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NEW TECHNOLOGY

Technique for endoscopic thyroidectomy with selective lateral neck dissection via a chest–breast approach

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Abstract

Background Endoscopic thyroidectomy has been widely accepted because it can effectively avoid neck scarring. However, there are seldom reports concerning completely endoscopic lateral neck dissection approaches. In this study, we introduced a technique for performing endoscopic thyroidectomy with lateral neck dissection via a chest–breast approach.

Methods We retrospectively reviewed 18 patients who underwent endoscopic total thyroidectomy along with levels II, III, IV, and VI dissection. All major outcomes, such as cosmetic effect, operative time and complications, etc., were analyzed. In addition, another 20 patients who underwent traditional open surgery (open group) were enrolled in the study to conduct a contrasting analysis between patients treated with the endoscopic technique (endoscopic group) and open group patients, in terms of demographic data and main operative outcomes, to evaluate the feasibility of this technique.

Results All 18 endoscopic surgery cases were successfully performed, and no patient was converted to the open procedure intra-operatively. There were no significant differences between the two groups regarding age ($P=0.209$), Body Mass Index ($P=0.479$), sex ($P=0.218$), drainage time ($P=0.153$), operation time ($P=0.065$), intra-operative blood loss ($P=0.139$), post-operative pain ($P=0.114$), and number of dissected lateral lymph nodes (II: $P=0.201$; III + IV: $P=0.107$). The mean total and lateral lymph nodes dissection (LLND) time in the endoscopic group were longer than those of the open group ($P=0.002$; 235 ± 35 vs. 182 ± 20 min, $P=0.000$; 125 ± 21 vs. 80 ± 14 min, $P=0.000$). The primary lesion diameter of the endoscopic group was smaller than that of the open group (1.7 ± 0.8 vs. 2.9 ± 1.3 cm, $P=0.002$). The scores for cosmetic satisfaction in the endoscopic group were higher than those in the open group (8.3 ± 0.7 vs. 4.4 ± 0.9, $P=0.000$). Among the complications, there was no significant difference between the two approaches in transient vocal cord paresis (1/18 vs. 0/20, $P=0.474$), transient hypoparathyroidism (4/18 vs. 4/20, $P=1.000$), post-operative lymphatic leakage (1/18 vs. 3/20, $P=0.606$), and intra-operative large blood vessel injury (2/18 vs. 0/20, $P=0.218$). There was no incidence of uncontrolled bleeding, mental nerve injury, permanent hypoparathyroidism, permanent recurrent laryngeal nerve (RLN) injury, skin bruise on the neck, asphyxia/dyspnea or other complications like tracheal injury, esophageal injury, etc., nor was there any death or recurrence in either of the two groups during the short follow-up period.

Conclusion It is feasible to perform LLND (levels II, III, IV, and VI) with endoscopic thyroidectomy via a chest–breast approach. In particular, this technique avoids a large scar on the patient's neck and has well operative outcomes compared with open surgery. Accordingly, this technique may offer one more option for selective patients.

Keywords Endoscopic thyroidectomy · Chest–breast approach · Lateral neck dissection · Clearance of lateral lymph nodes

Youming Guo and Rui Qu contributed equally to this work.

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Traditional open thyroid surgery along with lateral neck dissection always leaves a large "L" or "collar" scar on the neck, and it significantly affects the esthetics of patients.

Since endoscopic thyroidectomy has developed rapidly and gained wide acceptance, it has generally been performed for the treatment of benign diseases and differentiated thyroid cancer [1–5]. Thus, the therapeutic effects could be achieved on the premise, that a "scarless" surgical approach would produce a desired cosmetic outcome for these patients. To date, some studies [6–8] have been reported in terms of endoscopic or robotic lateral neck dissection, but the excision extent may not be enough (II dissection was not included routinely) and some problems (insufficient exposure and operative difficulties) may not be properly solved. In this study, we included a series of the 18 cases of endoscopic thyroidectomy along with ipsilateral neck dissection (at levels IIA, IIB, III, IV), using current endoscopic instruments in a modified strategy via a chest–breast approach.

