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ORIGINAL RESEARCH

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Transoral thyroidectomy implemented by a novice surgeon: Efforts for safe implementation

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Abstract

Background: This study aimed to evaluate the feasibility, safety, and early surgical outcomes of transoral robotic and endoscopic thyroidectomy conducted by a novice surgeon.

Methods: We analyzed 27 patients who underwent transoral thyroidectomy between December 2018 and November 2021. All the surgeries were performed by a novice surgeon without prior endoscopic or robotic surgery experience; the surgeon had experienced 12 cases of transcervical thyroidectomy before adopting transoral thyroidectomy.

Results: Of the 27 cases, 1 was converted to the transcervical approach due to poor bleeding control. Four cases had transient recurrent laryngeal nerve palsy, and three had transient hypoparathyroidism. Most of the patients were very satisfied with the postoperative cosmetic outcome.

Conclusions: Transoral robotic and endoscopic thyroidectomies are feasible for the novice surgeon, with reasonable results in the early adoption stage if preparations are according to the suggested framework.

Level of Evidence: Level 4.

KEYWORDS
endoscopic surgery, novice surgeon, outcomes, robotic surgery, transoral thyroidectomy

1 | INTRODUCTION

In the most recent decades, various remote access thyroidectomy techniques using surgical robots or endoscopy have been developed to achieve superior cosmetic results, including the transaxillary, bilateral axillo-breast, postauricular facelift, and transoral approaches.[1] In addition to superior cosmetic results, remote access endoscopic or robotic thyroidectomy improves surgical views through magnification under an endoscopic or robotic system compared to conventional transcervical thyroidectomy.[2–4]

Among these techniques for remote access thyroidectomy, transoral thyroidectomy has recently experienced increased adoption by many institutions. The transoral approach is considered a true natural orifice transluminal endoscopic surgery (NOTES) since it requires incisions on the inner surface of the lower lip and leaves no skin scar. Furthermore, the dissection area is smaller than in other types of remote thyroidectomy, making it less invasive in terms of workspace.

However, many surgeons without previous laparoscopic or robotic experience are reluctant to perform transoral thyroidectomy mainly due to technical obstacles when elevating the flaps and removing the thyroid through small vestibular incisions with endoscopic and robotic instruments, because this requires adequate experience with both the conventional and endoscopic/robotic approaches before performing this procedure. Therefore, most transoral endoscopic and robotic thyroidectomies have been conducted by surgeons who have experience with endoscopic and robotic surgery and have experienced a high-volume of conventional thyroidectomy cases.[1–5] Moreover, especially for beginners, there is no consensus among authors regarding when this new procedure can be started and concerning the minimum number of required open thyroidectomy cases.[6] Here, we report on our initial experiences of transoral endoscopic and robotic thyroidectomy conducted by a novice surgeon with no experience in endoscopic or robotic surgery. We focused on adverse outcomes, surgical time, and patient satisfaction to evaluate the technical feasibility, safety, and efficacy of the procedure in a novice surgeon.

2 | MATERIALS AND METHODS

2.1 | Patients

This study was approved by the Institutional Review Board of Daegu Catholic University Hospital (IRB No. CR-22-019). From December 2018 to November 2021, we studied 27 consecutive patients with thyroid nodules who underwent transoral thyroidectomy via endoscopy or the da Vinci Xi Surgical Robot (Intuitive Surgical, Sunnyvale, CA, USA) with CO_2 insufflation at a tertiary university hospital in Daegu, Korea. All operations were performed by a single surgeon (DWL). As a resident, the surgeon assisted as a first or second assistant in approximately 20 cases of open thyroidectomy per year and approximately 10 cases of robotic or endoscopic thyroidectomy with transaxillary and facelift approaches per year. Moreover, the surgeon had never performed an operation as an independent primary surgeon during the 4 years of residency training. Before beginning the transoral thyroid surgery, he had conducted 12 conventional transcervical thyroidectomies as an independent primary surgeon and had not independently performed an endoscopic or robotic thyroidectomy. He completed his fellowship training, which was supervised by a pioneering head-and-neck surgeon (KT) in robotic and endoscopic thyroidectomy, including the transaxillary, postauricular facelift, and transoral approaches.

Our eligibility criteria included benign thyroid nodules or cystic masses <5 cm in diameter and differentiated thyroid carcinoma <2 cm at its largest diameter. We excluded patients with (1) thyroid cancers with gross extrathyroidal extension, (2) lateral neck metastases, (3) huge goiters, and (4) a previous history of thyroid/neck surgery or irradiation. Informed consent was obtained from all patients for the transoral endoscopic or robotic thyroidectomy and for conversion to transcervical thyroidectomy. All patients underwent preoperative ultrasonography, fine-needle aspiration cytology, computed tomography, and thyroid hormone tests.

2.2 | Training for transoral thyroidectomy

2.2.1 | Observation and scrubbing as a first assistant

Since 2017 as a fellow, the surgeon had gained experience as a first assistant in 30 cases before performing the first independent transoral thyroidectomy.[7]

2.2.2 | Cadaver dissection training

For two fixed cadavers and four fresh cadavers, we conducted trocar insertion and studied the chin, lower neck anatomy, and mental nerve pathways via a cadaver dissection program. It was possible to simulate realistic training on a fresh cadaver using the endoscope devices.

