



# Scarless endoscopic thyroidectomy (SET) lateral neck dissection for papillary thyroid carcinoma through breast approach: 10 years of experience

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## Abstract

**Background** Breast approach endoscopic thyroidectomy with lateral neck lymph node metastases dissection has been described. However, in this article, we report on 10 years' experience with the breast approach to patients with endoscopic thyroidectomy with level II, III, and IV lateral neck dissection (LND). Patients with papillary thyroid carcinoma (PTC) who received scarless endoscopic thyroidectomy (SET) were included to evaluate its therapeutic effect.

**Methods** Between June 2009 and June 2019, we selected 155 patients with PTC with level II, III, or IV level lymph node metastasis suspected. Ipsilateral level II, III, and IV dissection was performed, accompanied by thyroidectomy and central compartment dissection. In addition, 102 patients received conventional open LND during the same period and were included. Clinicopathological characteristics, outcomes, and tumor prognosis were retrospectively compared in the two groups.

**Results** During the 10 years, the submitted patients' clinicopathological characteristics including tumor size, tumor stage, retrieved lymph nodes number, complication rates, postoperative PTH, and mean postoperative hospital stay were similar between the SET and open group. The mean operating time in the SET group ( $278.2 \pm 38.6$  min) was longer than in the open group ( $179.3 \pm 25.4$  min). The recurrent rate was not significantly different (2/155, 2/106) in the SET and conventional open group.

**Conclusion** The safety and oncological completeness dissection of SET was similar to that of open procedures. SET is an effective treatment approach for patients with PTC having cosmetic results' demand of lateral neck lymph node metastases.

**Keywords** Scarless endoscopic thyroidectomy · Lateral neck dissection · Thyroid cancer

## Abbreviations

PTC	Papillary thyroid carcinoma
BAET	Breast approach Endoscopic thyroidectomy
LND	Lateral neck dissection

Since Gagner first reported endoscopic parathyroidectomy in 1996 [1], endoscopic thyroidectomy has developed rapidly. Endoscopic thyroid surgery now has been applied to patients with thyroid cancer and achieved excellent cosmetic results

accompanied by effective lesions oncologically resected [2]. Various approaches including the transoral [3] approach, axillary approach [4], and robotic thyroidectomy [5] were appeared to conduct the endoscopy thyroid surgery process. Lateral neck dissection (LND) with a conventional open incision is the standard approach, and the consequence is a long scar on the neck that inevitably yields poor cosmetic results. To avoid the anterior neck scar in patients with PTC, endoscopy and video-assisted approaches were implemented to improve the cosmetic result [6, 7]. However, the scarless endoscopic thyroidectomy (SET) for LND remains controversial, and there are technical difficulties. Our surgical team reported our initial several cases of experience related to SET for LND [8]. In another report, few received cases were included, and the advantages and problems of this method have not been fully demonstrated [9]. Over 10 years, we performed a treatment on over 150 patients with PTC receiving endoscopy LND. Thus, in this study, we compared the surgical outcomes between SET and open LND for PTC

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with lateral neck lymph node metastases to assess the possible advantages, disadvantages, and complications between SET and open surgery for PTC with LND.

## Methods

### Patients' enrollment

#### Patient selection

Between June 2009 and June 2019, we prospectively enrolled 155 consecutive consenting patients with PTC with unilateral lateral neck lymph node metastasis who underwent total thyroidectomy or unilateral thyroidectomy with lateral neck lymph node metastases at the Thyroid Surgery Department in Second Affiliated Hospital, College of Medicine, Zhejiang University. All enrolled patients had lateral lymph node metastasis suspicious appearance on an ultrasonography or enhanced cervical computed tomography scan. Primary tumor invasion assessment was also applied before the operation. 102 patients receive conventional open operation were enrolled as control group. Control patients' clinical characteristics such as age, tumor size and TNM classifications were controlled comparable with STE group. TNM stage division follows the AJCC 8th edition guideline of thyroid cancer in 2017.