Materials and methods

All patients were selected at the First People's Hospital of Zunyi between January 2017 and May 2018. Inclusion criteria for this technique were as follows: (1) the diameter of the thyroid tumor was less than or equal to 3.0 cm; (2) pre-operative fine needle aspiration (FNA), ultrasonography, computed tomography (CT), or intra-operative exploration indicated that there were ipsilateral lymph nodes metastases papillary thyroid carcinoma (PTC) along with clinical one-side neck lymph nodes metastasis (level IIA, IIB, III, or IV); (3) 18–60 years old; and (4) the patient willingly chose this technique. Exclusion criteria were as follows: (1) patient had previous surgery or radiation on the neck; (2) evidence of distant metastasis, or metastatic lymph nodes fixed in the neck or fused with each other; (3) level I or V metastatic lymph nodes found pre-operatively, or invasion of the surrounding tissues like tracheal, large vessels etc.; and (4) patient could not tolerate anesthesia or operation.

Ultimately, 18 patients who chose to undergo endoscopic surgery via the chest–breast approach (endoscopic group) were included in the study, and their detailed information are shown in Table 1. In addition, another 20 patients who met the inclusion criteria (namely received traditional total thyroidectomy along with ipsilateral level VI, II, III, and IV dissection) were enrolled in the study as the control group (open group). All above 38 cases were completed by one surgeon (Youming Guo). Details of this technique were given to all patients and written informed consent was obtained from each patient. Ethical approval for this study was obtained from the local ethics committee.

Operative procedures

After general anesthesia, the patients and surgeon position, incisions, location of trocars were similar to previous reports [9–11] (Fig. 1). The subcutaneous loose connective tissue between the superficial layer of the sternohyoid muscles and the deep layer of the platysma muscle was separated to

Table 1 Information of the patients who chose endoscopic approach

No.	Sex	Age (years)	BMI	Diameter of the primary lesion (cm)	LLND/total operation time (min)	Lymph nodes metastasis (levels)		
						II	III + IV	VI
1	Female	34	20.3	1.8	160/280	1/3	4/10	2/6
2	Female	44	18.9	0.5	130/220	1/4	2/11	1/3
3	Female	37	19.7	2.0	120/260	0/4	9/15	8/12
4	Female	27	25.6	1.7	160/240	0/3	1/14	2/4
5	Female	47	22.3	1.7	140/300	4/5	3/13	1/3
6	Male	27	30.0	3.0	150/280	4/9	1/15	2/3
7	Female	65	23.1	1.2	130/200	0/3	2/16	5/15
8	Female	42	20.8	2.1	120/210	0/5	8/17	0/3
9	Female	32	19.4	0.6	100/190	2/8	2/20	1/7
10	Female	29	24.1	0.5	140/250	3/5	1/18	1/4
11	Female	29	26.1	2.5	135/230	0/10	2/21	0/2
12	Female	54	24.7	3.0	110/210	0/8	0/17	3/8
13	Female	20	17.6	2.8	130/280	0/7	0/15	4/4
14	Female	50	28.6	1.7	90/210	2/6	1/17	3/4
15	Female	27	22.4	1.2	130/220	0/5	9/23	1/3
16	Female	37	25.3	2.5	120/240	4/9	2/26	2/7
17	Male	46	26.3	0.8	100/170	0/6	6/16	5/5
18	Female	50	24.4	1.5	90/250	1/7	7/19	4/7

