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Transoral endoscopic and robotic thyroidectomy for thyroid cancer: the mid-term oncological outcome

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Abstract

Background Traditional open thyroidectomy is the surgical standard for thyroid cancer; however, it inevitably leaves a visible scar on the neck and affects the patient's quality of life. Therefore, to avoid making a neck incision, the transoral endoscopic thyroidectomy vestibular approach (TOETVA) and transoral robotic thyroidectomy (TORT) have been developed recently, and the surgical outcomes of these techniques are as favorable as open surgery for benign disease. Additionally, positive short-term surgical outcomes have also been achieved in a few patients with thyroid cancer. However, no data on the mid-to-long-term recurrence and survival rates of transoral thyroidectomy in thyroid cancer are available. Therefore, in this study, we analyzed the surgical outcomes and mid-term oncological results of the TOETVA and TORT in patients with thyroid cancer.

Methods We reviewed patients who had received TOETVA or TORT between July 2017 and November 2021 and followed up on their oncological outcomes until December 2022. Perioperative surgical and mid-term oncological outcomes were analyzed.

Results The 115 patients underwent 122 operations (57 TOETVAs and 65 TORTs), including seven complete thyroidectomies for differentiated thyroid cancer (DTC), Stage I–II, including T1–T3, N0–N1a, and initial low- to high-risk groups. There was no conversion from transoral to open surgery. TORT required a longer operating time (median [interquartile range]) than TOETVA (lobectomy: 279 [250, 318] vs. 196 [173, 253] min, $p < 0.001$; bilateral total thyroidectomy: 375 [309, 433] vs. 279 [238, 312] min, $p < 0.001$); however, no difference was found between the two groups regarding perioperative complications. Complete thyroidectomy with a second transoral approach was safe. TOETVA and TORT achieved favorable oncological outcomes with 100% survival and 98.2% acceptable response (excellent and indeterminate response) during a mean 37.88 ± 12.42 months mid-term follow-up.

Conclusions Transoral endoscopic and robotic thyroidectomy was safe and achieved favorable mid-term oncological outcomes in a selected cohort of patients with early-stage DTC.

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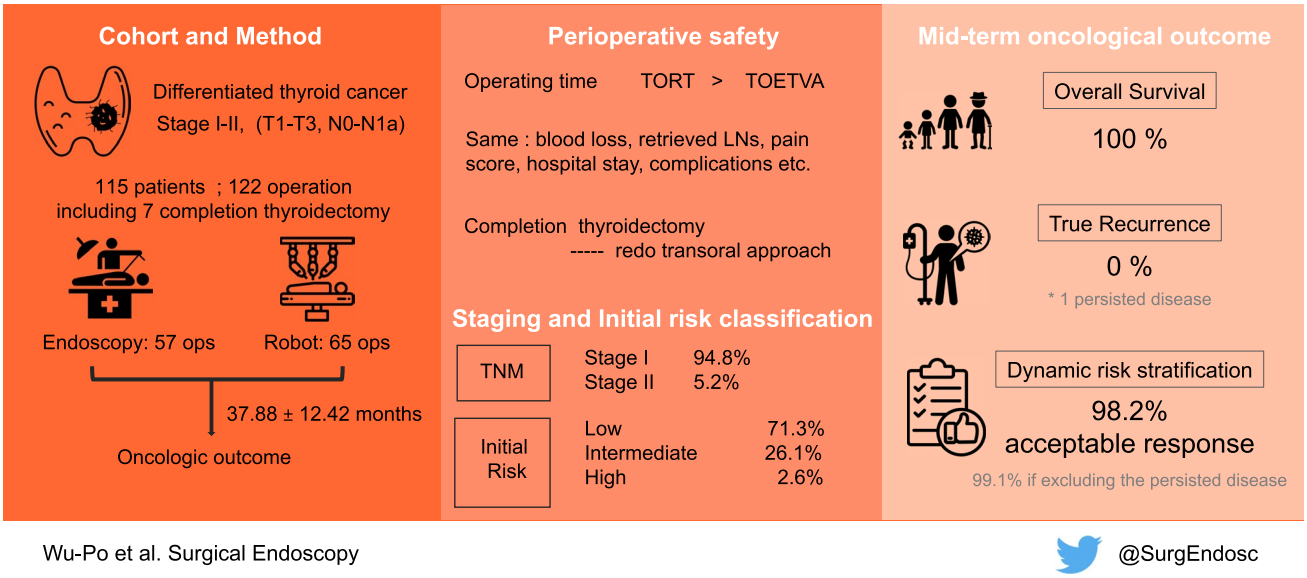
Graphical abstract