#### Inclusion and exclusion criteria for SET/conventional group

The SET group inclusion criteria were as follows: (1) a primary tumor size < 2 cm without severe invasion, (2) a differentiated thyroid carcinoma with suspected or confirmed lymph node metastasis, (3) a largest metastatic lymph node diameter < 2.0 cm, and (4) a highly cosmetic demand. The exclusion criteria were as follows: (1) previous neck or chest surgical history; (2) metastatic lymph nodes in the level V region; (3) metastatic lymph nodes were fused or fixed in the neck; (4) surrounding tissue invasion exists, such as trachea, esophagus, and recurrent laryngeal nerve (RLN); (5) patient with distant metastases; (6) no cosmetic demand.

Dissection of ipsilateral levels II, III, and IV was performed, followed by thyroidectomy and central compartment dissection, which were like those of the conventional surgery method. In addition, 102 patients who received conventional open surgery within the period were adopted to compare the clinical characteristics and outcomes with the SET group. Inclusion criteria of conventional surgery were as follows: (1) differentiated thyroid carcinoma with suspected or confirmed lymph node metastasis, (2) no surrounding tissue invasions, (3) aged 15–45 years, and (4) primary tumor size < 2 cm to match with the SET group. The study

protocol was approved by our institutional review board, and informed consent was obtained from all study participants.

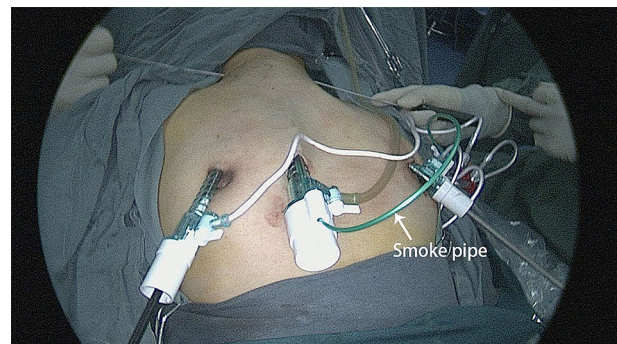
### SET thyroidectomy and LND surgical procedure

#### Thyroidectomy

Endoscopic thyroidectomy was applied the same as open surgery and is only briefly described here. Epinephrine solution was injected into the subcutaneous layer of the anterior chest for space creating. At nipple level, a 1.2-cm incision was made with 10-mm trocar access through the incision. Another two 5-mm trocars were applied through mammary areolas incision for auxiliary use (Fig. 1A). Ultrasonic coagulation devices (Ethicon Endosurgery, USA) were implemented to manage the thyroid vessel dividing. We first managed the thyroid surrounding vessels, and the inferior thyroid arteries and veins accompanied by the middle thyroid vein were isolated. The RLN was exposed by blunt dissection, which was then dissected progressively by the ultrasound device and pliers, after which the lobe was completely resected. Central compartment lymph node clearance was conducted including the prelaryngeal, pretracheal, and paratracheal areas.

#### LND in SET procedure

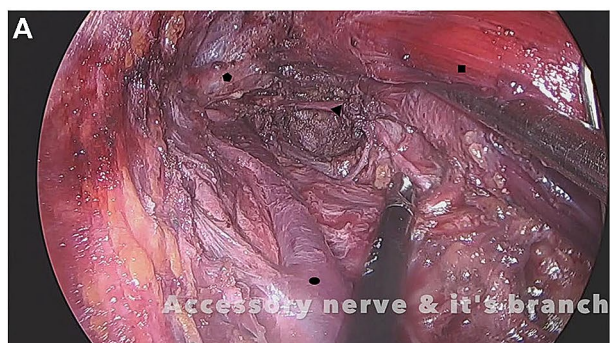
The LDN procedure comprised seven steps: (1) divide the sternocleidomastoid muscle between the sternal head and the clavicle head and place a pull hook between them; (2) dissect the sternocleidomastoid intermuscular region IV lymph nodes; (3) cut off the scapula hyoid muscle for internal jugular vein exposure, and in some cases, this step is unnecessary if surgical field exposure is sufficient for LND; (4) while carefully protecting the phrenic nerve and brachial plexus nerve, expose the vagus nerve and internal jugular