2.2.3 | Video clip watching and self-training using the webcam training tool to learn the relationship between the screen and endoscopic instruments

By repeatedly watching the videos of the mentor operator for more than 10 times per case, we were able to organize which instruments were used when and in which directions. With a self-training device using a webcam, the surgeon focused on synchronizing the screen with the endoscopic instruments (Figure S1). It was important for the surgeon to become acquainted with how the device would be displayed on the screen when hands were moved over it. To practice tissue peeling, we performed tangerine peeling using the endoscopic instruments. We also focused on improving the handling skills of the nondominant hand.

2.2.4 | Supervised independent operation of two cases

The first cases of the endoscopic and robotic surgeries were performed under the supervision of the mentor operator (K.T.).

2.3 | Operative procedure

The procedure was performed based on the surgical method previously described by several pioneers.[8,9] The patient was positioned in the supine position and a shoulder pillow was used to extend the neck on the operating table. An electromyographic endotracheal tube (Medtronic, Jacksonville, FL, USA) was used in all patients under general anesthesia. A flexible endoscope was inserted to check the appropriate depth of the electromyogram tube sensor. With povidone mixed with water, the oral cavity was disinfected and was rinsed again with normal saline. The skin was draped and prepared as usual. A 10- to 15-mm horizontal incision in the central region close to the

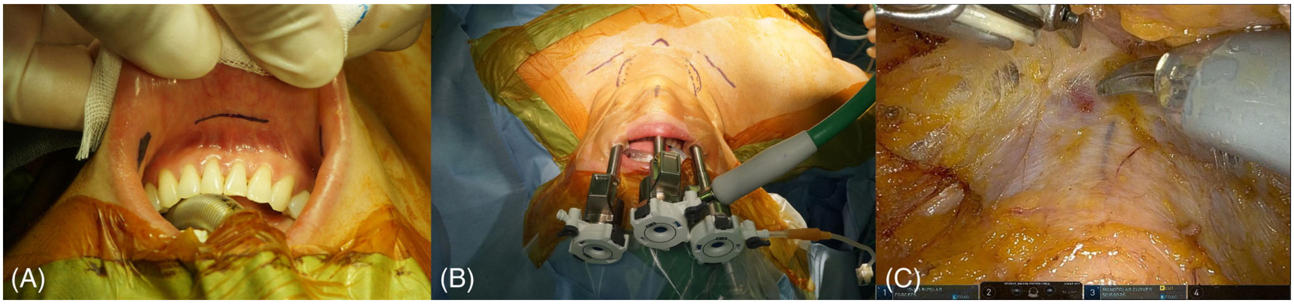
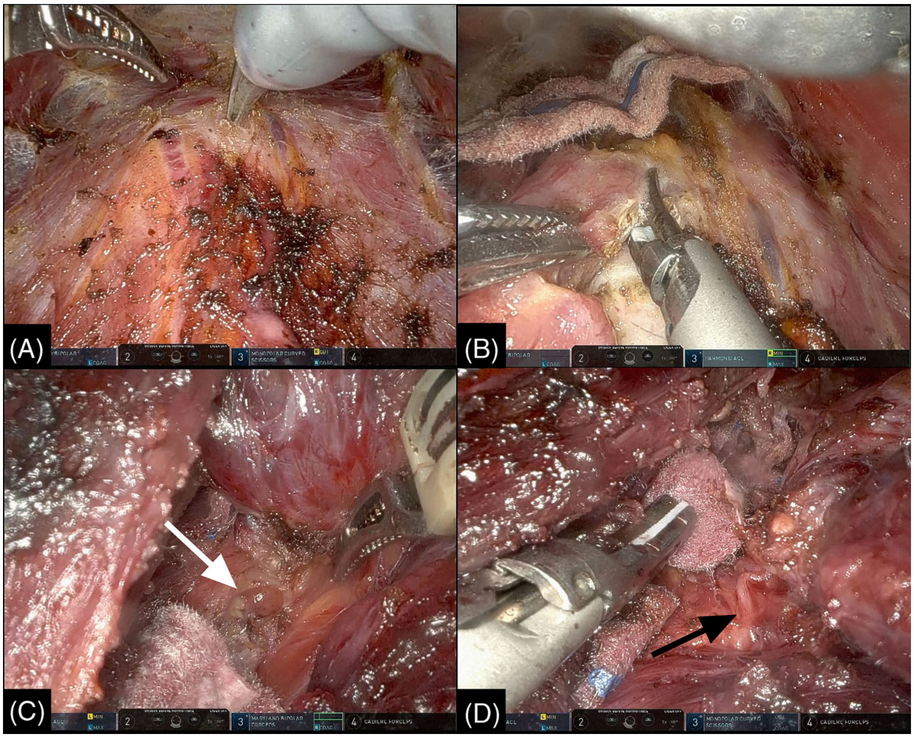


FIGURE 1 (A) A 10- to 15-mm horizontal incision in the central region close to the lower lip frenulum and two 5-mm lateral incisions close to both oral commissures were made. (B) A blunt-tip middle trocar and two lateral trocars were inserted through the oral vestibular incisions. (C) Following blunt dissection of the submental area, an additional flap elevation was performed under the three-dimensional magnified robotic surgical view