Keywords Remote access thyroidectomy · Transoral endoscopic thyroidectomy vestibular approach · Transoral robotic thyroidectomy · Transoral thyroidectomy · Thyroid cancer · Oncologic outcome

The incidence of thyroid cancer has increased worldwide over the last few years. Thyroid cancer is the most common endocrine gland malignancy, with female predominance, and was the seventh most common type of cancer in the United States in 2021 [1, 2]. The standard treatment for new patients is thyroidectomy with or without adjuvant radioiodine therapy, based on a risk assessment [3]. Traditional open thyroidectomy inevitably leaves a visible scar on the neck and affects the patient's quality of life, regardless of the scar type [4]. Since its introduction in 2009, transoral thyroidectomy has attracted increasing attention [5]. In addition, the procedure has evolved from a sublingual approach to the current vestibular approach [6]. As the procedure has advanced in the last two decades, the transoral endoscopic thyroidectomy vestibular approach (TOETVA) and transoral robotic thyroidectomy (TORT) have become reliable operations for thyroid goiter in selected patients [7, 8]. Several benefits of the transoral approach have been reported, including less difficulty in swallowing, less pain, and better neck scar appearance, without jeopardizing the safety outcomes of the operation [9–11]. By advancing this technique, the indications for transoral thyroidectomy have been expanded to include thyroid cancer [12]. Various reports have demonstrated promising perioperative surgical outcomes of transoral thyroidectomy and central neck lymph node dissection for thyroid cancer [13–16]. However, the oncological outcomes regarding survival and recurrence rates have not yet been evaluated. Therefore, in this study, we aimed to analyze the mid-term oncological outcomes of differentiated thyroid cancer (DTC) using the TOETVA and TORT.

Materials and methods

This study was conducted under the approval of the Institutional Ethics Review Board of Keelung Chang Gung Memorial Hospital (IRB number: 202201837B0). A study protocol (See Study Protocol, Supplemental Digital Content, which contains the study protocol) was developed in advance and reviewed by the Institutional Ethics Review Board of Keelung Chang Gung Memorial Hospital (IRB Number: 202201837B0). We reviewed patients with thyroid cancer who had undergone transoral endoscopic or robotic thyroidectomy between July 2017 and November 2021. The selection criteria for transoral thyroidectomy were patient preference and thyroid nodules suspected or proven for DTC, including T1 to T3, N0, or N1a disease. Patients with T4 (T4a and T4b) or N1b disease were excluded. In addition, the stages were determined according to the American Joint Committee on Cancer (AJCC)/Union for International Cancer Control 8th edition [17]. The choice between the TOETVA and TORT was based on the patient's decision. A single surgeon (Dr. Chen Y.H.) performed all surgeries at the Chung Gang Memorial Hospital Keelung Branch, Taiwan. The patients' data

were included in the oncological outcome analysis if the final pathology was DTC. Overall, 122 operations were performed in 115 patients, including seven complete thyroidectomies. The patients were followed up until December 2022.

The surgical techniques for TOEVA and TORT have been described in previous studies [8, 18–20]. Briefly, three incisions were made in the oral vestibular area. Trocars were placed through the incision to the anterior neck via the subplatysmal route. A subplatysmal working space was created, and the strap muscles were separated at the midline to expose the thyroid gland. Thyroid lobectomy or bilateral total thyroidectomy was performed after preserving the parathyroid and laryngeal nerves. Furthermore, level VI to VII lymph node dissection was performed if clinically indicated. Finally, a 1.5–2 cm incision was made in the right axilla to extract a large specimen to maintain specimen integrity for pathology review in both groups or to dock the 4th robotic arm in the robotic group [20]. The robotic surgeries were performed using the da Vinci Xi system.