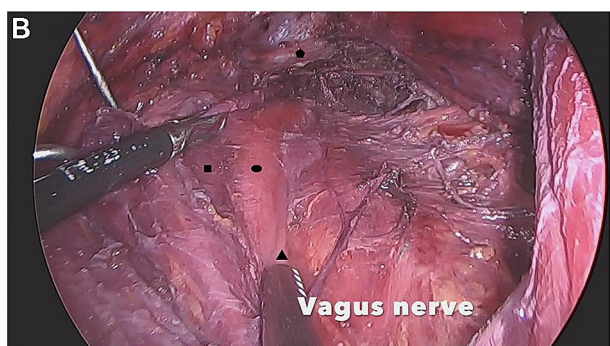
**Fig. 1** Incision design for SET patient, an incision (approximately 1.2 cm in length) was made at the nipple level close to the sternum. Two 5-mm trocars were inserted through the incisions (0.6 cm in length) at the margin of bilateral mammary areolas



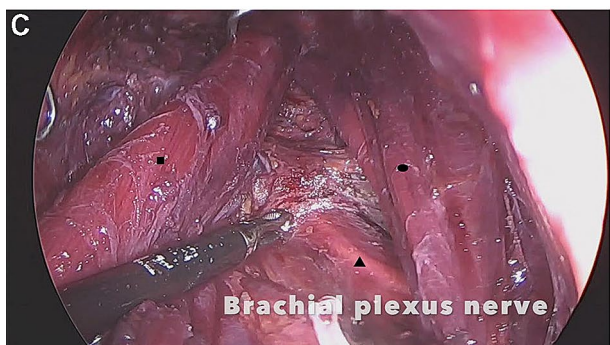
vein with the help of a retractor, after which dissect region III and IV lymph nodes; (5) divide the space between the sternocleidomastoid muscle and the anterior cervical muscle to reveal the diaphragm muscles; (6) search the accessory nerve in the upper third of the sternocleidomastoid muscle level; and (7) clear the lymph nodes of the IIA and IIB region areas while protecting the facial vein branches and hypoglossal nerve (Fig. 2A–C).



• Internal jugular vein ▲ Accessory nerve ■ Sternocleidomastoid muscle  
● Digastic muscle



■ Internal jugular vein ● Arteria carotis communis  
● Digastic muscle ▲ Vagus nerve



▲ Brachial plexus ■ Sternal head of sternocleidomastoid muscle  
● Sternocleidomastoid muscle clavicular head

**Fig. 2** Thyroidectomy and lateral lymph node dissection in SET. **A** Accessory nerve exposure after region II lymph node dissection. **B** Vagus nerve expression after para-jugular lymph nodes' dissection. **C** Plexus nerve exposure and protection after SCM traction during lateral lymph node dissection

After these steps, assess the panorama of the lateral cervical region, especially the internal jugular chain lymph node dissection, to ensure no residual tissue remains. If surgical field exposure difficulty occurs, minilap equipment may help retract the obstructive muscle and vessels (Fig. 3A, B).

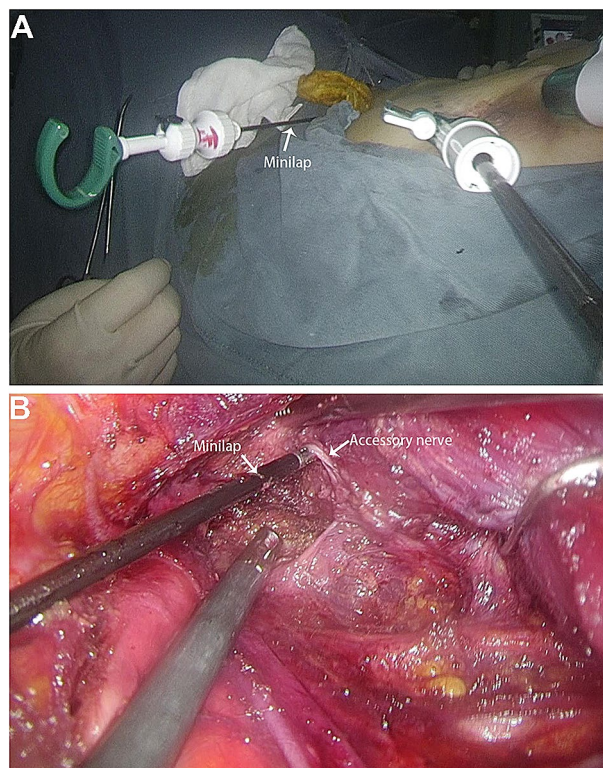
## Postoperation control

### Drainage control

After operation, two drainage tubes were placed in thyroid fossa area close to the trachea and lateral margin of internal jugular vein, respectively. The total amount of drainage amount and drainage traits were record every 24 h. The drainage tube was removed on the condition that the latest 24-h drainage amount was less than 30 ml. The patient was discharged after removing all drainage tubes.