FIGURE 2 Transoral thyroidectomy procedures. (A) The subplatysmal flap was elevated with an intact anterior jugular vein and a midline incision was initiated. (B) The strap muscle was dissected to expose the thyroid gland, and the isthmus was incised. (C,D) The left superior parathyroid gland (white arrow) and recurrent laryngeal nerve (black arrow) were identified and carefully preserved



lower lip frenulum and two 5-mm lateral incisions close to both oral commissures were designed to prevent damage to the mental nerve (Figure 1A). The central mucosa was incised and dissected to the tip of the chin with a pin-tip monopolar electrocautery and blunt curved mosquito clamp. With a Veress needle syringe, about 10 ml of diluted epinephrine solution (1:400,000) was injected into the subplatysmal layer of the submental area for hydrodissection. With a blunt-tip Hegar dilator (size 5–8), the submental area was expanded into a fan-like shape. A blunt-tip trocar (endoscopic 12 mm, robotic 8 mm) was inserted. Following the same procedure as in the middle, two trocars measuring 5 mm (for endoscopic procedure) or 8 mm (for robotic operation) were inserted through the oral vestibular incisions on both sides of the middle trocar (Figure 1B). The carbon dioxide insufflation pressure was set at 5–6 mmHg. A rigid 30-degree endoscopic or robotic camera was inserted into the middle trocar. The laparoscopic dissector and an ultrasonic energy device were inserted into both lateral ports. Skin flaps were raised to form working spaces in the plane of the subplatysmal layer under the view of the endoscope using a laparoscopic dissector, an L-hook monopolar cautery, and an ultrasound device. Skin flaps were elevated to the level of the sternal notch and laterally to the medial borders of both sternocleidomastoid muscles. With the robotic procedure, three robot arms were docked after creating the working space with endoscopic instruments to the level of the hyoid. Following placement of a robotic camera on the middle trocar, and monopolar scissors, Maryland bipolar forceps, or Harmonic curved shears on both trocars, an additional flap elevation was performed within the aforementioned range under the three-dimensional magnified robotic view (Figure 1C). The right axillary port

TABLE 1 Clinicopathological characteristics of the patients treated by robotic and endoscopic transoral thyroidectomy

Characteristics	Value ($n = 27$)
Age	43.7 ± 12.2 (range 23–70)
Sex	
Male	0
Female	27 (100%)
BMI (kg/m^2)	24.8 ± 3.6 (range 20.2–33.2)
Tumor size (mm)	10.4 ± 6.7 (range 3–32)
Pathology	
Hashimoto thyroiditis	1 (3.7%)
Nodular hyperplasia	1 (3.7%)
Papillary carcinoma	25 (92.6%)
Type of surgery	
Robotic procedure	21 (77.8%)
Endoscopic procedure	6 (21.2%)

was used as necessary to insert Prograsp or Cadiere forceps. The thyroidectomy was performed as previously described (Figure 2).[9]

2.4 | Postoperative follow-up and statistical analysis

The data collected included patient demographic information, such as age, sex, and body mass index (BMI), tumor size, pathology, multiplicity, extrathyroidal extension (minimal), type of surgery, extent of thyroidectomy and central neck dissection (CND), TNM stage, operative time, cosmetic satisfaction, and postoperative complications. Total operative time was defined as the time from the first incision to complete closure of the incision site. The docking time of the robot was included for robotic thyroidectomy. All patients underwent flexible laryngoscopy preoperatively and postoperatively to assess vocal cord mobility. Hypoparathyroidism referred to any decrease in blood parathyroid hormone levels below the normal range (15–65 pg/ml), regardless of hypocalcemia symptoms. Recurrent laryngeal nerve (RLN) palsy or hypoparathyroidism was considered permanent if recovery was unnoted within 6 months. A questionnaire was used to assess postoperative cosmetic satisfaction. The questionnaire items included "very satisfied," "satisfied," "moderate," "dissatisfied," and "very dissatisfied."

In addition, we compared early surgical outcomes of transoral robotic and endoscopic thyroidectomy performed over the same period with those of transcervical thyroidectomy.

All statistical analyses were conducted using SPSS 21.0 (Chicago, IL, USA). We compared continuous variables using Student's *t*-test or the Mann–Whitney *U* test depending on whether the distribution was normal. Categorical variables were analyzed using Fisher's exact test. $p < .05$ was considered statistically significant.

TABLE 2 Surgical outcomes of the patients who underwent robotic and endoscopic transoral thyroidectomy

Variables	Value
Conversion to open approach	1/27 (3.7%)
Extent of thyroidectomy	
Isthmusectomy	1/26 (3.8%)
Lobectomy	20/26 (76.9%)
Total thyroidectomy	5/26 (19.2%)
Central neck dissection	15/24 (62.5%)
Multiplicity	6/24 (25%)
Extrathyroidal extension (minimal)	5/24 (20.8%)
T classification	
T1	22/24 (91.7%)
T2	2/24 (8.3%)
T3	0
T4	0
N classification	
cN0	10/24 (41.7%)
pN0	9/24 (37.5%)
pN1a	5/24 (20.8%)
Operative time (min)	
Skin flap elevation	40.7 ± 12.5
Docking (only for robotic procedure)	9.7 ± 2.3
Thyroidectomy time	174.4 ± 53.8
Closure time	26.3 ± 5.4
Total time	249.3 ± 56.8
Lobectomy, isthmusectomy	229.2 ± 38.1
Total thyroidectomy	333.6 ± 43.4
Drain insertion	
No drainage	16/26 (61.5%)
Drainage volume (ml)	156.8 ± 106.7
Cosmetic satisfaction	
Very satisfied	17/20 (85%)
Satisfied	2/20 (10%)
Average	1/20 (5%)

Abbreviations: cN0, clinically negative neck; pN, pathologic N classification.

