Three-Port Transoral Robotic Thyroidectomy: Technical Description and Early Outcomes

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Francesco Brucchi[1,2], Carla Colombo[2,3], Hoon Yub Kim[4], Gianlorenzo Dionigi[1,2]

[1]Division of General Surgery, Istituto di Ricovero e Cura a Carattere Scientifico (IRCCS) Istituto Auxologico Italiano, 20145 Milan, Italy
[2]Department of Pathophysiology and Transplantation, University of Milan, 20122 Milan, Italy
[3]Division of Endocrinology, Istituto di Ricovero e Cura a Carattere Scientifico (IRCCS) Istituto Auxologico Italiano, 20145 Milan, Italy
[4]Department of Surgery, KUMC Thyroid Center, Korea University Hospital, Korea University College of Medicine, 02841 Seoul, Republic of Korea

AIM: Transoral robotic thyroidectomy has emerged as a scarless alternative to conventional and remote-access approaches; however, technical standardization and outcome data for truly scarless three-port configurations remain limited. The aim of this study was to describe the surgical technique and early clinical outcomes of three-port transoral robotic thyroidectomy (TORT) as a truly scarless remote-access approach to the thyroid gland.

METHODS: This technical note reports a consecutive series of 25 patients who underwent three-port transoral robotic thyroidectomy between June 2017 and May 2019 at Korea University Hospital. Surgical steps, including vestibular port placement, working-space creation, robotic docking, and lobectomy procedures, are detailed. Perioperative data, postoperative outcomes, and complications were retrospectively analyzed.

RESULTS: The median age was 41.0 years, and 76.0% of patients were female. Unilateral thyroidectomy was performed in 80.0% of cases, and central neck dissection in 52.0%. The median operative time was 308.0 minutes, with minimal blood loss (3.0 mL). No intraoperative complications occurred. Transient hypoparathyroidism and recurrent laryngeal nerve palsy were observed in 4.0% of patients each, while one permanent recurrent laryngeal nerve injury (4.0%) was recorded. No cases of mental nerve injury or surgical site infection were observed. Postoperative pain was low, and the median hospital stay was 3 days.

CONCLUSIONS: Three-port transoral robotic thyroidectomy is a feasible and safe technique in carefully selected patients when performed in experienced centers. Despite a prolonged operative time during the initial learning phase, complication rates were acceptable and cosmetic outcomes were excellent. This approach should currently be reserved for high-volume endocrine robotic units under strict indication criteria and structured training pathways.

Keywords: transoral robotic thyroidectomy; TOETVA; robotic surgery; thyroidectomy; scarless surgery; mental nerve; technical note

Introduction

Transoral Endoscopic Thyroidectomy Vestibular Approach (TOETVA) was initially developed as an endoscopic technique and later adapted to robotic platforms to take advantage of three-dimensional vision and articulating instruments [1–3]. Compared with other remote-access routes (transaxillary, bilateral axillo-breast, retroauricular), the transoral vestibular approach provides a midline, short-flap corridor to the central neck and is unique in achieving a truly cervical-scarless result [4–11].

A four-port configuration, using three oral vestibular trocars and one axillary port, is most frequently reported; however, a three-port "truly scarless" transoral robotic thyroidectomy (TORT) variant that omits the axillary incision has recently been described, with shorter operative time and similar safety in early series [12–15]. This technical note provides a step-by-step description of three-port TORT and outlines key perioperative considerations.

Methods

Patient Positioning and Preparation

The study was conducted in accordance with the Declaration of Helsinki and complied with institutional ethical standards. Given the retrospective nature of this technical report and the use of anonymized data collected as part of routine clinical care, this study was exempted from ethics review by the KUMC Thyroid Center Ethics Commitee, Korea University Hospital. Written informed consent was obtained from all patients for the surgical procedure and for the use of anonymized clinical data and intraoperative images for scientific and educational purposes.