### Biochemical monitoring

Preoperative PTH and calcium were recorded 3 days before surgery, postoperation PTH and calcium blood sample was collected at 6 a.m. the day next to the operation. If the patient has symptoms of numbness or convulsions in limbs,



**Fig. 3** Minilap application during SET lateral lymph node dissection. **A** Minilap placement through neck skin surface. **B** Improved operation field and working space after minilap application with accessory nerve push

intravenous 2 g calcium gluconate was used each time and oral calcium supplement was applied to relieve hypocalcemia symptoms.

### Patient follow-up

In our center, patients receive postoperative review every month within 3 months after surgery. Thyroid function, serum calcium and PTH were tested, and TSH inhibition therapy strategy follows the 2015 ATA thyroid nodule guideline [10]. After the period, we conduct patient follow-up every 6–12 months, thyroid function and cervical B ultrasound were included each time.

## Results

### Clinicopathologic characteristics

The clinicopathologic characteristics are summarized in Table 1. The endoscopy group comprised 155 patients: 6 males and 149 females, and mean age was  $28.8 \pm 8.3$  years. The open group comprised 102 patients: 16 males and 86 females, and mean age was  $30.2 \pm 9.2$  years. The two groups' characteristics were different in sex ratio ( $p < 0.01$ ) because of cosmetic demand diversity between male and female patients.

The two groups were similar in age ( $p = 0.057$ ), tumor ( $1.26 \pm 0.71$  SET group vs  $1.31 \pm 0.65$  cm in open group,  $p = 0.72$ ), preoperative TNM stage assessment ( $p = 0.36$ ), and unilateral/bilateral thyroidectomy ratio ( $p = 0.07$ ). All the patients were identified to have cervical lymph node metastasis with postoperative pathology identification. On the other time, the mean operating time was  $278.2 \pm 38.6$  min in the SET group, which, is longer in the open group at  $179.3 \pm 25.4$  min ( $p < 0.01$ ), and the duration of postoperative hospital stay was similar ( $6.02 \pm 1.94$ d vs  $5.63 \pm 1.94$ d) between the two groups ( $p = 0.66$ ).

**Table 1** Clinicopathological characteristics

	Endoscopy group (N = 155)	Open group (N = 102)	p
Age (years)	$28.8 \pm 8.3$	$30.2 \pm 9.2$	0.057
Male	6 (3.8%)	16 (15.7%)	<0.01
Operation time (min)	$278.2 \pm 38.6$	$179.3 \pm 25.4$	<0.01
Postoperative hospital stay (days)	$6.02 \pm 1.94$	$5.63 \pm 1.94$	0.66
Max tumor size (cm)	$1.26 \pm 0.71$	$1.31 \pm 0.65$	0.72
Unilateral thyroidectomy	61 (39.4%)	29 (28.4%)	0.07
Bilateral thyroidectomy	94 (60.6%)	73 (71.6%)	
TNM classifications			
T1/T2/T3/T4a	132/0/18/5	89/0/7/6	0.36
N0/N1a/N1b	0/0/155	0/0/102	

### Operation complications

Thyroid cancer operations are usually accompanied by several common complications because of cancer invasion or energy equipment injury. The complication rates were similar between the two groups (Table 2). In both the SET and open surgery group, no permanent RLN injury occurred. Transit hoarseness occurred in 8/155 (5.16%) and 7/102 (6.86%) in the SET and open surgery group ( $p = 0.57$ ), respectively. Respectively, 3/155 (1.94%) and 2/102 (1.96%) cases manipulated hematoma formation, and all the patients were relieved with local compression without further hemorrhage.