3 | RESULTS

3.1 | Clinicopathological characteristics

Table 1 presents the patients' demographic and clinicopathological characteristics. Twenty-seven patients were female, and their mean age was 43.7 ± 12.2 (range 23–70) years. The mean BMI was 24.8 ± 3.6 kg/m^2. The endoscopic and robotic procedures were performed in 6 and 21 patients, respectively. Regarding postoperative pathology, 25 patients had papillary carcinomas, 1 had nodular hyperplasia, and

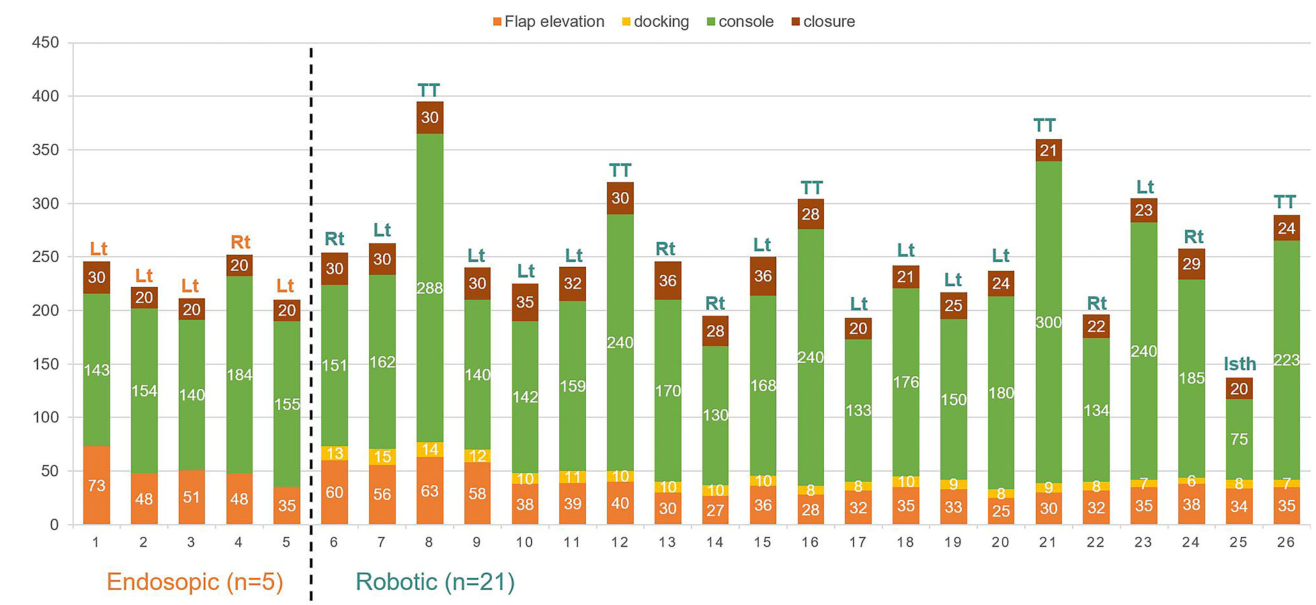


FIGURE 3 The operative time for 26 consecutive patients who underwent transoral endoscopic and robotic thyroidectomy (TT, total thyroidectomy; Lt, left; Rt, right)

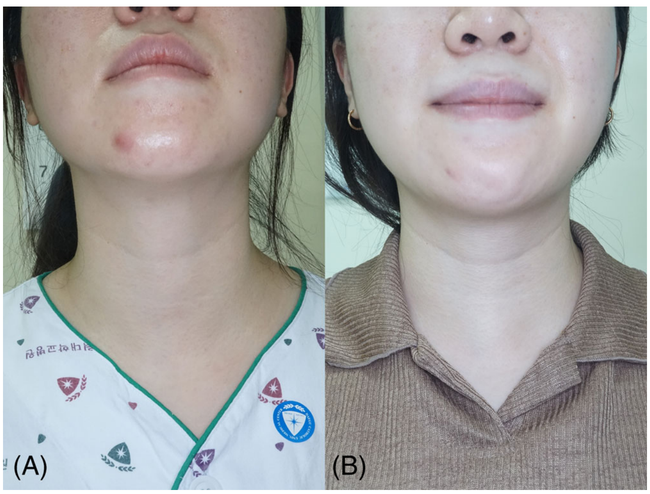


FIGURE 4 Pre (A) and post (B) operative 1-month photos of a patient who underwent transoral thyroidectomy

TABLE 3 Postoperative complications of the patients treated by robotic and endoscopic transoral thyroidectomy

Characteristics	Value ($n = 26$)
Hypoparathyroidism	
Transient	3 (11.5%)
Permanent	0
Recurrent laryngeal nerve injury	
Transient	4 (15.4%)
Permanent	0
Mental nerve injury	0
Trachea injury	0
Hematoma	0
Seroma	1 (3.8%)
Surgical site infection	0
Subcutaneous emphysema	0
Pneumomediastinum	0
Carbon dioxide embolism	0
Neck skin flap perforation	0

1 had Hashimoto thyroiditis. The mean tumor size was 10.4 ± 6.7 (range 3–32) mm.