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Correspondence to: Francesco Brucchi, Division of General Surgery, Istituto di Ricovero e Cura a Carattere Scientifico (IRCCS) Istituto Auxologico Italiano, 20145 Milan, Italy; Department of Pathophysiology and Transplantation, University of Milan, 20122 Milan, Italy (e-mail: Francesco.brucchi@unimi.it).
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The patient is placed in a supine position with the neck slightly extended and the shoulders supported. A nasotracheal or oral endotracheal tube is secured at the oral commissure opposite the main working channel, ensuring it does not interfere with the vestibular ports. After dental protection and intraoral antisepsis with chlorhexidine or povidone–iodine, prophylactic intravenous antibiotics are administered according to institutional protocol. The skin of the chin and anterior neck is prepared and draped in a sterile manner, with the lower lip and vestibule exposed.

Vestibular Incisions and Working-Space Creation

Three small mucosal incisions are made in the lower lip vestibule: one central incision (midline, just above the frenulum) for the camera, and two lateral incisions placed paramedian between the canine and first premolar roots, carefully avoiding the mental foramen region. Blunt dissection with a vascular tunneler or dilator is used to enter the subplatysmal plane and create a working tunnel toward the anterior neck.

CO_2 insufflation (typically 5–6 mmHg) is then initiated, and a subplatysmal pocket is developed under endoscopic guidance from the mentum to the sternal notch, preserving the strap muscles. Particular attention is paid to limiting lateral dissection and avoiding overdistension to reduce the risk of subcutaneous emphysema and hypercarbia.

Robotic Docking and Exposure

All procedures were performed using the da Vinci Xi Surgical System (Intuitive Surgical, Sunnyvale, CA, USA). Trocars (usually 8 mm) are inserted through the three vestibular incisions, and the robotic cart is docked at the head of the patient with a central 30° down-looking camera and two working arms. Commonly used configurations include energy devices such as monopolar curved scissors, bipolar forceps, vessel-sealing devices, and a Maryland dissector.

The strap muscles are separated in the midline and retracted laterally to expose the thyroid lobe. The isthmus is divided early to improve mobility, and the operative field is maintained by gentle cephalad retraction of the strap muscles and the inferior pole.

Lobectomy Steps

Dissection proceeds in a caudal-to-cranial direction along the avascular plane between the thyroid capsule and surrounding soft tissues. Key steps include (Figs. 1,2,3):

1. Identification and control of the inferior thyroid vessels close to the capsule to reduce risk to the parathyroid glands.
2. Identification of the recurrent laryngeal nerve (RLN) at its entry into the larynx from a medial vantage point; intraoperative neuromonitoring can be used when available. Intraoperative neuromonitoring was performed using an electromyogram (EMG) endotracheal tube with surface electrodes positioned at the vocal cords.
3. Capsular dissection around the parathyroid glands, preserving their vascular pedicles; if devascularization is suspected, selective autotransplantation is performed according to standard endocrine protocols.
4. Management of superior pole vessels with careful traction and counter-traction to protect the external branch of the superior laryngeal nerve.

After completion of lobectomy, the specimen is retrieved via an endoscopic bag through the central vestibular incision. Hemostasis is meticulously checked, the strap muscles are reapproximated if necessary, and the working space is irrigated.

Table 1. Patient characteristics and surgical outcomes.

Characteristic	TORT Group (n = 25)
Age, median (IQR), years	41.0 (35.0–54.0)
Female sex, n (%)	19 (76)
BMI, mean (SD), kg/m²	23.48 (3.56)
Nodule size, median (IQR), cm	2.2 (1.4–3.7)
Bethesda class IV–VI, n (%)	17 (68)
Cancer, n (%)	10 (40)
Operative time, median (IQR), min	308.0 (284.0–391.0)
Blood loss, median (IQR), mL	3.0 (2.0–3.5)
Unilateral thyroidectomy, n (%)	20 (80)
Total thyroidectomy, n (%)	5 (20)
Central neck dissection, n (%)	13 (52)
Length of stay, median (IQR), days	3.0 (2.0–3.0)
Transient hypoparathyroidism, n (%)	1 (4)
Permanent hypoparathyroidism, n (%)	0
Transient RLN injury, n (%)	1 (4)
Permanent RLN injury, n (%)	1 (4)
Mental nerve injury, n (%)	0
Surgical site infection, n (%)	0
VAS POD 1, median (IQR)	2.0 (2.0–3.0)
VAS POD 2, median (IQR)	2.0 (2.0–2.0)

IQR, Interquartile Range; TORT, transoral robotic thyroidectomy; SD, Standard Deviation; BMI, Body Mass Index; RLN, recurrent laryngeal nerve; VAS, visual analog scale; POD, Post Operative Day.