All patients received oral intubation with intraoperative nerve monitoring and prophylactic antibiotics for Augmentin. In addition, clindamycin was administered to patients with a history of penicillin allergy. Initial risk stratification and completion thyroidectomy was performed according to the 2015 American Thyroid Association Guidelines [21]. We allocated patients with the BRAF mutation to an intermediate group; however, we did not perform complete thyroidectomy solely because of a positive BRAF mutation. According to the initial risk stratification in the ATA guidelines, radioiodine I^{131} remnant ablation was recommended and discussed with the patients.

Statistical analysis

Perioperative outcome measures included operation time, blood loss, conversion rate, and postoperative complications, such as bleeding, surgical site infection, nerve injury, and hypoparathyroidism. In addition, dynamic risk stratification was re-evaluated at each subsequent clinical follow-up to determine oncological outcomes.

Continuous variables were presented as means with standard deviations if the data were normally distributed using the Kolmogorov–Smirnov test; otherwise, medians with interquartile ranges were used. Categorical variables were summarized as frequencies and percentages. The differences in perioperative outcomes between the TOETVA and TORT were analyzed using the Student's t-test, Fisher's exact test, or Mann–Whitney U-test where appropriate. Statistical significance was set at $p < 0.05$.

Results

A total of 122 operations were performed in 115 patients, including seven complete thyroidectomies. Two patients who had complete thyroidectomy still had cancer in the contralateral lobe, while five were negative for malignancy. Table 1 presents demographic and clinical details. In the 115 patients, the mean age was 44.71 ± 12.06 years, with a predominance of females (78.3%). The mean BMI was 23.52 ± 3.74 kg/m^2, with 16.5% classified as obese. Tumors were located in the right lobe (42.6%), left lobe (44.3%), and both lobes (13%). Hashimoto's disease, non-invasive follicular thyroid neoplasm with papillary-like nuclear features, and Graves' disease were present in 19.1%, 1.7%, and 3.5% of patients, respectively.

Table 2 presents clinical-pathological results. Papillary thyroid microcarcinoma (PTMC), papillary thyroid carcinoma (PTC), and follicular thyroid carcinoma were observed in 40%, 54.8%, and 5.2% of patients, respectively. The median tumor size was 1.1 cm. The mean number of retrieved lymph nodes was 4.91 ± 4.38, with 1.53 ± 2.92 metastatic lymph nodes. The positivity rate was 43.9%. Most patients were classified as stage I (94.8%) and had low initial calcification risk (71.3%). BRAF mutations were present in 76.5% of the patients.

Comparing the surgical results of the TOETVA and TORT (Table 3), TORT required a longer operative time than TOETVA ($p < 0.001$). There was no conversion in this study; however, there was one case of left subclavian vein injury in the TOETVA group, which was repaired without the need to revert to open surgery. The mean pain score decreased from 2.13 to 1.84 in the TOEVA group and 2.02 to 1.63 in the TORT group, with a range generally below 4. The mean length of stay was 2.54 and 2.63 days for the TOEVA and TORT groups, respectively. Regarding the postoperative complications, there was one temporary recurrent laryngeal nerve (RLN) injury and two cases of temporary hypoparathyroidism in the TOETVA group; in the TORT group, there was one permanent RLN injury and one permeant hypoparathyroidism (i-PTH fluctuation between 5.2 and 12.7 pg/mL during follow-up). Otherwise, no bleeding, seroma collection, chyle leak, mental nerve injury, or surgical site infection was found.

We used dynamic risk stratification, 2015 ATA guidelines, to assess the clinical response during the follow-up period (Table 4); Our study cohort showed a 0% all-cause and disease-specific mortality at a mean follow-up of 37.88 ± 12.42 months. There were no instances of true structural recurrence. One patient was categorized as having persistent disease, as one level VI metastatic lymph node (< 0.5 cm) was identified at the first follow-up, which was not discovered preoperatively. Furthermore, one