3.2 | Surgical outcomes

Table 2 shows the surgical outcomes. During endoscopic lobectomy, one case of papillary carcinoma was converted to an open procedure due to bleeding during dissection of the uppermost part of the superior pole that could not be controlled by the endoscopic approach. Among the patients, 20 (76.9%) underwent thyroid lobectomy, 1 (3.9%) underwent isthmusectomy, and 5 (19.2%) received total thyroidectomy. Prophylactic CND was performed in 15 (62.5%) of the 24 patients with papillary carcinomas. The mean operation time was 249.3 ± 56.8 min. The time for skin flap elevation was 40.7 ± 12.5 min, docking time for the robotic procedure was 9.7 ± 2.3 min, thyroidectomy time was 174.4 ± 53.8 min, and closure time was 26.3 ± 5.4 min. The time for lobectomy and isthmusectomy was 229.2 ± 38.1 min, and the time for total thyroidectomy was 333.6 ± 43.4 min. Figure 3 shows the operative time according to the case number. In 16 patients (61.5%), drains were not inserted, whereas

TABLE 4 Comparison of early surgical outcomes by a novice surgeon in transoral thyroidectomies and transcervical thyroidectomy

	Transoral ($n = 26$)	Transcervical ($n = 25$)	p value
Age (y)	44.1 ± 12.3	52.4 ± 16.7	.041*
Sex			.002*
Male	0	8 (32%)	
Female	26 (100%)	17 (68%)	
BMI (kg/m^2)	24.8 ± 3.7	24.2 ± 2.9	.664
Pathology			.140
Benign	2 (7.7%)	6 (24%)	
Malignant	24 (92.3%)	19 (76%)	
Tumor size (mm)	10.3 ± 6.8)	17.3 ± 13.3)	.062
Extent of thyroidectomy			.099
Isthmusectomy	1 (3.8%)	0	
Lobectomy	20 (76.9%)	14 (56%)	
Total thyroidectomy	5 (19.2%)	11 (44%)	
Central neck dissection	15/24 (62.5%)	14/19 (73.7%)	.523
Operative time (min)	249.3 ± 56.8	157.6 ± 37.9	<.001*
Lobectomy, isthmusectomy	240 (229.2 ± 38.1)	143 (140.9 ± 35.6)	<.001*
Total thyroidectomy	320 (333.6 ± 43.4)	175 (178.9 ± 30.3)	<.001*
Hypoparathyroidism			
Transient	3 (11.5%)	2 (8%)	1.000
Permanent	0	0	
RLN injury			
Transient	4 (15.4%)	2 (8%)	.668
Permanent	0	0	
Mental nerve injury	0	0	
Trachea injury	0	0	
Hematoma	0	1 (4%)	.490
Seroma	1 (3.8%)	1 (4%)	1.000
Surgical site infection	0	1 (4%)	.490

Abbreviations: NA, not applicable; RLN, recurrent laryngeal nerve.
*$p < .05$.

10 patients had a drain inserted. The mean amount of drainage was 156.8 ± 106.7 ml in the drainage group. Twenty patients completed a postoperative cosmetic satisfaction questionnaire 3 months after surgery. Of these, 17 patients (85%) were "very satisfied," 2 (10%) were "satisfied," and 1 (5%) had "average" satisfaction (Table 2 and Figure 4).

3.3 | Postoperative complications

Transient RLN palsy occurred in four patients (15.4%) and resolved within 6 months. Transient hypoparathyroidism occurred in three patients (11.5%) and returned to normal within 3 months. Permanent RLN paralysis and hypoparathyroidism were not observed as postoperative complications. One case of seroma occurred but resolved with one-time aspiration. There were no injuries to the trachea, esophagus, or larynx and no damage to the mental or marginal nerves. None of the patients had their neck skin perforated (Table 3).

3.4 | Comparison between early outcomes of transoral and transcervical thyroidectomy

We compared the early surgical outcomes of transoral robotic and endoscopic thyroidectomy with those of transcervical thyroidectomy performed over the same period (Table 4). In the transoral group, the mean age was significantly lower than in the transcervical group ($p = .041$). There were no significant differences in BMI, pathology, tumor size, extent of thyroidectomy, and frequency of CND. There were no male patients in the transoral group ($p = .002$). Operative time was longer in the transoral group than in the transcervical group ($p < .001$). Postoperative complications were not significantly different between the two groups.