Chyle leaks were observed four cases in the SET group and four cases in the open group ( $p = 0.34$ ), and these cases successfully responded to conservative treatment. No major chyle leak was observed in either group. In addition, four cases (2 in SET and 2 in open group) had postoperation infection during the in-hospital period ( $p = 0.67$ ). All the patients expressed local redness and swelling, which was controlled with antibiotic application without re-operation. Internal jugular vein rupture occurrence was 19/155 (12.26%) in the SET group and 3/102

**Table 2** Operation-related complications

	Endoscopy group (N = 155)	Open group (N = 102)	p value
Transit hoarseness	8 (5.2%)	7 (6.9%)	0.57
Hematoma formation	3 (1.9%)	2 (2.0%)	1.00
Chyle leak	4 (2.6%)	4 (3.9%)	0.34
Postoperation infection	2 (1.3%)	2 (2.0%)	0.67
Internal jugular vein rupture	19 (12.3%)	3 (2.9%)	<0.01
Phrenic nerve injury	0	0	1.00
Limb lift restriction	6 (3.9%)	4 (3.9%)	0.37
Local recurrence or residue at follow-up ultrasound	2 (1.3%)	2 (2.0%)	0.67

(2.94%) in open the group ( $p < 0.01$ ). Phrenic nerve injury did not occur in either group. In addition, 6/155 (3.87%) in the SET group and 4/102 (3.92%) in the open group were found to have limb lift restriction, respectively ( $p = 0.37$ ). Most importantly, in four cases (2 in the SET group and 2 in the open group,  $p = 0.67$ ), local recurrence presented during the observation, and these patients received a secondary operation since now. Patients receive chest computerized tomographic scanning every 12 months. No patient developed distant metastases after surgery. All the patients remain survival at present under our follow-up.

### Cervical lymph node dissection characteristics

Complete metastasis suspected lymph node dissection is the main malignant tumor therapy strategy. We calculate the total and positive dissected lymph node in level II, III, and IV of the cervical lymph region (Table 3). The dissected lymph node number in level II, III, and IV is similar in the SET group and conventional open group (level II,  $8.23 \pm 2.74$  vs  $8.78 \pm 2.43$ ,  $p = 0.19$ , level III–IV,  $14.68 \pm 7.25$  vs  $14.72 \pm 8.03$ ,  $p = 0.80$ ), alone with metastasis dissected lymph node (level II–IV,  $3.18 \pm 3.02$  vs  $2.68 \pm 2.87$ ,  $p = 0.48$ ).

### Postoperative parathyroid function

Hypoparathyroid function sometimes occurred in patients who underwent bilateral thyroidectomy, which influenced the patient's quality of life. We calculate the PTH and calcium in patients that underwent bilateral thyroidectomy in both groups (Table 4). No differences were detected in the two groups: preoperative PTH ( $45.29 \pm 15.10$  vs  $50.58 \pm 18.96$ ,  $p = 0.06$ ), postoperative PTH ( $19.63 \pm 12.98$  vs  $20.85 \pm 17.59$ ,  $p = 0.62$ ), preoperative calcium ( $2.36 \pm 0.12$  vs  $2.39 \pm 0.09$ ,  $p = 0.30$ ), and postoperative calcium ( $2.05 \pm 0.16$  vs  $2.06 \pm 0.15$ ,  $p = 0.50$ ).

**Table 3** Cervical lymph node dissection

	Endoscopy group	Open group	<i>p</i>
Total	$22.91 \pm 9.88$	$23.50 \pm 11.46$	0.50
III–IV	$14.68 \pm 7.25$	$14.72 \pm 8.03$	0.80
II	$8.23 \pm 2.74$	$8.78 \pm 2.43$	0.19
II–IV metastasis	$3.18 \pm 3.02$	$2.68 \pm 2.87$	0.48
Development of distant metastases	0	0	

**Table 4** Postoperative parathyroid function

	Bilateral endoscopy <i>n</i> = 94	Bilateral open <i>n</i> = 73	<i>p</i> value
Preoperative PTH	$45.29 \pm 15.10$	$50.58 \pm 18.96$	0.06
Postoperative PTH	$19.63 \pm 12.98$	$20.85 \pm 17.59$	0.62
Preoperative calcium	$2.36 \pm 0.12$	$2.39 \pm 0.09$	0.30
Postoperative calcium	$2.05 \pm 0.16$	$2.06 \pm 0.15$	0.50