BMI body mass index, *LLND* lateral lymph node dissection

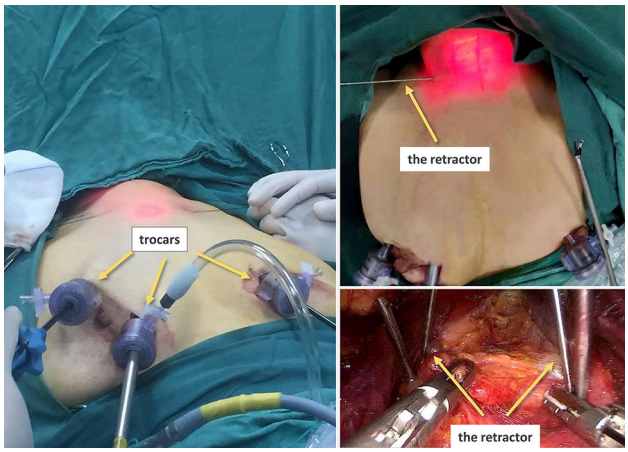

Fig. 1 Placement of the operative trocars, incisions and retractors

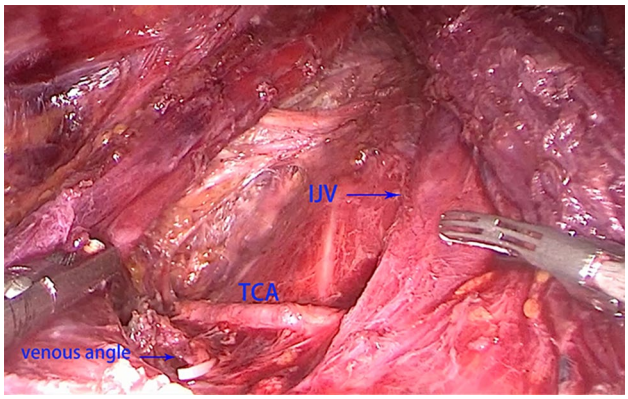

Fig. 2 After clearance of lymph nodes at level IV. *IJV* internal jugular vein, *TCA* transverse cervical artery

create the working space, using an ultrasonic coagulation device (Harmonic Scalpel; Ethicon Inc., Bridgewater, NJ, USA). The range should be superiorly to the upper edge of the thyroid cartilage and laterally to the medial edge of each of the sternocleidomastoid muscles (SCMs) at the bilateral sides.

Thyroidectomy and central lymph nodes dissection

After the infrahyoid muscle was opened at the middle and separated from the thyroid capsule, two sutures were placed into the SCMs, which were pulled toward the bilateral sides so as to maintain the working space. The thyroid isthmus was exposed and separated from the trachea with the ultrasonic scalpel, then the thyroid lobe with the tumor was freed and the vessels of each pole were carefully dissected. From the inferior pole of the thyroid lobe to the Berry's ligament area, the recurrent laryngeal nerve (RLN) and the parathyroid glands were routinely exposed and preserved as much as possible. All removed tissues must be put into a special bag and removed through the observation port for frozen pathology. The lymph nodes in prelaryngeal, pretracheal, and paratracheal areas were carefully and thoroughly dissected. Damage to the RLN and inferior parathyroid gland should be avoided during the lymph node clearance (more detailed procedures shown in Reference [9]).

Ipsilateral lateral neck dissection (levels IIa, IIb, III, and IV)

The head of the patient should be turned around to the contralateral side for the following procedures. Then, the working space range should be expanded to the lower edge of the submandibular gland superiorly and the lateral edge of the SCM on the ipsilateral side (external jugular vein can be exposed). The SCM was opened longitudinally at the site between its sternal head and clavicular head, and superiorly to the level of the carotid bifurcation. Subsequently, two special 1-mm-tractors or sutures were inserted in the working space from the neck surface. The sternal head and clavicular head of the SCM were then pulled medially towards each of the bilateral sides (Fig. 1). Afterwards, the omohyoid muscle and internal jugular vein will be exposed. Then, the omohyoid muscle was dissected to enlarge the space to the lateral neck, and the internal jugular vein was cautiously isolated and retracted to help dissect the surrounding tissues. During the progress of the isolation procedure, the lymph vessels nearby the venous angle should be carefully clipped with biological clamps (Fig. 2). The dissection was performed paying attention to avoid injury of the thoracic duct (left side) or lymphatic trunk (right side). When the internal jugular vein was pulled towards the inner side, the lymph nodes and surrounding fatty tissue in the level IV can be freed and retracted from the lower edge of the supraclavicular line to the upper side. After that, the level III lymph node clearance was performed in the inferior to superior direction, from the level of the clavicle inferiorly to the level of the carotid bifurcation superiorly. The vagus nerve, transverse cervical artery, phrenic nerve, anterior scalenus muscle, and cervical plexus etc. were all exposed and preserved (Fig. 3). The careful operation of the lymph nodes clearance continued going towards the level IIb and the accessory nerve should be protected under endoscopy (Fig. 4). Some patients needed the dissection at level IIa, then the space between the SCM and sternothyroid muscle would be opened and retracted to widen the working space. Lymph nodes in this compartment can be removed superiorly to the lower edge of the digastric muscle and laterally to the front edge of the trapezius muscle (Fig. 5). All resected lymph nodes (levels IIa, IIb, III, IV) were removed in a special bag (Fig. 6). Finally, hemostasis was

