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Original Article

The Improved Techniques of Holding the Lens in Endoscopic Thyroidectomy via Bilateral Areola Approach

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Abstract:

Introduction: Inexperienced endoscope holder usually affects the time and quality of endoscopic thyroidectomy by bilateral areola approach. In this study, several lens holding techniques were summarized and evaluated.

Methods: Two hundred eligible patients were enrolled in two time periods: June 2015-June 2018 (Control group) and September 2019-Fubrurary 2021 (Improved group). Surgical approach was unilateral lobectomy and isthmus resection plus ipsilateral cervical central lymph nodes dissection via bilateral areola approach of endoscopic thyroidectomy, then the perioperative indicators were compared. Postoperative complications included temporary hoarseness, transient hypoparathyroidism and postoperative subcutaneous effusion.

Results: The operation time of stage 1, stage 2 and stage 3 in the improved group was significantly shorter than those in the control group. The intraoperative blood loss, postoperative hospitalization time and the indwelling time of drainage tube were no significant difference between the two groups. Complications in the control group included 14 cases of temporary hoarseness, 14 cases of transient hypoparathyroidism, and 7 cases of postoperative subcutaneous effusion. And the improved group included 12 cases, 11 cases, and 5 case, respectively.

Conclusion: The endoscopic lens holding technique can shorten the operation time, it's suitable for novices.

Keywords: Endoscopic thyroidectomy; Thyroid cancer; Recurrent laryngeal nerve

Introduction

Thyroid cancer ranks 9th in global incidence in 2020, with 586.202 novel cases and 43.646 deaths [1]. Traditional open surgery is the standard procedure for thyroid cancer and the most universal procedure performed in recent decades. With the renewal of surgical instruments and the maturity of surgical techniques, endoscopic thyroidectomy (ET,endoscopic thyroidectomy) has been gradually accepted as a new type of surgery currently, and its aesthetic effect was beyond the reach of traditional open surgery [2]. With the expansion of indications from benign to malignant tumors, ET can also be performed in patients with lymph node metastasis [3].

By far, the most widely accepted and widely used surgical procedure was the anterior chest approach, in which the bilateral areola approach has become a routine treatment to the best cosmetic effect [4]. Based on the anatomical pathway was identical to open surgery, it also became a beginner's operation to ET. The lead surgeon loses the haptic sense of the hands during the surgery, accordingly there is a higher requirement for clarity of vision.

As the eye of the main surgeon, the endoscope

holder plays an extremely crucial role in the operation, which directly affects the time and quality of the operation. There is little literature on endoscope holders, so this study summarized the experience for reference.

Methods

The Institutional Review Board of the Fifth Clinical Medical College of Fujian University of Traditional Chinese Medicine reviewed and approved this research.

Patients

This study enrolled 200 women diagnosed with papillary thyroid carcinoma (PTC,papillary thyroid carcinoma) by postoperative histopathological after unilateral thyroidectomy and central cervical lymph node dissection (CLND,central cervical lymph node dissection) at the Fifth Clinical Medical College of Fujian University of Traditional Chinese Medicine. Data were collection in two time periods: June 2015-June 2018 (Control group, n=100) and September 2019-February 2021 (Improved group, n=100). The eligible patients were examined twice depending on whether the skill were used. The duration of the inexperienced endoscope holders was treated as group 1. Group 2 was experienced endoscope holders trained in 10 surgeries with improved techniques, working with the same attending physician to complete the same procedure. No significant abnormality was found in all patients by preoperative examination. In particular, there was no hoarseness, and preoperative laryngoscopy showed normal vocal cords fold activity bilaterally.

The Entry and Exclusion Criteria

The admission criteria for enrollment of PTC were as follows: Firstly, both preoperative examinations consist of clinical palpation and imaging and intraoperative inspection of cervical lymph nodes were negative; Secondly, primary thyroid carcinoma; Thirdly, tumor smaller than 4 cm in diameter ; Fourth, all participants in the study were female.