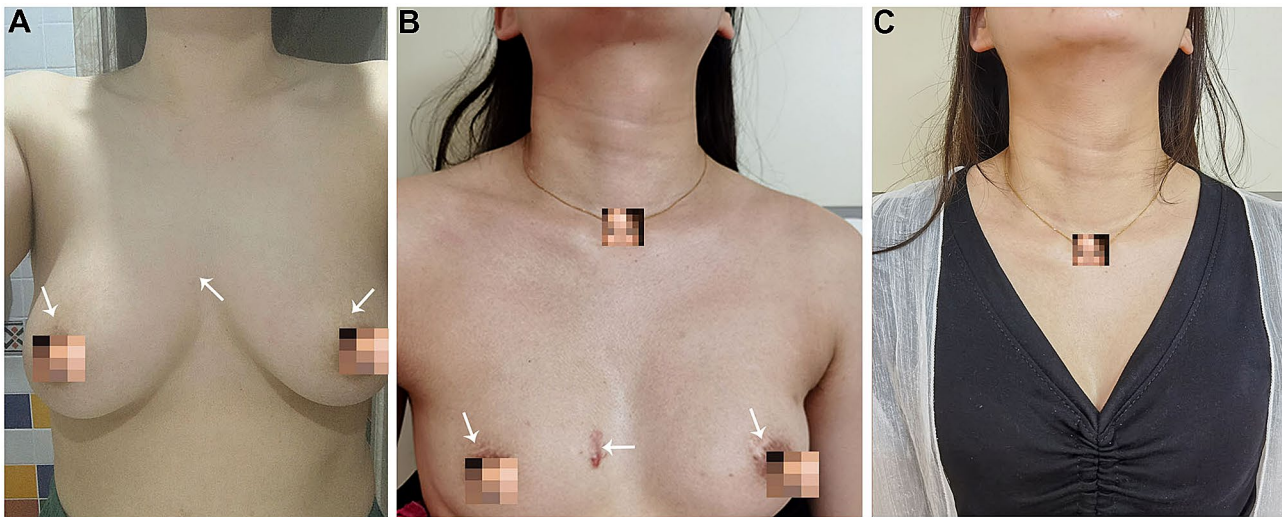
### Discussion

Therapeutic neck dissection was indicated with evident lymph node involvement suspect [11]. The common procedures for LND resulted in a long, unsightly L-shaped scar after conventional surgery because the incision length is usually as long as 20 cm. In China, typically younger patients especially unmarried female patients and people of certain occupations may concern for the noticeable scar some. Compared with open surgery, SET LND only requires 3 small incisions in the anterior chest and bilateral areolas areas. These wounds are well hidden in a patient's daily life (Fig. 4A–C); thus, the novel procedure fulfills the demand of private surgical history information protection [8].

The data presented reveal that the patients enrolled in both the endoscopy and convention open groups had similar clinical characteristics, for example, age, tumor size, hospital stay time, and TNM classifications. Only the female ratio was higher in the endoscopy group, and that occurred because of the higher cosmetic demands of female patients. Respectively, a stronger sternocleidomastoid in male patients usually acts as an obstacle to male patients' operation. As a result, in clinical, female patient with lymph node metastasis suspected was more trending to receive SET cervical lymph dissection. Because of the limitation of working space and endoscopy instrument management is time-consuming, endoscopy for LND will take a longer time compared with the open group. In a report on 18 patients, Qu found that the endoscopic clearance of lymph nodes slightly increased the operation time [12]. Lee et al. reported that the average operative time of a robot group was 271.8 min, which was longer than that of the open group (271.8 vs. 208.9 min) and similar to our study. For this reason, we strongly recommended patients to have urethral catheterization before the operation.

Surgical-related complications usually influence the application of new technology. In our study, we found that the RLN injury rate, hematoma formation, chyle leak, postoperation infection, phrenic nerve injury, accessory nerve injury, and hypoparathyroid function incidence were similar in the SET group and open group. Most notably, internal jugular vein protection was more challengeable in





**Fig. 4** Postoperative incision scar. **A** Postoperative incision in patients with scar-free constitution. **B** Surgical incision scar in patients with scar physique. **C** Hyperplastic scars are covered by clothes

endoscopy lymph dissection. The reason for this finding has three aspects: (1) the space limitation in the endoscopy environment, (2) no direct touch with the vessels' surface led to more vascular wall tear during the dissection procedure, and (3) uncontrolled clamps clip onto the vascular wall during the operation.