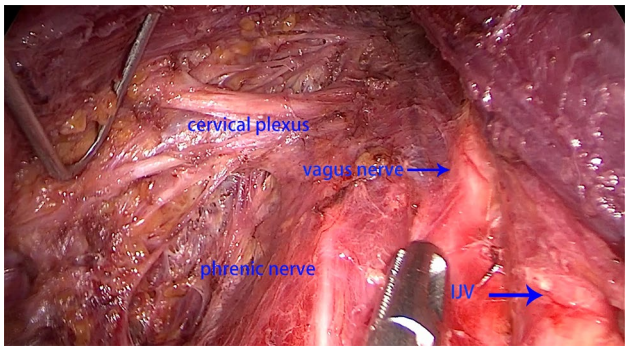

Fig. 3 After clearance of lymph nodes at level III. *IJV* internal jugular vein

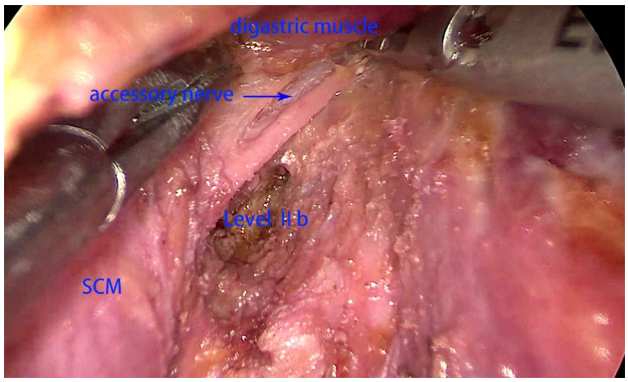

Fig. 4 After clearance of lymphnodes at level IIb. *SCM* sternocleidomastoid muscle

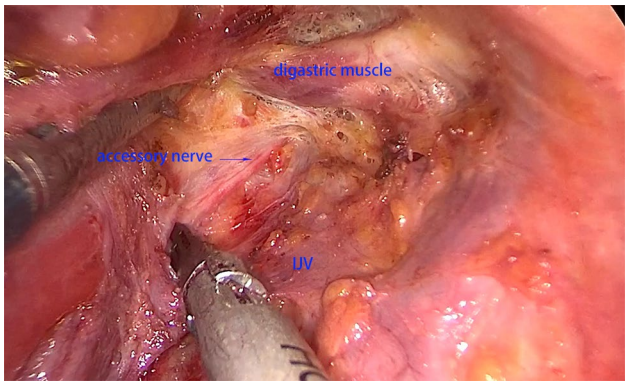

Fig. 5 After clearance of lymph nodes at level IIa. *IJV* internal jugular vein

checked at the end of the dissection. Two drainage tubes were left in situ, one in the central zone and another in the lateral zone. If level I or V LN metastases are found during endoscopic dissection, we recommend an additional small localized incision for level I or V dissection with the assistance of an endoscope. (more details shown in the submitted video).

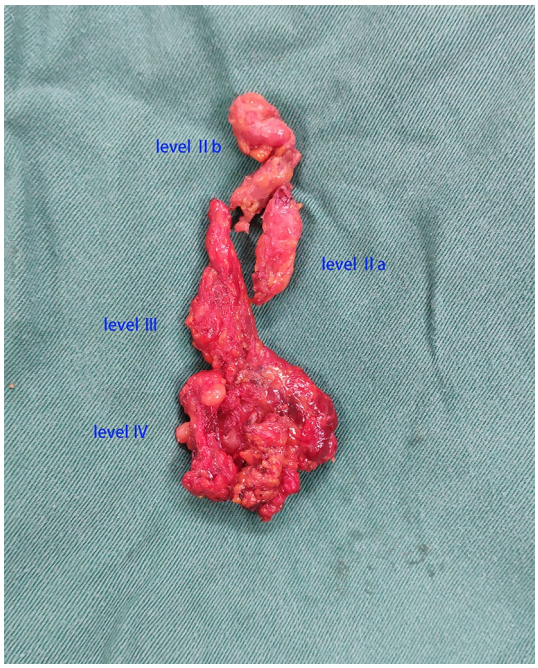

Fig. 6 The removed lymph nodes (IIa, IIb, III, IV)