Closure and Postoperative Care

CO_2 insufflation is stopped, trocars are removed, and the vestibular incisions are closed with absorbable sutures. A suction drain is generally avoided unless specific concerns arise; if used, it is exteriorized percutaneously in the submental area.

Postoperative management includes early oral intake, continued mouth rinses, monitoring for neck swelling, respiratory compromise, or signs of infection, and routine laryngeal assessment according to institutional practice.

Indications and Contraindications

Three-port TORT is primarily indicated for (Fig. 4):

- Benign thyroid nodules or multinodular goiter confined to one lobe, typically $\leq$4–5 cm in maximal diameter, depending on neck anatomy.

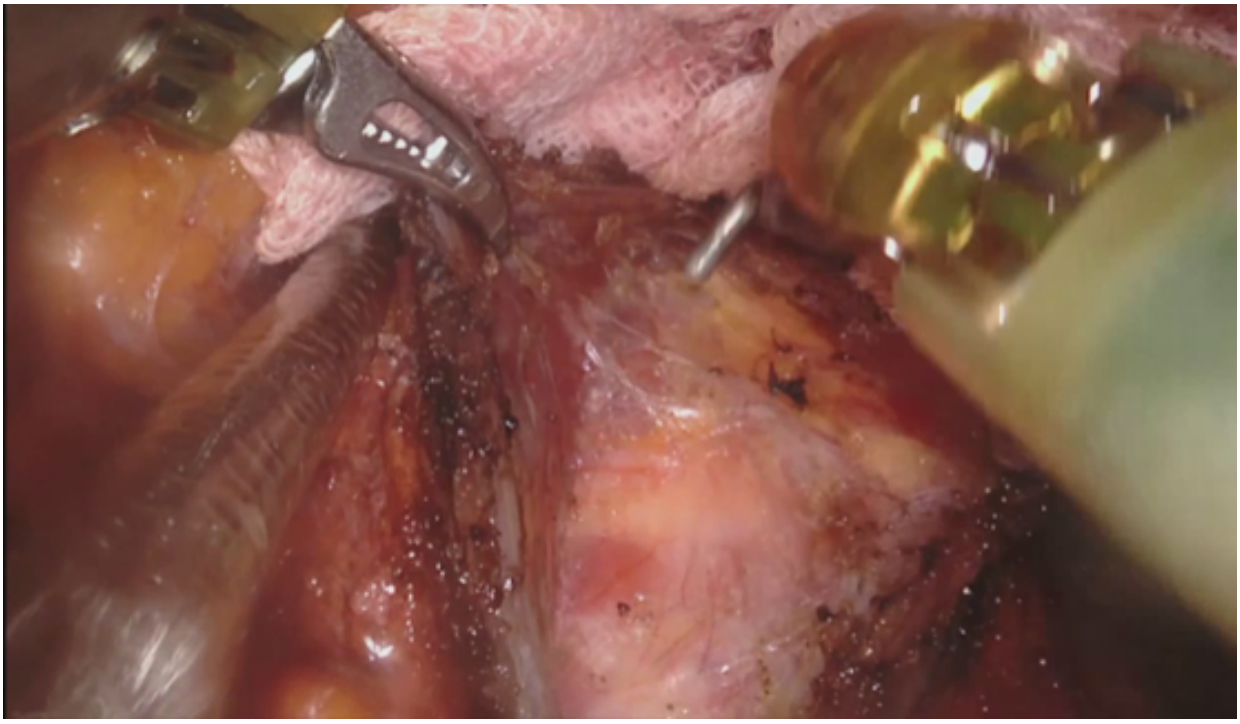

Fig. 1. Intraoperative view of the subplatysmal working space during three-port transoral robotic thyroidectomy. The midline separation of the strap muscles allows direct exposure of the thyroid lobe through the oral vestibular approach, illustrating the central, caudal-to-cranial operative orientation.