4 | DISCUSSION

Before the introduction of transoral thyroidectomy, a surgeon must have a thorough understanding of conventional thyroidectomy, CND, and parathyroidectomy and should be proficient in performing these procedures. This is because conventional thyroidectomy is the basis of endoscopic or robotic thyroidectomy, and it is essential to complete the operation if the surgery is converted to transcervical thyroidectomy. Using unfamiliar endoscopic or robotic tools requires mastering the exact anatomy of the operative area and tissue dissection techniques. Therefore, it is recommended that transoral thyroidectomy needs to be performed by an experienced surgeon.[10,11]

For the safe introduction of transoral thyroidectomy, a leading group established a framework and set the recommended minimum requirements for safe implementation. These include adequate experience of thyroid surgery, departmental and administrative support, familiarity with instruments, real-time case observation, gradual learning, cadaver dissection, and appropriate first case.[12] In particular, with respect to adequate experience in thyroid surgery, it seems natural for a high-volume surgeon to demonstrate improved surgical outcomes, but there was no consensus among the authors regarding the minimum required number of open thyroidectomies for transoral thyroidectomy to be performed.[12]

This study aimed to assess whether a surgeon with limited experience in conventional thyroidectomy and no previous experience in independent laparoscopic or robotic surgery could perform transoral thyroidectomy. We also aimed to evaluate the feasibility, safety, and early surgical outcomes of transoral thyroidectomy conducted by the novice surgeon.

A few studies on remote access thyroidectomy performed by low-volume surgeons or surgeons without previous endoscopic experience have been published. Jung et al. reported that one surgical fellow, who had experienced 47 open thyroidectomies but no endoscopic thyroidectomy, and another international surgical fellow, who had experienced 200 open thyroidectomies and 5 endoscopic thyroidectomies, safely performed robotic thyroidectomy using the gasless transaxillary single-incision technique after training for about 6 months.[13] This emphasizes the importance of specialized systematic training programs for beginners with respect to observation, assistance, creation of a working space, introduction to the robotic console, and independent practice under supervision. In transoral thyroidectomy, Khafif et al. described the outcomes of 71 patients with transoral endoscopic vestibular approach for thyroidectomy (TOETVA) and parathyroidectomy (TOEPVA) by surgeons with no previous laparoscopic or robotic experience. All but one case of conversion demonstrated successful surgical outcomes with no permanent RLN injury or hypoparathyroidism.[14]

In this study, the transoral thyroidectomy was performed by a novice surgeon who had experienced 12 cases of transcervical thyroidectomy but had not independently performed endoscopic or robotic thyroidectomy. In addition, the surgeon initiated robotic transoral thyroidectomy immediately following only six cases of endoscopic transoral thyroidectomy. To the best of our knowledge, this study has the fewest cases of transcervical thyroidectomy prior to implementing transoral thyroidectomy. The rates of RLN injury, hypoparathyroidism, and wound infections in the present study appear comparable to the results of high-volume surgeons with previous experience in endoscopic or robotic thyroidectomy.[2–4,15,16] Our mean surgical time was also comparable to the initial results of most pioneers.[2,17,18] In addition, postoperative cosmetic satisfaction was good as noted in the literature.[7,19]

There are some hurdles to starting and performing transoral thyroidectomy from a beginner's point of view. The first obstacle is flap elevation. In the midline anterior neck area, the skin flap is thin due to the absence of platysma muscles. The surgeon should elevate the skin flap through a small vestibular hole without clearly identifying the skin layer using a blunt dilator and Kelly forceps. Special care should be taken not to perforate the skin flap, and the flap should be elevated to an appropriate thickness in the plane of the subplatysmal layer. In addition, after experiencing CO_2 embolism caused by anterior jugular vein tears during the first assistant training, we realized that flap elevation is crucial.[20,21] Since CO_2 embolism usually results from tearing of the anterior jugular vein, we used ultrasound for the first several cases to detect the subplatysmal layer and enlarged anterior jugular vein and to elevate flaps safely and precisely.[22] By carefully dissecting the skin flap, there was no perforation of the skin flap, laceration of the anterior jugular vein, or CO_2 embolism.

The second obstacle is a lack of familiarity with laparoscopic or robotic instruments. To overcome this, we practiced the position and direction of the instruments that should be moved in each surgical scene while watching a video clip through a training device using a self-manufactured training set with a webcam on a desk. Moreover, because the robot does not provide haptic feedback, we practiced getting used to the movement of the laparoscopic devices and hand movement coordination on the monitor screen. While practicing the peeling of a tangerine without tearing the tangerine, we developed a sense of dissection and attempted to get used to the device. It is important to start with isthmusectomy or excision of benign masses before gradually approaching difficult cases after getting used to the instruments and surgical view. A superficial benign upper neck mass case is also helpful because it does not require strap muscle dissection.[23]

The third obstacle is the potential risk of mental nerve injury. In the vestibular approach, a patient is exposed to the risk of mental nerve injury, which is the sensory nerve that supplies sensation to the chin area. Since the initial lateral incision is close to the course of the mental nerve, several cases of injury have been reported.[2,24] The solution we adopted was to make two lateral incisions very close to the oral commissure, and there was no mental nerve injury in our study. When these lateral incisions are placed close to the oral commissure, the mental nerves can be protected from injury, and this allows for adequate distance and angle between the central endoscope and the instruments at the lateral ports, making manipulation of the instruments easier.[9,24,25]

The fourth obstacle is the unfamiliar anatomical view of the structures according to the surgical direction. In particular, the course of the RLN and the location of the parathyroid glands are important. Realistic training on a fresh cadaver using the endoscope devices helped the surgeon in our study to become familiar with the anatomy. Many surgeons have performed preoperative cadaver dissection to familiarize themselves with this new method.[26,27] Moreover, the transcervical thyroidectomy was performed in the craniocaudal direction to achieve a similar view of the operation.