Internal jugular vein rupture during operation is usually the primary reason for conversions to open surgery if hemostasis failure occurs. Internal jugular vein rupture is more common in giant thyroid tumors, Hashimoto's thyroiditis hyperthyroidism, and patients with more vascular branches along the internal jugular vein. Based on our experience, internal jugular vein rupture incidence was higher than in the open group because of the aforementioned reasons. If internal jugular vein bleeding occurs, small lacerations can be sutured directly with a 5-0 proline wire. A supplied MacFee may help repair larger lacerations under direct vision. In addition, coagulated directly with ultrasonic equipment accompanied by a hemlock clip may stop internal jugular vein hemostasis. Generally, it is more difficult to repair under endoscopy, and a ruptured branch of the internal jugular is also difficult to manage. If possible, using hemlock clips for thick branches of vascular in advance may avoid uncontrolled bleeding during surgery. Although there is higher incidence of internal jugular vein rupture, luckily, most patients had only small break and were sutured successfully. In our 155 cases' management, no conversion to open surgery happened.

In our center, we were the first to report the RLN monitor implemented in transoral endoscopy thyroidectomy [13]. With the help of the RLN monitor, it was more convenient to correctly identify the RLN, vagus and accessory nerve before tissue isolation.

Within the 155 cases, postoperative bleeding and hematoma occurred in two cases, and this was controlled with conventional local compression. Based on our experience, the correct use of an ultrasonic scalpel in vessel management and avoidance of forceful coughs postoperatively decrease the incidence rate of postoperative bleeding. The thick vessels should be cut only after being coagulated a broad range by an ultrasonic scalpel. Endoscopy thyroid operations require a large space creating before chest area, which increases the tunnel hematoma rate after the operation. Based on our experience with 1932 thyroid endoscopy cases, we conclude that a "suture compressed bandage" method for patients with high hematoma risk can control and decrease the bleeding ratio in endoscopy patients and produce satisfactory hemostasis results [14].

To decrease the incidence of hypoparathyroid function and the chyle leak rate, we strongly recommend the application of carbon nanoparticles, which reduce the risk of mistakenly injuring the parathyroid, and reduce the incidence of postoperative hypoparathyroidism [15]. With the help of the endoscopy zoom-in function, a nanoparticle-dyed lymphatic tunnel can be easily recognized on a screen. After careful lymphatic coagulation, the incidence of chyle leak rate was similar to that in the open group. In open surgery cases, when chyle leak occurs during surgery, we strongly recommend a ligation with wire of the chest catheter and main branches. If in an STE surgery environment, hemlock application at the rupture point sometimes helps stop a chyle leak.

Radical lymph node dissection ensures the acceptable recurrent incidence. In our center, patients regularly receive II–IV level dissection along with the open surgery group. If patients were suspected of a large amount of cervical lymph node metastasis or level V region lymph node metastasis,

they were excluded from endoscopy surgery, and we recommended that they receive conventional open surgery. Because the operation should be performed similar to the conventional approach to expand the working space benefit for lymph dissection, the step for lateral cervical lymph node dissection is also similar to our open surgery operation. Thus, the recurrent rate was similar between the open surgery group and SET group. In this study, the mean tumor size in the SET group was similar to that in the open group. Usually, we deemed that a tumor size larger than 2 cm was unsuitable for SET dissection. A large-volume thyroid malignant mass would increase the obstacles during the tumor tissue drag out procedure and the incidence of specimen bag rupture which may lead to tumor transplantation. After surgery, patients receive SET operations sometimes complained about dysesthesia in anterior chest area. In most case, the dysesthesia symptom results from the chest area flap separation procedure during space creating. In a small percentage of patients, this symptom would persist or partial recovery only. During the space creating step, the interval should be established between the latissimus dorsi and the fascia of the neck to minimize sensory nerve damage.

During our 10 years' experience, we collected 155 cases of patients who received breast approach endoscopy lateral cervical dissection. In the literature, the therapeutic effect has been as satisfactory as in the open surgery group. We conclude that this approach is safe and effective and offers many cosmetic and private effects in selected patients with PTC and lateral neck lymph node metastasis. We suggest that thyroid surgeons carefully communicate with patients and evaluate if they were caring about the scar on the neck and help them to make the decision on which surgical method to receive. In addition, longer follow-up is necessary to further assess the advantages and oncologic completeness of endoscopy thyroid cancer therapy.

### Compliance with ethical standards

**Disclosures** Drs. Hai-chao Yan, Cheng Xiang, Yong Wang and Ping Wang have no conflicts of interest or financial ties to disclose.

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