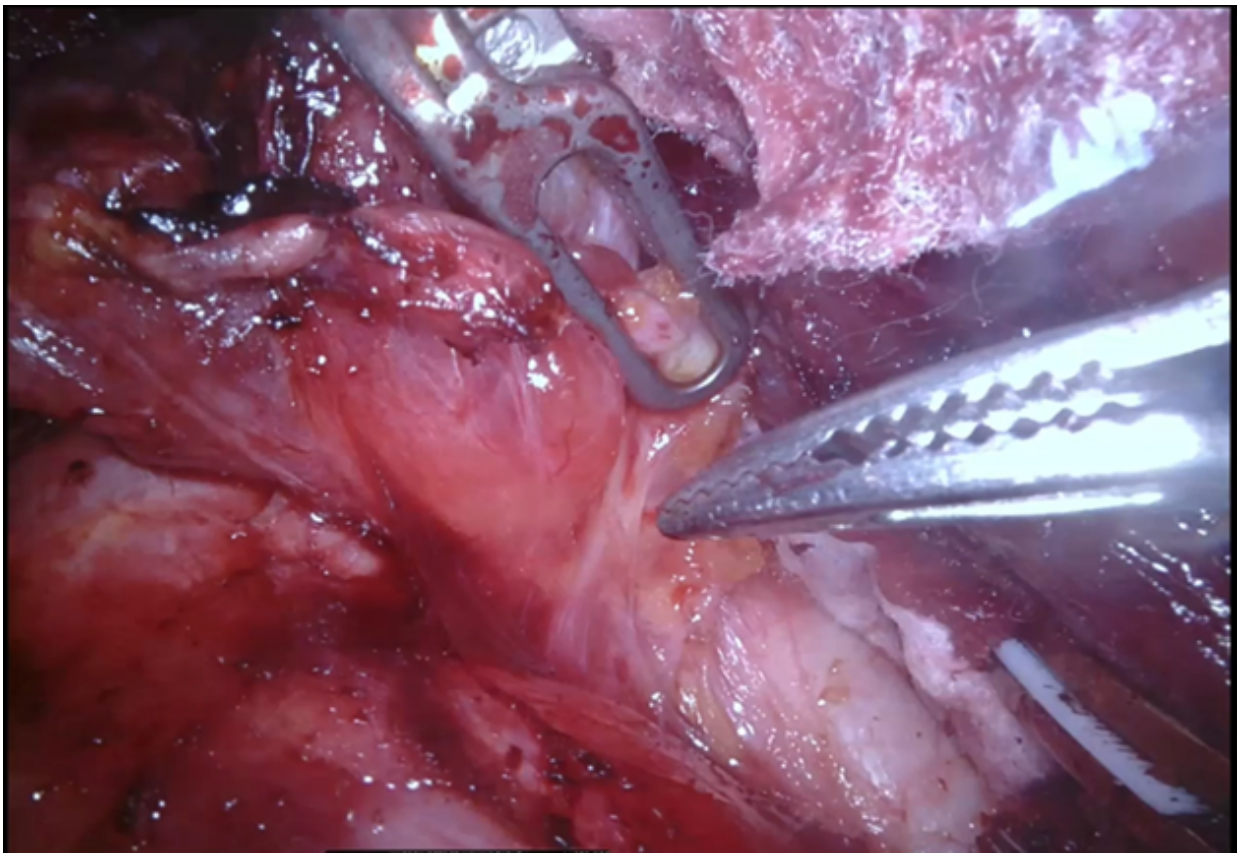

Fig. 2. Intraoperative identification of the recurrent laryngeal nerve during three-port transoral robotic thyroidectomy. The nerve is visualized from a medial perspective at its entry into the larynx, enabling safe capsular dissection of the thyroid lobe using articulating robotic instruments.