Table 1 Demographics and clinical details of TOETVA and TORT

Variables	Overall procedure $n=122$	Overall patient $n=115$
Age (mean ± SD), years	44.71 ± 11.99	44.71 ± 12.06
Sex (%)		
Female	96 (78.7%)	90 (78.3%)
Male	26 (21.3%)	25 (21.7%)
BMI (mean ± SD), kg/m^2	23.51 ± 3.70	23.52 ± 3.74
BMI > 27	19 (15.6%)	19 (16.5%)
Tumor location, *n* (%)		
Right lobe	50 (42.7%)	49 (42.6%)
Left lobe	52 (44.4%)	51 (44.3%)
Isthmus	0	
Both lobe	15 (12.8%)	15 (13%)
The extent of surgery, *n* (%)		
Bilateral total thyroidectomy	34 (27.9%)	41 (35.7%)
Lobectomy	88 (72.1%)	74 (64.3%)
Central neck lymph node dissection	49 (40.2%)	46 (40%)
Associated disease, *n* (%)		
NIFTP	2 (1.6%)	2 (1.7%)
Graves' disease	4 (3.2%)	4 (3.5%)
Hashimoto's thyroiditis	23 (18.9%)	22 (19.1%)

BMI body mass index, *TOETVA* transoral endoscopic thyroidectomy vestibular approach, *TORT* transoral robotic thyroidectomy, *SD* standard deviation, *NIFTP* non-invasive follicular thyroid neoplasm with papillary-like nuclear feature

patient underwent lobectomy, and Tg fluctuated between 21 and 64 ng/mL during follow-up and was categorized as biochemically inadequate. The remaining patients exhibited excellent and indeterminate responses. The overall acceptable response rate (excellent + indeterminate) was 98.2%. If excluding the cases of persistent disease, the acceptable response rate reached 99.1%.

Discussion

In our series, we show that in DTC, Stage I–II, including T1–T3, N0–N1a, and low- to a high-risk group (*2017 TNM Staging AJCC Eighth Edition* and *2015 ATA Guideline Initial Risk Stratification*), transoral thyroidectomy, TOETVA, and TORT, achieved favorable oncological outcomes as 100% survival and 98.2% acceptable response (excellent and indeterminate response) during a mean 37.88 ± 12.42 months mid-term follow-up. The completion of thyroidectomy using a redo transoral approach is also safe. If excluding the cases of persistent disease, the acceptable response rate reached 99.1%. This result is comparable to open thyroidectomy's overall and disease-free survival published in the literature [22, 23]. In our data, TORT requires a significant time investment compared to TOETVA; however, no substantial difference was observed between the two groups in the oncological outcome or perioperative complication rate.

A report based on the Surveillance, Epidemiology, and End Results database showed that from 1975 to 2018, the incidence of papillary thyroid cancer increased from 4.8 to 14.9 per 100,000 people; however, survival rates have remained stable [2, 24]. Differential thyroid cancers typically have good survival rates, with expected 10-year disease-specific survival rates of 98–100% and 85–95% for patients with stage I or II diseases, respectively [17]. Conversely, in contrast to good survival rates, thyroid cancer has a higher recurrence rate. The 2009 risk stratification system, originally proposed by the ATA, predicted that recurrence or persistent structural disease would occur in 3%, 21%, and 68% of patients in the low-, intermediate-, and high-risk groups, respectively [25]. Recurrence, in turn, typically occurs in the first 5 years, with local recurrence being the most common [26–28]. Consequently, some patients require multiple operations or radioactive-iodine treatment to control the persistent or recurrent disease [29]. The mean follow-up period in our series was 37.88 ± 12.42 months, representing the highest recurrent period of thyroid cancer (within the first 3–5 years).

Thyroid cancer is most common within the 40- to 60-year age range. This demographic typically has a long survival time after thyroid surgery; therefore, post-treatment quality of life has become increasingly important [30]. Open transcervical thyroid surgery is considered the gold standard for thyroid cancer procedures; however,

Table 2 Pathologic results, cancer staging and risk classification of TOETVA and TORT