Post-operative management and follow-up

All patients required close observation after operation, being cautious of serious events such as respiratory tract obstruction, lymphorrhagia, Horner's syndrome, uncontrolled bleeding, etc. The drainage tubes would be removed when the post-operative drainage volume was less than 15 ml/day. Then, these patients should receive radioactive iodine therapy (RAI) 1–3 months later. In theory, follow-up would be conducted regularly at 1, 3, 6 months, and then annually after surgery in the outpatients clinic.

Results

All 18 endoscopic surgery cases were performed successfully, and no patient was converted to the open procedure intra-operatively. The outcomes (compared with open surgery) are presented in Table 2. There was no significant difference in the demographic data, including age (38.7 ± 11.8 vs. 43.0 ± 9.0 years, $P = 0.209$), Body Mass Index (BMI) (23.3 ± 3.4 vs. 24.1 ± 3.0, $P = 0.479$), and sex [(F/M) 16/2 vs. 20/0, $P = 0.218$], between the endoscopic group and open group. The mean total and lateral lymph nodes dissection (LLND) time in the endoscopic group were longer than those in the open group (235 ± 35 vs. 182 ± 20 min,

Table 2 Surgical outcomes of the endoscopic and open groups

Characteristics	Endoscopic ($n=18$)	Open ($n=20$)	P value
Age (years)	38.7 ± 11.8	43.0 ± 9.0	0.209
Sex (F/M)	16/2	20/0	0.218
Body mass index (BMI)	23.3 ± 3.4	24.1 ± 3.0	0.479
Diameter of primary lesion (cm)	1.7 ± 0.8	2.9 ± 1.3	0.002
Cosmetic satisfaction (scores)	8.3 ± 0.7	4.4 ± 0.9	0.000
Post-operative pain (scores)	4.1 ± 0.8	4.3 ± 1.0	0.114
Drainage time (days)	7.3 ± 2.4	6.2 ± 2.4	0.153
Intra-operative blood loss (ml)	48 ± 36	35 ± 14	0.139
Operation time (min)			
Total	235 ± 35	182 ± 20	0.000
Lateral lymph node dissection (LLND)	125 ± 21	80 ± 14	0.000
Dissected lateral lymph nodes (n)			
II	5.8 ± 2.0	6.6 ± 1.9	0.201
III + IV	16.3 ± 3.3	18.6 ± 5.2	0.107

Table 3 Operative complications of this technique

Complications (n)	Endoscopic ($n=18$)	Open ($n=20$)	P
Lymphatic leakage	1	3	0.606
Bleeding (out of control)	0	0	NA
RLN injury			
Permanent	0	0	NA
Temporary	1	0	0.474
Mental nerve injury	0	0	NA
Hypoparathyroidism			
Permanent	0	0	NA
Temporary	4	4	1.000
Infection	0	0	NA
Skin bruise on the neck	0	0	NA
Large blood vessels injury	2	0	0.218
Asphyxia or dyspnea	0	0	NA
Subcutaneous ecchymosis or hydrops	0	0	NA
Other complications[a]	0	0	NA

[a]Represent dysphagia, tracheal injury, esophageal injury and so on

$P=0.000$; 125 ± 21 vs. 80 ± 14 min, $P=0.000$). The primary lesion diameter in the endoscopic group was smaller than that in the open group (1.7 ± 0.8 vs. 2.9 ± 1.3 cm, $P=0.002$). The cosmetic satisfaction scores in the endoscopic group were higher than those in the open group (8.3 ± 0.7 vs. 4.4 ± 0.9, $P=0.000$). The data presented in Table 3 reveal that there was no significant difference between the two approaches in intra-operative blood loss (48 ± 36 vs. 35 ± 14 ml, $P=0.139$), post-operative pain (4.1 ± 0.8 vs. 4.3 ± 1.0 scores, $P=0.114$), drainage time (7.3 ± 2.4 vs. 6.2 ± 2.4 days, $P=0.153$), and number of dissected lateral lymph nodes (II: 5.8 ± 2.0 vs. 6.6 ± 1.9 min, $P=0.201$; III + IV: 16.3 ± 3.3 vs. 18.6 ± 5.2 min, $P=0.107$). Among the complications, there was no significant difference between the two approaches in transient vocal cord paresis (1/18 vs. 0/20, $P=0.474$), transient hypoparathyroidism (4/18 vs. 4/20, $P=1.000$), post-operative lymphatic leakage (1/18 vs. 3/20, $P=0.606$), and intra-operative large blood vessels injury (2/18 vs. 0/20, $P=0.218$). There was no incidence of uncontrolled bleeding, mental nerve injury, permanent hypoparathyroidism, permanent RLN injury, skin bruise on the neck, asphyxia/dyspnea or other complications like tracheal injury, esophageal injury, etc., nor was there any death or recurrence in either of the two groups during the short follow-up period.

