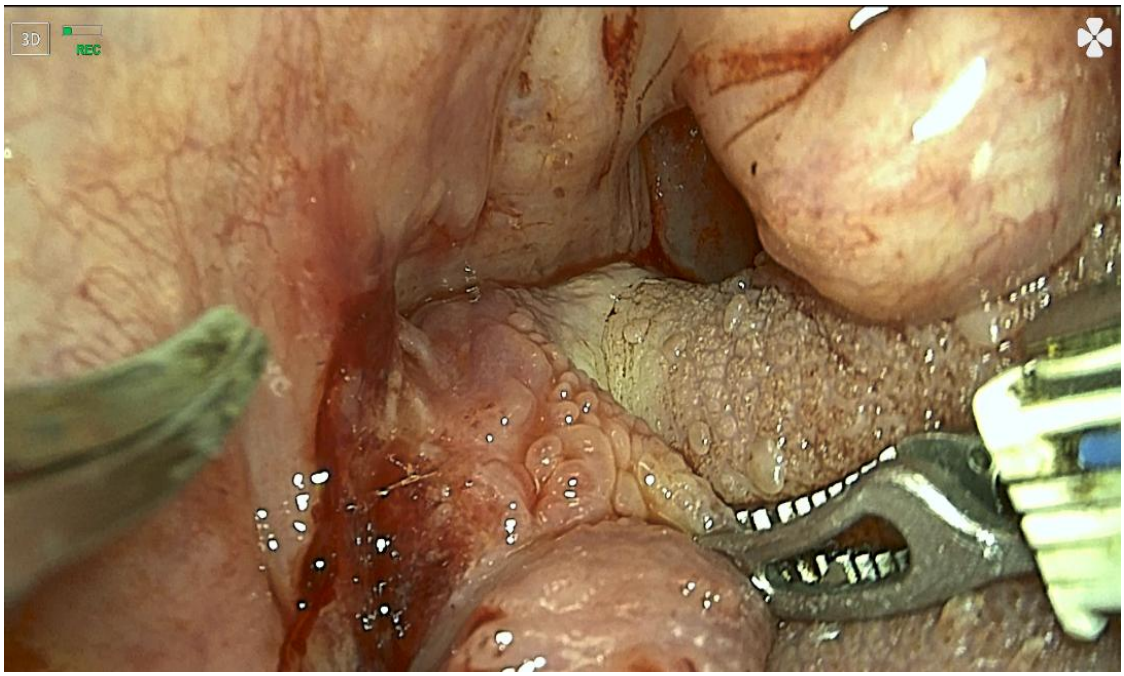


**Figure 1. Pre-resection endoscopic view demonstrating the glossotonsillar lesion prior to mucosal incision.**

The MIZZO™ Endo 4000 robotic arm cart was positioned laterally on the operative side in an oblique configuration relative to the patient axis (30° angle) to facilitate optimal internal triangulation within the confined oropharyngeal workspace. Sequential docking commenced with the endoscope arm introduced centrally through the oral cavity, followed by two articulating working arms (Monopolar Straight Scissors and Bipolar Maryland Forceps) positioned bilaterally to establish stable instrument convergence around the target lesion. External arm spacing was adjusted to ensure collision-free articulation and smooth instrument excursion (average docking time: 15 min).