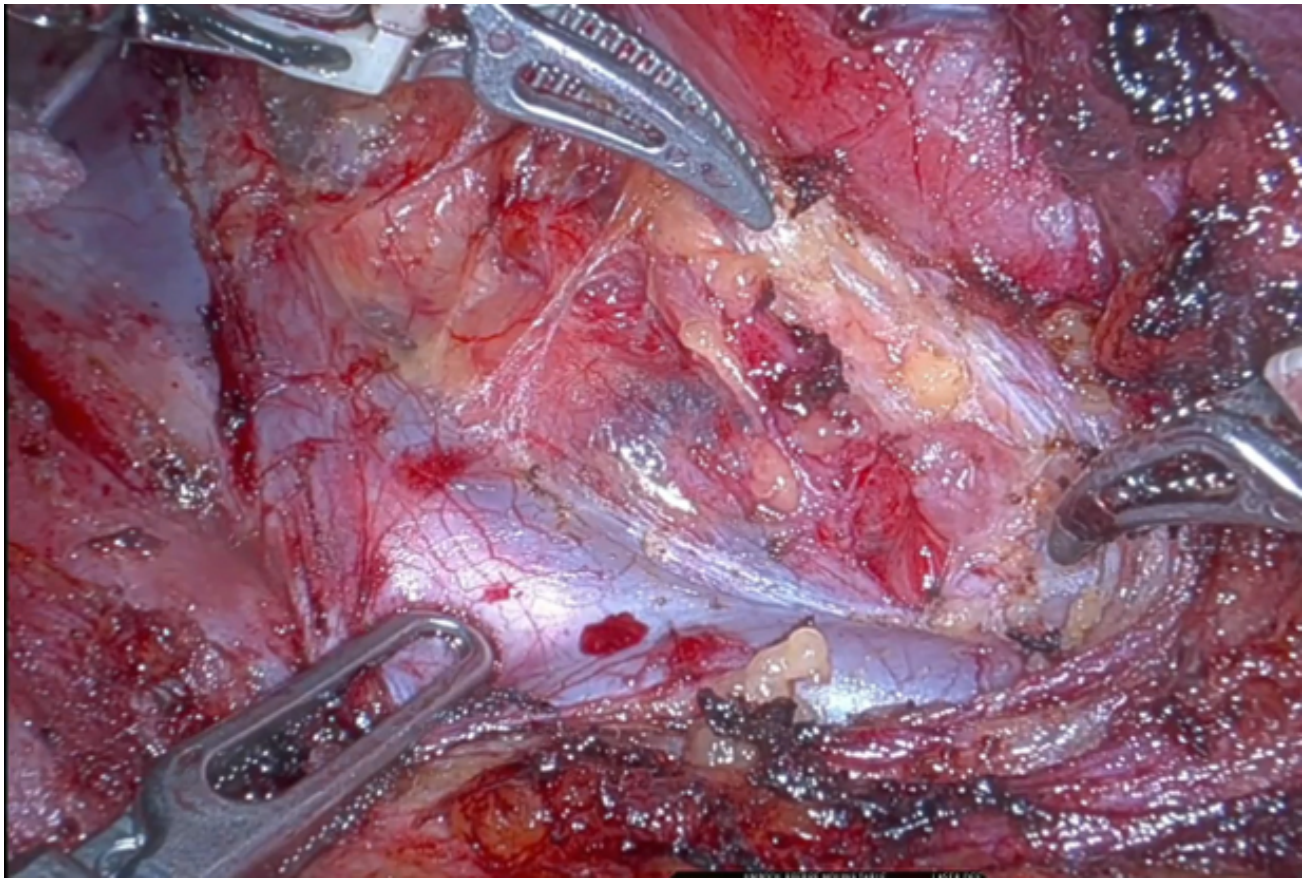

Fig. 3. Superior pole dissection during three-port transoral robotic thyroidectomy. Capsular traction and counter-traction are applied to allow safe division of the superior vascular pedicle while preserving the external branch of the superior laryngeal nerve.

- Low-risk, intrathyroidal differentiated thyroid carcinoma (T1–T2) without clinical or radiological evidence of bulky nodal disease.

Contraindications include:

- Extensive extrathyroidal extension, large or posteriorly located tumors, or bulky central or lateral lymphadenopathy.
- Previous major neck surgery or radiotherapy, severe dental or mandibular disease, active oral infection, or poor oral hygiene not correctable preoperatively.
- Severe cardiopulmonary comorbidities that increase risk from prolonged anesthesia and CO_2 insufflation.