The exclusion criteria of PTC were as follows: Firstly, local or contralateral recurrence after surgery; Secondly, bilateral thyroid cancer; Thirdly, the other pathological type of thyroid carcinoma in addition to PTC; Fourthly, intraoperative conversion to open surgery; Fifthly, patients were prolonged the length of hospitalization on account of basal diseases.

Surgical Procedure

All patients underwent unilateral lobectomy and isthmus resection plus ipsilateral CLND via bilateral areola approach of ET.

STAGE 1: There were three mini-incisions on the front of the chest: Two 0.5 cm operation holes were established in each areola between 10 and 12 o'clock on both sides. One 1cm observation hole was set up in the right areola between 2 and 4 o'clock (Fig 1).

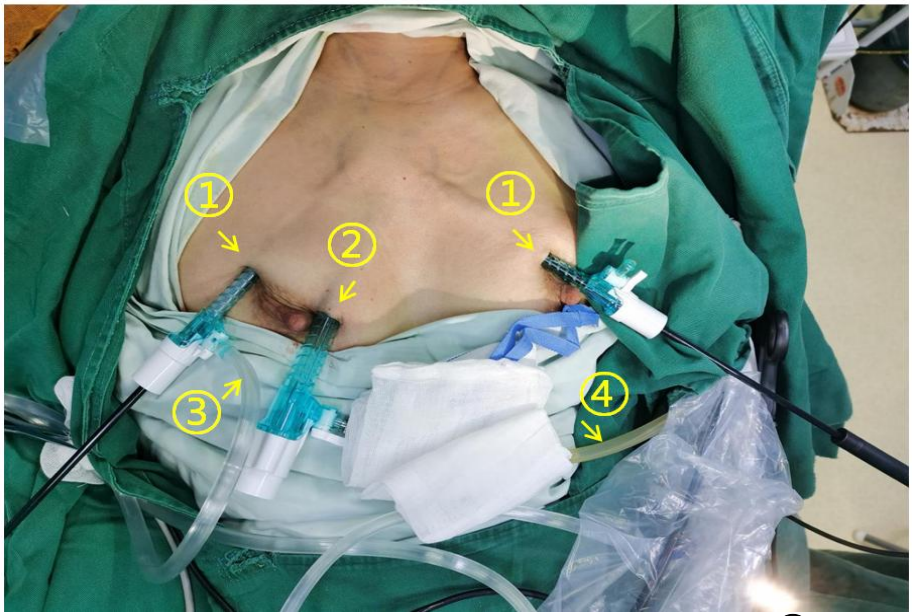

Figure 1 The placement of various instruments before the operation. ① Operation hole; ② Observation hole; ③ Suction tube; ④ Pneumoperitoneum tube.

Accustomed electric hook was employed to separate the natural space between the superficial cervical fascia and the superficial layer of the deep cervical fascia which has no vascularity. Finally, a space up to thyroid cartilage and the lateral edge of the sternocleidomastoid muscle was formed (Fig 2).