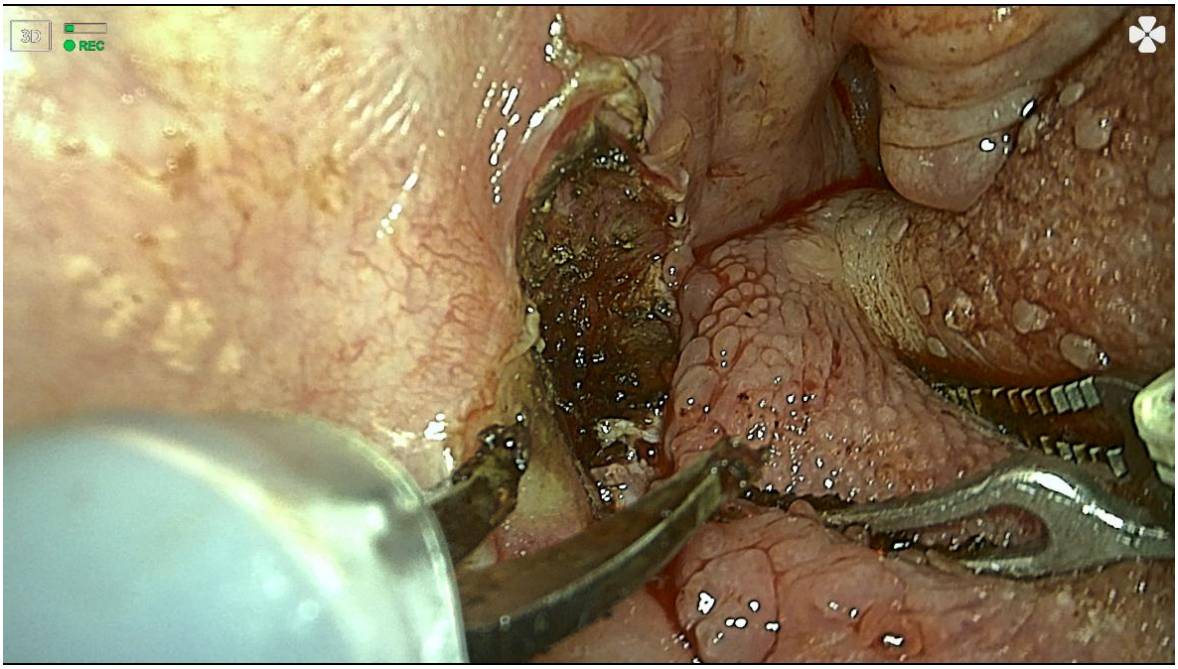


**Figure 2. Robotic circumferential mucosal incision and initiation of submucosal dissection.**

A 30° endoscope was utilized (MIZZO™ Endo 4000 is equipped with both 30° and 0° camera) to provide enhanced three-dimensional magnified visualization of the glossotonsillar region, tongue base musculature, and adjacent neurovascular structures. Under motion scaling and tremor filtration, a circumferential mucosal incision was performed around the lesion with intent to preserve oncologic margins. (Fig. 2) Submucosal dissection proceeded in a controlled plane along the tumor capsule, maintaining constant visualization of surrounding musculature (Fig 3).

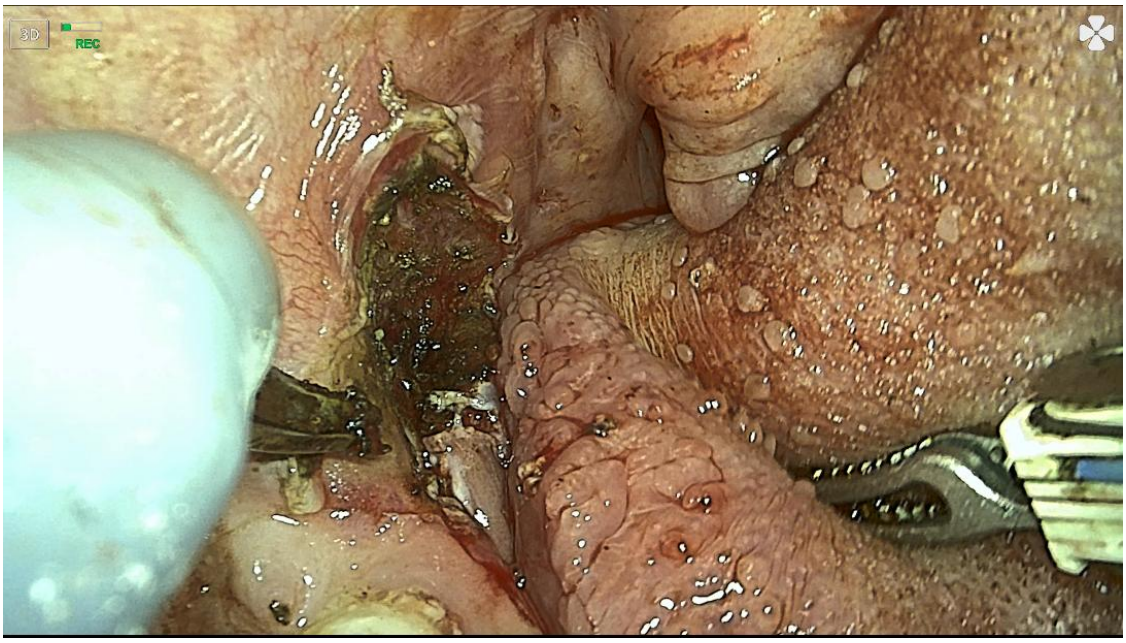


**Figure 3. Advanced submucosal dissection under three-dimensional visualization with tumor mobilization.**

Hemostasis was secured under direct magnified visualization (console time: 80 min). The specimen was retrieved transorally in an endoscopic retrieval bag and oriented for pathological assessment. The robotic system was sequentially undocked following confirmation of hemostasis. A right selective neck dissection (levels II–V) was subsequently performed through a standard cervical incision. The right lingual artery was identified intraoperatively and ligated as part of the oncologic resection strategy.

Total operative time, including TORS and neck dissection, was approximately 100 minutes. Estimated blood loss was less than 50 mL. No robotic malfunction, instrument instability, arm collision, or need for conversion occurred.