Careful preoperative counseling should address the specific risks of mental nerve dysfunction, lower lip paresthesia, and oral-to-neck infection, as well as the possibility of conversion to open surgery.

The flowchart summarizes the main indications and contraindications for three-port TORT. Eligible patients include those with benign thyroid nodules or multinodular goiter confined to one lobe ($\leq$4–5 cm) and patients with low-risk intrathyroidal differentiated thyroid carcinoma (T1–T2) without clinical or radiological evidence of bulky nodal disease. Contraindications include extensive extrathyroidal extension, large or posteriorly located tumors, bulky central or lateral lymphadenopathy, previous major neck surgery or radiotherapy, active oral infection, poor oral hygiene, and severe cardiopulmonary comorbidities. Careful preoperative counseling regarding access-related risks and possible conversion to open surgery is emphasized.

Results

Between June 2017 and May 2019, a total of 25 consecutive patients underwent three-port transoral robotic thyroidectomy at Korea University Hospital (Table 1).

The median age was 41.0 years (Interquartile Range [IQR] 35.0–54.0), and 19 patients (76%) were female. The mean body mass index was 23.48 $\pm$ 3.56 kg/m^2. The median thyroid nodule size was 2.2 cm (IQR 1.4–3.7).

Preoperative fine-needle aspiration cytology revealed Bethesda class IV–VI lesions in 17 patients (68%) and Bethesda class II–III lesions in 8 patients (32%). Thyroid carcinoma was confirmed in 10 patients (40%).

Unilateral thyroidectomy was performed in 20 patients (80.0%), while 5 patients (20.0%) underwent bilateral total thyroidectomy. Central neck lymph node dissection was performed in 13 patients (52%), with a mean of 4.00 $\pm$ 2.48 lymph nodes retrieved. Among these, 3 patients (23.1%) had positive central lymph nodes.