Discussion

Until now, endoscopic thyroid surgery has undergone great development worldwide [12–14]. As indicated by some reports [15–18], it has not only been successfully applied in treating thyroid benign diseases and differentiated thyroid carcinoma, but also has achieved similar therapeutic outcomes for thyroidectomy and central lymph nodes dissection (CLND) by open surgery [19, 20]. For those patients who require LLND, the demand for avoiding neck scarring is very strong. However, although it remains controversial in terms of technical exposure, operation standards, indications, etc., the complete endoscopic approach for LLND should be explored using current techniques and instruments. In addition, we have extensive experience and excellent team cooperation in endoscopic thyroidectomy [9, 10, 21, 22]. Accordingly, we explored and performed endoscopic surgery via a chest–breast approach for treating papillary thyroid carcinoma along with ipsilateral lateral neck metastasis and evaluated its surgical outcomes.

Outcomes of this technique

The data presented in Table 2 reveal that the patients enrolled in both groups had similar demographic characteristics like age, BMI, etc. According to the operative factors in this study, the pain score, drainage time, intra-operative blood loss, and the mean quantity of dissected lymph nodes in lateral levels in the endoscopic group were comparable to those in the open group. Regardless of whether the level was II or III + IV, the endoscopic clearance of lymph nodes had similar operative equivalence as the open approach. Therefore, we believe that this technique may achieve excellent therapeutic results. Even though LLND takes longer by this technique, the patients preferred it instead of the traditional surgery because the large neck-scar can be successfully avoided. Actually, we believe that the operative time will be shortened with growing experience. Therefore, we think that endoscopic thyroidectomy with ipsilateral levels II, III, IV, and VI is feasible and deserves to be further explored and improved. As shown in Table 3, no patient died or had severe complications, such as asphyxia, main nerves (cervical plexus, vagus nerve, accessary nerve etc.) and permanent RLN injury, etc., with either of the approaches. However, some patients in both groups, unexpectedly, had mild and common complications, like temporary hypoparathyroidism and lymphatic leakage, etc. Although all these adverse events in the endoscopic group could be controlled intra-operatively or the patient recovered within 1 month, the safety of this technique needs to be further evaluated with more cases.

Technical difficulty and strategies for this technique

Among the first five patients, injury to external jugular vein and internal jugular vein, each occurred in one patient. Fortunately, it was not serious and was immediately addressed to control and stop the bleeding as soon as possible. Accordingly, the surgeon must be very familiar with the anatomy of the neck and experienced in endoscopic surgery. In the rest of the cases, as experience accumulated, the surgery was more precise and no more injury to large blood vessels occurred. In this study, one patient suffered from mild lymphatic leakage, which may have been caused by carelessness when removing the level III and IV lymph nodes. Similarly, lymphatic leakage is a common complication in open surgery. Also, more attention needs to be paid to the tissues nearby; the venous angle and the lymph vessels should be carefully clipped endoscopically with biological clamps to prevent lymphatic leakage. Therefore, we suggest that the surgeon should be very familiar with neck anatomy and experienced in endoscopic thyroidectomy.