The fifth obstacle is upper pole dissection. Other than one endoscopic case in this study, all operations were completed safely and successfully. In the second endoscopic case, which was converted to open surgery, the upper pole was slightly higher. The upper pole bleeding was difficult to control, and complete tumor removal was also difficult due to the lack of an angle to manipulate the instrument. The most difficult part of transoral thyroidectomy is upper pole dissection because of the surgical view. However, this problem can be solved by partially cutting the sternothyroid muscle.[28] After this case, we cut a part of the sternothyroid muscle as necessary. An adequate range of flap elevation is also required. If the flap of the upper neck area cannot be sufficiently lifted, the movement of both instruments will be restricted.

There have been very different evaluations of the learning curve for transoral thyroidectomy in the literature,[29–33] ranging from 7 to 58 cases. A plateau could not be obtained as an initial result in this study, but the average operation time was not inferior to those in other reports by experienced surgeons in reports of early surgical outcomes.[2,17] For total thyroidectomy, time decreases with an increased number of cases.

Intraoperative nerve monitoring (IONM) tubes were used for all transoral thyroidectomies. IONM makes it easy to determine the RLN course in an unfamiliar field of view. The location of the external branch of the superior laryngeal nerve can also be assessed. In this study, temporary hypoparathyroidism and temporary RLN injury occurred in three and four cases, respectively, but recovery was noted for all within 6 months. The particularly difficult points when using the IONM included tube intubation, positioning the sensor, preventing it from turning, and avoiding impingement and bending by both instrument trocars. To solve these mechanical causes, collaboration with an anesthesiologist is important from tube insertion to maintenance.

In this study, the robot was used more than the endoscope, although it is argued that the endoscope is more advantageous than the robot in transoral thyroidectomy. The operation time with the endoscope is shorter, and the cost is lower. In addition, haptic feedback is transmitted through the instrument and instrument changeover is fast. However, robotic surgery has several advantages over endoscopy. An excellent surgical view is achieved by the three-dimensional magnification and easy manipulation of surgical instruments without tremor, and an assistant is not required to hold the scope. Furthermore, if the third robotic instrument is used for counttraction through the axillary port, it facilitates dissection and has greater dexterity than the endoscopic instruments and can facilitate the easy removal of large specimens through this port.

This research has some limitations. First, the number of enrolled patients was quite small and there were no male patients in the robotic and endoscopic groups. Selection bias may have arisen, and a larger number of patients will be needed to determine the learning curve. Second, the follow-up period was relatively short, and a longer follow-up seems necessary to confirm oncological safety. Third, it may be difficult to generalize our findings because the data are from one operator. However, despite these limitations, this study seems to demonstrate that transoral robotic and endoscopic thyroidectomies are feasible for beginner surgeons with limited experience in open thyroidectomy. A suggested preparation framework, comprising sufficient observation, cadaver dissection, video watching, and supervision by a mentor operator, appears useful for safe implementation.

5 | CONCLUSIONS

Transoral endoscopic and robotic thyroidectomies are safe, feasible, and cosmetically excellent procedures and are reproducible by novice surgeons with limited experience in thyroidectomy in the context of properly selected patients and appropriate training.

FUNDING INFORMATION

No relevant financial relationship exists.

CONFLICT OF INTEREST

There are no conflicts of interest to declare.

PATIENT CONSENT STATEMENT

Patients consented to participate in the study.

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REFERENCES

1. Dionigi G, Bacuzzi A, Lavazza M, et al. Transoral endoscopic thyroidectomy: preliminary experience in Italy. *Updates Surg*. 2017;69(2):225-234.
2. Kim HY, Chai YJ, Dionigi G, Anuwong A, Richmon JD. Transoral robotic thyroidectomy: lessons learned from an initial consecutive series of 24 patients. *Surg Endosc*. 2018;32(2):688-694.
3. Chai YJ, Chung JK, Anuwong A, et al. Transoral endoscopic thyroidectomy for papillary thyroid microcarcinoma: initial experience of a single surgeon. *Ann Surg Treat Res*. 2017;93(2):70-75.
4. Russell JO, Clark J, Noureldine SI, et al. Transoral thyroidectomy and parathyroidectomy—a North American series of robotic and endoscopic transoral approaches to the central neck. *Oral Oncol*. 2017;71:75-80.
5. Park JO, Sun DI. Transoral endoscopic thyroidectomy: our initial experience using a new endoscopic technique. *Surg Endosc*. 2017;31(12):5436-5443.
6. Adam MA, Thomas S, Youngwirth L, et al. Is there a minimum number of thyroidectomies a surgeon should perform to optimize patient outcomes? *Ann Surg*. 2017;265(2):402-407.
7. Tae K, Lee DW, Song CM, et al. Early experience of transoral thyroidectomy: comparison of robotic and endoscopic procedures. *Head Neck*. 2019;41(3):730-738.