## 4. DISCUSSION

Advancements in robotic-assisted surgery have significantly influenced the management of oropharyngeal squamous cell carcinoma (OPSCC), enabling minimally invasive transoral access while avoiding the morbidity associated with mandibulotomy and extensive open approaches.[4,5] Transoral robotic surgery (TORS) has demonstrated favorable oncologic and functional outcomes in selected T1–T2 lesions and is now incorporated into multidisciplinary treatment strategies for appropriately selected patients.[6,7]

Procedural success in TORS is contingent upon standardized technical execution. Early clinical series emphasized reproducible patient positioning, stable transoral retraction, and precise robotic docking to achieve effective triangulation within the confined oropharyngeal workspace.[4,8] Lateral cart alignment and appropriate arm spacing have been described as essential to minimize mechanical interference and maintain instrument stability during transoral articulation.[4,9] In the present case, controlled cervical extension and oblique cart orientation enabled consistent glossotonsillar exposure without intraoperative interruption or need for redocking, in keeping with established technical principles.

Oncologic resection principles remain fundamental regardless of the robotic platform employed. A circumferential mucosal incision with controlled submucosal elevation is critical for achieving negative deep margins while preserving adjacent neurovascular structures.[10] In experienced centres, TORS for early-stage OPSCC has demonstrated high negative-margin rates (approximately 80–90%) and positive margins have been associated with an increased risk of local recurrence.[6,7] In this patient, complete resection with negative margins and a pathologically node-negative neck dissection (0/29 lymph nodes) was achieved, consistent with favorable early oncologic outcomes reported in the TORS literature.[10]

Postoperative haemorrhage remains one of the most clinically significant complications of TORS, with reported bleeding rates ranging between 5% and 10% in large institutional series.[11] Severe or life-threatening haemorrhage occurs less frequently but represents the primary cause of TORS-related morbidity. Prophylactic transcervical arterial ligation targeting the external carotid artery or its major branches has been shown to significantly reduce the rate of severe postoperative bleeding in selected patients.[12] In this case, no postoperative haemorrhage, airway compromise, or requirement for tracheostomy was encountered.

Functional preservation, particularly swallowing function and avoidance of long-term enteral access, remains a principal advantage of the transoral approach. Contemporary evidence demonstrates favorable swallowing-related quality-of-life outcomes and earlier return to oral diet following primary TORS, particularly in patients who do not require adjuvant therapy 13,14.

Emerging evidence suggests that reproducible docking geometry, stable instrument articulation, and consistent visualization are fundamental determinants of safety and feasibility in TORS, irrespective of robotic platform configuration.15. In this case, the modular multi-arm

configuration of the MIZZO™ Endo 4000 system provided stable triangulation and uninterrupted instrument control without system malfunction or conversion, supporting technical feasibility within established TORS methodology. A prospective multicenter evaluation across robotic platforms remains necessary to define long-term oncologic outcomes and establish comparative performance benchmarks.

Overall, this case reaffirms that adherence to standardised TORS principles enables oncologic clearance while preserving function in early-stage OPSCC. Prospective multicenter evaluation across robotic platforms remains necessary to define long-term oncologic outcomes and comparative performance metrics.

## 5. LIMITATIONS

This report represents a single-case experience, limiting generalizability of outcomes. Comparative performance against established robotic platforms cannot be determined from this observation alone. Long-term oncologic and functional outcomes were not evaluated. Larger prospective studies are required to validate reproducibility and platform consistency across centers.

**Learning Points**

- Standardized patient positioning and precise docking geometry are critical to achieving stable triangulation in transoral robotic surgery.
- Adherence to oncologic principles, including a circumferential mucosal incision and controlled submucosal dissection, remains fundamental regardless of the robotic platform.
- Prophylactic lingual artery ligation may reduce postoperative hemorrhage risk in glossotonsillar resections.
- Modular multi-arm robotic systems can achieve technically feasible TORS when ergonomic and surgical principles are systematically applied.

## 6. CONCLUSION

Transoral robotic surgery for early-stage OPSCC was safely performed using a modular multi-arm robotic platform with stable docking, effective triangulation, and satisfactory early oncologic outcomes. Negative margins and a pathologically node-negative neck were achieved without perioperative complications. This case supports the technical feasibility of the MIZZO™ Endo 4000 in TORS when established surgical principles are applied. Larger prospective studies are required to confirm reproducibility and long-term outcomes.

**Conflict of Interest:**

Dr. Kiran Kumar Shetty is an employee of Meril Life Sciences Pvt. Ltd. His contribution to the case report was limited to providing editorial support during manuscript preparation and technical input regarding the description of the medical device. He was not involved in the clinical management of the patient or interpretation of the clinical findings.

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