Previously, some authors [6, 23, 24] reported scarless (on the neck) surgery for selective lateral neck dissection and achieved certain satisfactory outcomes. These reports indicated that, the difficult visualization and access were considered to be the main challenges for endoscope-assisted or endoscopic approach for LLND. In our experience, the surgical field exposure was also hard for the surgeon (especially with overweight, short-neck, or male patient) and modification of some details was essential. In these surgeries, the surgeon should recognize and cut off the appropriate tissue interspaces (mentioned in Operative procedures) so as to enlarge the working space. In addition, some special tractors and sutures can be used cooperatively to maintain the working space in a good condition. Thus, we built enough exposure for the level II–IV dissection. Moreover, a well-coordinated endoscope holder was necessary to provide the surgeon with the best endoscopic visualization to ensure the operation went smoothly.

Generally speaking, this technique definitely has a difficult learning curve. Thus, it needs further technical improvement, optimal indications, and more cases in the future.

Surgical indications and patients selection

Certainly, there is still a debate concerning the optimal solution of LLND. Caron et al [25]. reported that a formal modified (or traditional) radical lymph node dissection including levels I, II, III, IV, V, and VI is not necessary for all patients, as most of lymph nodes metastases always occur at levels II, III, and IV. Kim et al [26]. indicated that level V dissection may just be needed for II–IV levels simultaneous metastasis or clinically/radiologically evident metastasis. Accordingly, the comprehensive and accurate assessments are of instructive significance in this study, and it should be completed pre-operatively. When there are evidence of level II, III, or (and) IV lymph node metastasis in PTC patients, the total thyroidectomy + ipsilateral neck of levels II, III, IV, and VI would be performed with this technique. Level I or V dissection is unnecessary because it has low incidence of lymph node metastasis or recurrence [5, 25]. If someone was suspected to have level I or V metastasis, confluent multinodules or surrounding tissue has been invaded, the operation should be performed by the open approach or intra-operatively expanding the working space by adding another incision on the neck. Additionally, if those metastatic lymph nodes blended each other or invaded surrounding vital structures, these lymph nodes should not be removed endoscopically. Otherwise, it may be a great risk to cause injury to mental nerves or large vessels during the operation. In this study, the mean tumor size in the endoscopic group was smaller than that in the open group. We thought that an oversize tumor (more than 3 cm) was unsuitable for operating and removal endoscopically.

In the end, based on our experience we can summarize the above findings as follows. Indications for this surgery:

(1) the primary lesion should be PTC and its diameter ≤ 3 cm, then the ipsilateral CLND would be routinely performed; (2) if ipsilateral neck metastasis only suspected in level III or IV, the levels III and IV dissection should be routinely performed; (3) if ipsilateral neck metastasis in level II or II–IV, the levels II–IV dissection should be performed. Contraindications include: (1) evidence suggesting level I/V lymph node metastasis; (2) lymph nodes blended or fused with each other, below the sternoclavicular joint or distant metastasis; (3) the primary lesion or metastatic lymph nodes invaded surrounding tissues; (4) patient is excessively overweight (BMI > 30), or short-neck; (5) history of neck surgery or radiotherapy; and (6) less than 18 years old, or more than 60 years old.

Limitation

This study has certain limitations, including the following. The study is just a preliminary exploration of completely endoscopic LLND for selective patients, and as such it is mainly focused on the introduction of this technique. The open group was used only to illustrate that this technique can be used to perform adequate oncological dissection at levels IIa, IIb, III, and IV, while avoiding a visible neck incision. Thus, a bias may be introduced into the analysis during the selection of the patient. In addition, this is a retrospective study with a limited number of cases and short follow-up, involving a technique whose safety and effectiveness need further evaluation. Accordingly, prospectively designed and controlled trial studies with more cases and long-term follow-up are needed. Furthermore, the level I or V cannot be effectively performed due to the technical difficulty. Therefore, additional research is needed to ascertain whether further improvement or other approaches, like oral-vestibule, will be useful.

Conclusion

In our initial experience, it was feasible to perform endoscopic thyroidectomy with LLND (levels II, III, IV, and VI) via chest–breast approach. In particular, this technique avoids a large scar on the patient's neck and has good operative outcomes compared with open surgery. Therefore, this technique may offer one more option for selective patients.

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Compliance with ethical standards

Disclosures Drs. Youming Guo, Rui Qu, Jinlong Huo, Cunchuan Wang, Xiaochi Hu, Chen Chen, Daosheng Liu, Weiwei Chen and Jing Xiong have no conflicts of interest or financial ties to disclose.

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