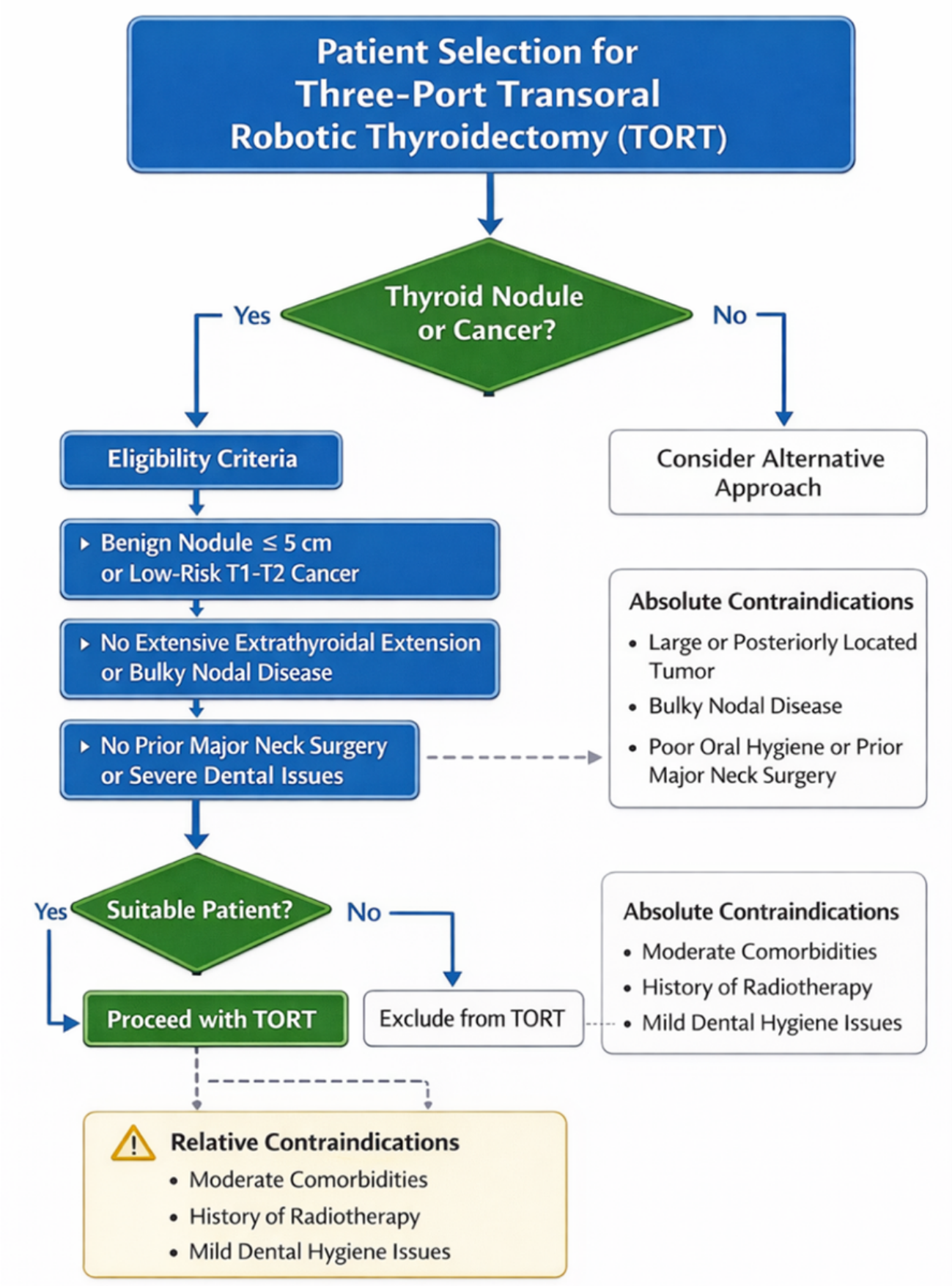

Fig. 4. Patient selection algorithm for three-port transoral robotic thyroidectomy (TORT).

The median operative time was 308.0 minutes (IQR 284.0–391.0), and the median estimated blood loss was 3.0 mL (IQR 2.0–3.5). No intraoperative complications were observed.

Postoperative pain, assessed using the visual analog scale (VAS), showed a median score of 2.0 (IQR 2.0–3.0) on postoperative day 1 and 2.0 (IQR 2.0–2.0) on postoperative day 2. The median length of hospital stay was 3.0 days (IQR 2.0–3.0).

Regarding postoperative complications, no cases of mental nerve injury, inferior labial branch injury, or surgical site infection were recorded. One patient (4%) developed transient hypoparathyroidism, and no cases of permanent hypoparathyroidism occurred. Transient recurrent laryngeal nerve palsy was observed in one patient (4%), while one patient (4%) experienced permanent recurrent laryngeal nerve injury.

The median follow-up duration was 6 months. During follow-up, based on clinical examination, no major cosmetic concerns, persistent sensory disturbances, or functional impairments were reported.

Literature Review (Summary of Reported Experience)

In a recent comparative series of three-port and four-port transoral robotic lobectomy for thyroid carcinoma, the three-port technique achieved a shorter mean operative time (approximately 107 minutes versus 141 minutes), with similar rates of minor complications and no conversions to open surgery [16]. Across published TORT cohorts, blood loss is typically low and hospital stay is short in appropriately selected patients [17–22].

Reported complication profiles include:

- Transient RLN palsy and transient hypocalcemia at rates broadly comparable to conventional and other remote-access robotic thyroidectomy in experienced centers, with permanent deficits uncommon [16,23].
- Access-specific events such as mental nerve neuropraxia with lower lip hypesthesia, usually transient, and rare but potentially severe infections or abscesses along the subplatysmal tunnel [24].
- CO_2-related issues such as subcutaneous emphysema and hypercarbia are generally self-limited with appropriate anesthetic monitoring and low-pressure insufflation.

Cosmetic satisfaction is consistently high, with most patients reporting a strong preference for the absence of a visible cervical scar [1].