Variables	Overall specimen with cancer $n=117$	Overall patient $n=115$
Pathology, *n* (%)		
PTMC	47 (38.5%)	46 (40%)
PTC	64 (52.5%)	63 (54.8%)
FTC	6 (4.9%)	6 (5.2%)
Tumor size (median [IQR]), cm	1.1 [0.7,1.7]	1.1 [0.7,1.7]
T1, *n* (%)	96 (78.7%)	94 (81.7%)
T2, *n* (%)	16 (13.1%)	16 (13.9%)
T3, *n* (%)	5 (4.1%)	5 (4.3%)
Nodal stage, *n* (%)		
N0a	34 (27.9%)	32 (27.8%)
N0b	58 (47.5%)	58 (50.4%)
N1a	25 (20.5%)	25 (21.7%)
Number of retrieved LNs (mean ± SD)	4.67 ± 3.96	4.91 ± 4.38
Number of involved LNs (mean ± SD)	1.45 ± 2.82	1.53 ± 2.92
Positive rate of LNs, (%)	42.4%	43.9%
8th AJCC stage, *n* (%)	Patient $n=115$	
Stage I	109 (94.8%)	
Stage II	6 (5.2%)	
Stage III	0	
Stage IV	0	
Initial risk classification, *n* (%)		
Low	82 (71.3%)	
Intermediate	30 (26.1%)	
High	3 (2.6%)	
BRAF mutation	76.5%	

TOETVA transoral endoscopic thyroidectomy vestibular approach, *TORT* transoral robotic thyroidectomy, *SD* standard deviation, *PTMC* papillary thyroid microcarcinoma, *PTC* papillary thyroid carcinoma, *FTC* follicular thyroid carcinoma, *AJCC* American Joint Committee on Cancer

the quality of life following surgery is affected to varying degrees. For example, the impact of neck scarring on the quality of life is comparable to that of severe atopic dermatitis, and patient satisfaction with neck scarring is only marginally satisfactory [31, 32]. Consequently, numerous endoscopic and robotic procedures have been developed for this purpose. The surgical wound has evolved from a traditional Kocher incision to a concealed remote incision in the axilla, breast, or fold behind the ear, followed by a natural orifice procedure (transoral thyroidectomy) [33].

Transoral thyroidectomy avoids incisions of the neck and is considered safe for treating benign thyroid disease, similar to conventional open thyroidectomy [7]. In addition, the postoperative quality of life is good or better than that of open thyroidectomy [9–11]. With advancements in the procedure, transoral thyroidectomy has also been applied to treat thyroid cancer [13, 15, 16]. In previous studies on thyroid cancer treatment, the short-term surgical outcomes of transoral thyroidectomy were comparable to those of open thyroidectomy [34].

However, there is no study addressing the mid- or long-term oncological outcomes. Therefore, this study aim to examine mid-term oncological outcomes after transoral thyroidectomy for DTC.

The extent of surgery and the need for lymph node dissection in this series followed the ATA and NCCN guidelines; however, some controversy remains [35]. In our series, 72% of the patients underwent radical lobectomy, and most patients were classified as low-risk (71.3%). Most patients were classified in the intermediate group in the series because of positive BRAF mutations in PTC (76.5% of all patients) rather than lymph node metastases or pathological features (worrisome histology, extrathyroidal extension, or vascular invasion). These patients still underwent radical lobectomy because the benefit of bilateral total thyroidectomy in cases with zero intermediate-risk features other than BRAF mutations remains controversial [36]. Ultimately, 27.9% of patients underwent a total bilateral thyroidectomy. Notably, the central cervical lymph node dissection (40.2%) was performed selectively

Table 3 Peri-operative outcomes in TOETVA vs. TORT

Variables	TOETVA ($n=57$)	TORT ($n=65$)	
Operative time (median [IQR]), min			
Lobectomy	196 [173, 253.75]	279 [250.5, 318.25]	$p<0.001$
Bilateral total thyroidectomy	279 [238, 312]	375 [309, 433]	$p<0.001$
Previous treatment (n(%))			
No	52 (91.2%)	61 (93.8%)	$p=0.732$
RFA	0	1 (1.5%)	
Open	0	1 (1.5%)	
TOETVA (completion)	4 (7.0%)	2 (3.0%)	
TORT (completion)	1 (1.7%)	0	
Blood loss (median [IQR]), mL	2 [2, 5]	2 [2, 3]	$p=0.626$
Number of retrieved LNs (mean ± SD)	4.70 ± 3.24	4.65 ± 4.40	$p=0.628$
Conversion	0	0	
Intraoperative complication (%)	1 (1.7%)[a]	0	
VAS score (median [IQR])			
POD1	2 [2, 3]	2 [2, 3]	$p=0.601$
POD2	2 [2, 3]	2 [1, 2]	$p=0.312$
Length of stay (median [IQR]), days	2 [2, 3]	2 [2, 3]	$p=0.594$
Postoperative complication			
Bleeding	0	0	NA
Seroma collection	0	0	NA
Chyle leakage	0	0	NA
Mental nerve injury (%)	0	0	NA
RLN injury			
Temporary	1 (1.7%)	0	$p=0.467$
Permanent	0	1 (1.5%)	$p=1$
Hypoparathyroidism			
Temporary	2 (3.5%)	2 (3%)	$p=1$
Permanent	0	1 (1.5%)	$p=1$
Surgical site infection (%)	0	0	NA