8. Anuwong A, Ketwong K, Jitpratoom P, Sasanakietkul T, Duh QY. Safety and outcomes of the transoral endoscopic thyroidectomy vestibular approach. *JAMA Surg*. 2018;153(1):21-27.
9. Tae K, Ji YB, Song CM, Park JS, Park JH, Kim DS. Safety and efficacy of transoral robotic and endoscopic thyroidectomy: the first 100 cases. *Head Neck*. 2020;42(2):321-329.
10. Park JO, Anuwong A, Kim MR, Sun DI, Kim MS. Transoral endoscopic thyroid surgery in a Korean population. *Surg Endosc*. 2019;33(7):2104-2113.
11. Tesseroli MAS, Spagnol M, Sanabria Á. Transoral endoscopic thyroidectomy by vestibular approach (TOETVA): initial experience in Brazil. *Rev Col Bras Cir*. 2018;45(5):e1951.
12. Russell JO, Anuwong A, Dionigi G, et al. Transoral thyroid and parathyroid surgery vestibular approach: a framework for assessment and safe exploration. *Thyroid*. 2018;28(7):825-829.
13. Park JH, Lee J, Hakim NA, et al. Robotic thyroidectomy learning curve for beginning surgeons with little or no experience of endoscopic surgery: learning curve for robotic thyroidectomy. *Head Neck*. 2015;37(12):1705-1711.
14. Khafif A, Cohen O, Masalha M, Yaish I, Hod K, Assadi N. Adoption of the transoral endoscopic vestibular approach by head and neck surgeons without prior laparoscopic/robotic experience. *Head Neck*. 2021;43(2):496-504.
15. Anuwong A. Transoral endoscopic thyroidectomy vestibular approach: a series of the first 60 human cases. *World J Surg*. 2016;40(3):491-497.
16. Richmon JD, Kim HY. Transoral robotic thyroidectomy (TORT): procedures and outcomes. *Gland Surg*. 2017;6(3):285-289.
17. Razavi CR, Khadem MGA, Fondong A, et al. Early outcomes in transoral vestibular thyroidectomy: robotic versus endoscopic techniques. *Head Neck*. 2018;40(10):2246-2253.
18. Lira RB, Ramos AT, Nogueira RMR, et al. Transoral thyroidectomy (TOETVA): complications, surgical time and learning curve. *Oral Oncol*. 2020;110:104871.
19. Lee DW, Bang HS, Jeong JH, Kwak SG, Choi YY, Tae K. Cosmetic outcomes after transoral robotic thyroidectomy: comparison with transaxillary, postauricular, and conventional approaches. *Oral Oncol*. 2021;114:105139.
20. Kim KN, Lee DW, Kim JY, Han KH, Tae K. Carbon dioxide embolism during transoral robotic thyroidectomy: a case report. *Head Neck*. 2018;40(3):E25-E28.
21. Tae K. Complications of transoral thyroidectomy: overview and update. *Clin Exp Otorhinolaryngol*. 2021;14(2):169-178.
22. Lee DW, Kim JK, Shin SH, Tae K. Application of ultrasonography for safe flap elevation at the learning period of transoral thyroidectomy: a technical report. *Korean J Otorhinolaryngol-Head Neck Surg*. 2022;65(3):180-185.
23. Lee DW, Kim JK, Tae K. Application of the transoral endoscopic vestibular approach for a benign upper neck mass: a case report. *Medicine (Baltimore)*. 2021;100(2):e24087.
24. Anuwong A, Sasanakietkul T, Jitpratoom P, et al. Transoral endoscopic thyroidectomy vestibular approach (TOETVA): indications, techniques and results. *Surg Endosc*. 2018;32(1):456-465.
25. You JY, Kim H, Park DW, Yang HW, Dionigi G, Tufano RP. Prevention of transoral thyroidectomy complications: an analysis of surgical outcomes in 423 consecutive series. *Surgery*. 2021;170(4):1155-1159.
26. Park JO, Kim CS, Song JN, et al. Transoral endoscopic thyroidectomy via the tri-vestibular routes: results of a preclinical cadaver feasibility study. *Eur Arch Otorhinolaryngol*. 2014;271(12):3269-3275.
27. Oliva A, Grassi S, Minelli N, et al. Transoral endoscopic thyroidectomy by a vestibular approach: cadaver simulation experience and ethicolegal issues. *Br J Surg*. 2021;108(12):e396-e397.
28. Lee HS, Kim SW, Park HS, et al. Partial cutting of sternothyroid muscle during total thyroidectomy: impact on postoperative vocal outcomes. *ScientificWorldJournal*. 2013;2013:416535.
29. Razavi CR, Vasiliou E, Tufano RP, Russell JO. Learning curve for transoral endoscopic thyroid lobectomy. *Otolaryngol Head Neck Surg*. 2018;159(4):625-629.
30. Luna-Ortiz K, Gómez-Pedraza A, Anuwong A. Lessons learned from the transoral endoscopic thyroidectomy with vestibular approach (TOETVA) for the treatment of thyroid carcinoma. *Ann Surg Oncol*. 2020;27(5):1356-1360.
31. Chai YJ, Chae S, Oh MY, Kwon H, Park WS. Transoral endoscopic thyroidectomy vestibular approach (TOETVA): surgical outcomes and learning curve. *J Clin Med*. 2021;10(4):863.
32. Luo JH, Xiang C, Wang P, Wang Y. The learning curve for transoral endoscopic thyroid surgery: a single surgeon's 204 case experience. *J Laparoendosc Adv Surg Tech A*. 2020;30(2):163-169.
33. Chen YH, Kim HY, Anuwong A, Huang TS, Duh QY. Transoral robotic thyroidectomy versus transoral endoscopic thyroidectomy: a propensity-score-matched analysis of surgical outcomes. *Surg Endosc*. 2021;35(11):6179-6189.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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