Discussion

Three-port transoral robotic thyroidectomy represents an evolution in remote-access endocrine surgery, aiming to minimize both skin incisions and subcutaneous dissection. By eliminating the auxiliary axillary port, this approach achieves a “truly scarless” result while maintaining adequate working space and instrument triangulation through three vestibular trocars [16,25].

However, its safe application depends on:

- A high-volume setting with substantial experience in conventional thyroidectomy and robotic surgery [26].
- Meticulous attention to mental nerve preservation through precise vestibular port placement and limited lateral flap dissection.
- Standardized oral decontamination, antibiotic prophylaxis, and postoperative surveillance to reduce infection risk [4].

Current evidence is based mainly on retrospective single-center series with limited long-term follow-up and small cancer cohorts, so oncologic equivalence to open surgery, particularly for higher-risk disease, cannot yet be assumed. The relatively long operative time observed in the present series is likely related to the initial learning phase of three-port transoral robotic thyroidectomy. Kim *et al*. [27] reported, using cumulative summation analysis in a large cohort, that surgical proficiency is achieved after approximately 52–55 cases, with significant reductions in operative time and complication rates beyond this threshold.

Future prospective registries and multicenter collaborations are needed to define learning curves, complication benchmarks, and long-term oncologic and functional outcomes, also accounting for emerging single-port robotic platforms such as the da Vinci SP [28,29].

Given that the present series includes 25 cases performed during the early adoption phase, the operative times observed are consistent with previously reported learning patterns. Furthermore, the use of a three-port configuration without an auxiliary trocar may influence instrument triangulation and ergonomic handling, potentially affecting the learning process. Further studies are therefore needed to clarify whether port configuration impacts the learning curve of TORT. These findings highlight the importance of careful case selection and structured training in high-volume endocrine robotic centers.

Higher procedural costs related to robotic platform utilization and disposable instruments remain an important limitation for the wider adoption of three-port transoral robotic thyroidectomy.

Limitations and Future Directions

This study has several limitations. First, it is a retrospective, single-center technical report based on a relatively small sample size, which limits the generalizability of the findings. Second, the relatively short median follow-up represents a relevant limitation, particularly with regard to the assessment of long-term oncologic outcomes and late functional complications.

In addition, formal patient-reported outcome measures and standardized cosmetic satisfaction questionnaires were not routinely collected, which may have limited the objective evaluation of patient-centered outcomes. Cost-

effectiveness analyses were also beyond the scope of the present study.

Future multicenter prospective studies with larger cohorts and longer follow-up are needed to better define complication benchmarks and long-term oncologic and functional results. Furthermore, emerging technologies such as artificial intelligence-based image analysis and computer vision systems may support intraoperative identification of critical anatomical structures, including the recurrent laryngeal nerve and parathyroid glands, potentially enhancing surgical safety and training in the future.

Conclusions

Three-port transoral robotic thyroidectomy is a feasible and reproducible technique that enables thyroid lobectomy — and, in selected cases, total thyroidectomy — through a completely scarless vestibular approach. Early data indicate that, in well-selected patients and with experienced endocrine robotic teams, perioperative outcomes and complication rates are comparable to those of other remote-access techniques, with the added cosmetic benefit of no visible skin incisions.

Given its specific risk profile and technical complexity, three-port TORT should currently be limited to specialized centers, under strict indication criteria, comprehensive informed consent, and ongoing audit. As higher-quality evidence accumulates, its role within the broader spectrum of thyroid and parathyroid surgery can be more precisely defined.

Availability of Data and Materials

The data used and analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

Conceptualization, GD and FB; methodology, HYK, GD, FB, and CC; investigation, FB and CC; resources, GD; writing–original draft preparation, FB; writing–review and editing, HYK, GD and CC; supervision, GD. All authors contributed to the critical revision of the manuscript for important intellectual content. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the Declaration of Helsinki. Given the retrospective nature of this technical report and the use of anonymized data collected as part of routine clinical care, this study was exempted from ethics review by the KUMC Thyroid Center Ethics Committee, Korea University Hospital. Written informed consent was obtained from all patients for the surgical procedure and for the use of anonymized clinical data and intraoperative images for scientific and educational purposes.

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Conflict of Interest

The authors declare no conflict of interest.

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