TOETVA transoral endoscopic thyroidectomy vestibular approach, *TORT* transoral robotic thyroidectomy, *RFA* radiofrequency ablation, *SD* standard deviation, *VAS* visual analogue scale, *IQR* interquartile range, *RLN* recurrent laryngeal nerve

[a]One patient had a left subclavian vein injury during the operation, which was repaired without the need to revert to open surgery

rather than routinely. Our series showed a 42% positive rate for lymph node metastasis.

Postoperative complications, including hypoparathyroidism, recurrent laryngeal nerve injury, postoperative bleeding, and surgical site infection, were low and comparable to those of most transoral or open thyroidectomy series [37, 38]. Blood loss in most cases was minimal and required no conversion from transoral surgery to an open procedure. In addition, the perioperative surgical outcome indicated that transoral surgery was as safe for thyroid cancer as in the other study [13, 15]. Longer operation time seemed inevitable in the transoral approach, as compared to open approach. In our data, TORT was significantly time-consuming compared to TOETVA, probably due to the docking process and the nature of robotic surgery. However, the course might be shorter after completing the learning curve.

Tumor biology influences cancer behavior. For example, middle-aged patients have the lowest recurrence and longest survival among thyroid cancers [39]. In our series, the mean age of patients was 44.71 ± 12.06 years, and females predominated in 78% of patients, representing the most common DTC profiles. PTMC is typically associated with a favorable prognosis, and our study aligns with the reported prevalence of 40%, which is generally around 35–45% of all thyroid cancer cases [40–42]. The presence of Hashimoto's thyroiditis, which is considered less aggressive, was consistent at 19.1%, in line with previous epidemiologic studies that have reported a mean coexistence rate of approximately 23% (range, 5–85%) [43]. Therefore, our study cohort represents a common group of patients with early-stage DTC.

While most PTMC cases have excellent outcomes, it's important to note that certain PTMCs with higher risk

Table 4 Mid-term oncological outcome

Follow-up period (mean ± SD), months: 37.88 ± 12.42					
Overall survival 100% *True recurrence* 0% (1 persisted disease) *Dynamic risk stratification* 98.2% acceptable response (99.1% if excluding the persisted disease)					
Stage/initial risk (*n*)	Dynamic risk stratification, *n* (%)				
	Acceptable response			Biochemical incomplete	Structure incomplete
	Excellent response	Indeterminate response	Excellent + indeterminate		
Stage I (109)					
Low (77)	62 (80.5%)	13 (16.9%)	75 (97.4%)	1[a] (1.29%)	1[b] (1.29%)
Intermediate (30)	26 (86.7%)	4 (13.3%)	30 (100%)	0	0
High (2)	1 (50%)	1 (50%)	2 (100%)	0	0
Stage II (6)					
Low (5)	5 (100%)	0	5 (100%)	0	0
Intermediate (0)	0	0	0	0	0
High (1)	1 (100%)	0	1 (100%)	0	0

SD standard deviation

[a]The patient underwent lobectomy, and Tg fluctuated between 21 and 64 ng/mL during follow-up

[b]The patient was categorized as having the persistent disease as one level VI metastatic lymph node (< 0.5 cm) was identified at the first follow-up and was not discovered preoperatively

factors may have unfavorable outcomes and increased recurrence rates [44, 45]. Previous studies have reported PTMC recurrence rates ranging from 2.7 to 19%, with the highest recurrence occurring within the first 2–4 years [46–48]. However, in our series, the recurrence-free survival rate for PTMCs, including all risk categories, was 100% during a mean follow-up of 37.88 ± 12.42 months. In all DTC patients, the mid-term oncological outcome indicated 100% overall survival rates.

We used 2015 ATA risk stratification to classify responses during follow-up. At intermediate and high-risk, patients in stage I and all stage II risk groups achieved a 100% acceptable response (excellent and indeterminate response). Most of these patients were classified into the indeterminate group because of the preoperative presence and postoperative decline of anti-Tg antibodies. One patient who underwent lobectomy with Tg fluctuating between 21 and 64 ng/ml rather than elevated Tg or anti-Tg antibodies was classified as biochemically inadequate. The patient categorized with a persistent disease as having one metastatic lymph node (< 0.5 cm) located at level VI was identified at the first postoperative sonographic follow-up and was not discovered preoperatively. The metastatic lymph node was stable during follow-up and was treated with radioiodine I131. This represents a current problem with the preoperative diagnosis of lymph node metastasis in thyroid cancer rather than a surgical completeness problem per se.

Regarding lymph node dissection in our group, we reserved the option of central neck lymph node dissection for patients with a preoperative diagnosis of lymph node metastasis or suspected metastasis but did not meet the diagnostic criteria. In previous studies, prophylactic central neck lymph node dissection did not contribute to thyroid cancer survival; it reduced local recurrence and increased the complication rate [49, 50]. Therefore, whether prophylactic lymph node dissection is needed or which patients will benefit is still controversial. However, for patients requiring central cervical lymphatic dissection, transoral surgery has advantages over open thyroidectomy or the bilateral axillary-breast approach, mainly magnified views and cranial to caudal routes to reach levels VI and VII lymph nodes. In addition, in transoral surgery, a central route for bilateral central neck lymph node dissection is easier to achieve than unilateral approaches in transaxillary or retroauricular procedures.

The completion of thyroidectomy is also necessary for thyroid cancer surgery, particularly with radical lobectomy, which is increasingly serving as the initial procedure. If vascular invasion, extrathyroid extension, or > 5 pathological N1 are identified after initial lobectomy, a completion thyroidectomy is recommended treatment. In transoral surgery, completion of thyroidectomy is a concern because of the surgical difficulties caused by postoperative adhesions, which are routinely reduced using anti-adhesive hyaluronic acid agents. In our series, 5.7% of patients required completion thyroidectomy; they underwent repeat transoral reoperation without a change in the open surgery, transaxillary, or breast approach. The second procedure was successful, demonstrating the safety of the reoperative transoral thyroidectomy.

Tumor seeding in the trocar tract or spread in the surgical field is a concern, and piecemeal specimen removal increases this possibility [51]. In addition, a significant proportion (68%) of TOETVA specimens were disrupted or fragmented, as reported by Stephen et al., which can compromise tumor information, including size, number, margin status, and microscopic extrathyroidal extension [52]. Therefore, it is crucial to maintain specimen integrity during surgery and retrieval. We avoided this problem by creating a 1.5–2 cm incision in the patient's right axillary skin fold to remove the larger specimen after securing it in a specimen bag, thereby preventing specimen disruption and avoiding the compromise of the patient's aesthetic appearance.

Although this study appears promising, it has some limitations. First, the nature of a retrospective study conducted by a single surgeon may have an inherent bias and a result that cannot be generalized. Second, the number of cases was insufficient for subgroup analysis of different approach types and carcinomas. Therefore, long-term follow-up data are needed because of the generally favorable thyroid cancer outcomes. Third, our study did not include a control group of patients undergoing open thyroidectomy. Therefore, we can only compare our outcomes to the data reported for standard open thyroidectomy during the most common period of recurrence. In the future, a multicenter with comparative study will be necessary to fully evaluate the oncological outcomes of transoral thyroidectomy for thyroid cancer.

In conclusion, transoral endoscopic and robotic thyroidectomy was safe and achieved favorable mid-term oncological outcomes in a selected cohort of patients with early-stage DTC.

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Data availability The study protocol and the datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Disclosures Wu-Po Chao, Suo-Hsien Wang, Yu-Ting Huang, Soh-Ching Ng and Yu-Hsien Chen have no conflicts of interest or financial ties to disclose..

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