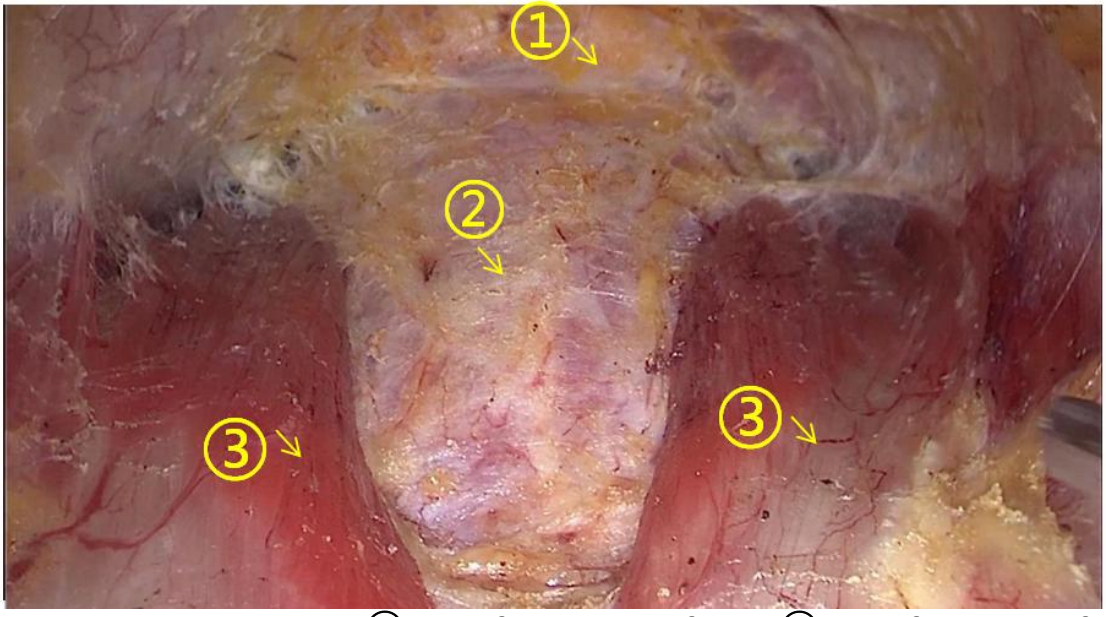

Figure 2 Surgical space is created. ① Superficial cervical fascia; ② Superficial layer of the deep cervical fascia; ③ Sternocleidomastoid muscle.

STAGE 2: A neck white line incision was made to sufficiently reveal thyroid gland. To avoid damage to the external branches of the superior laryngeal nerve, the superior thyroid vessels were concentrated and transected very close to the superior thyroid extremity (Fig 3).

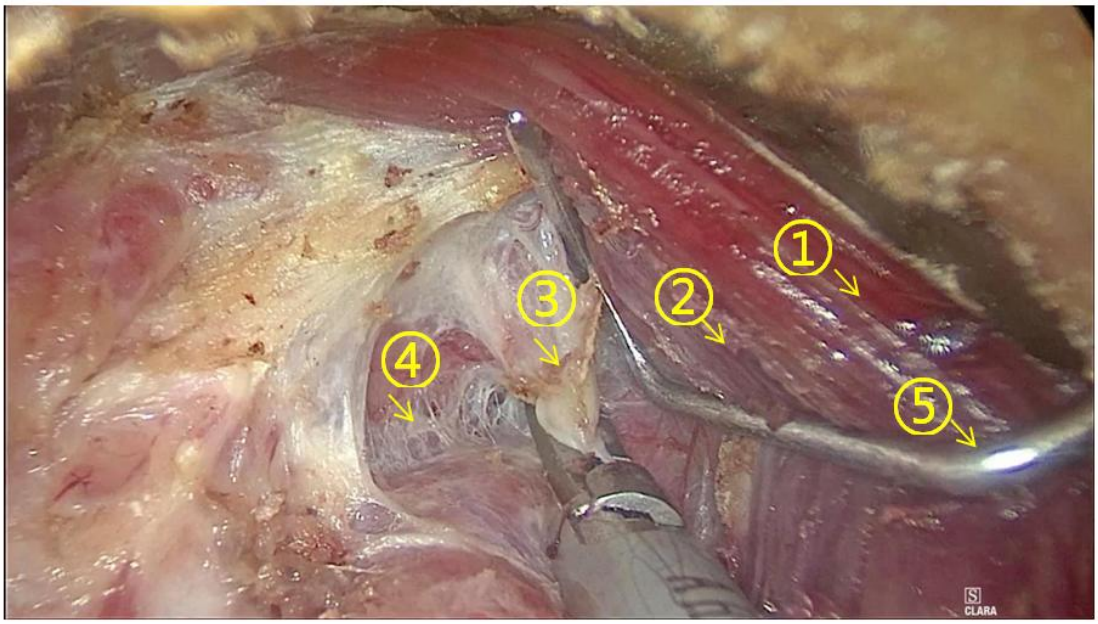

Figure 3 Cut off the upper pole blood vessels of the thyroid. ① Sternohyoid muscle; ② Sternothyroid muscle; ③ Superior thyroid vessels; ④ Cricothyroid interval; ⑤ Homemade retractor.

Close to the inferior pole of the thyroid, the secondary and tertiary branches of the inferior thyroid vessel were severed (Fig 4).

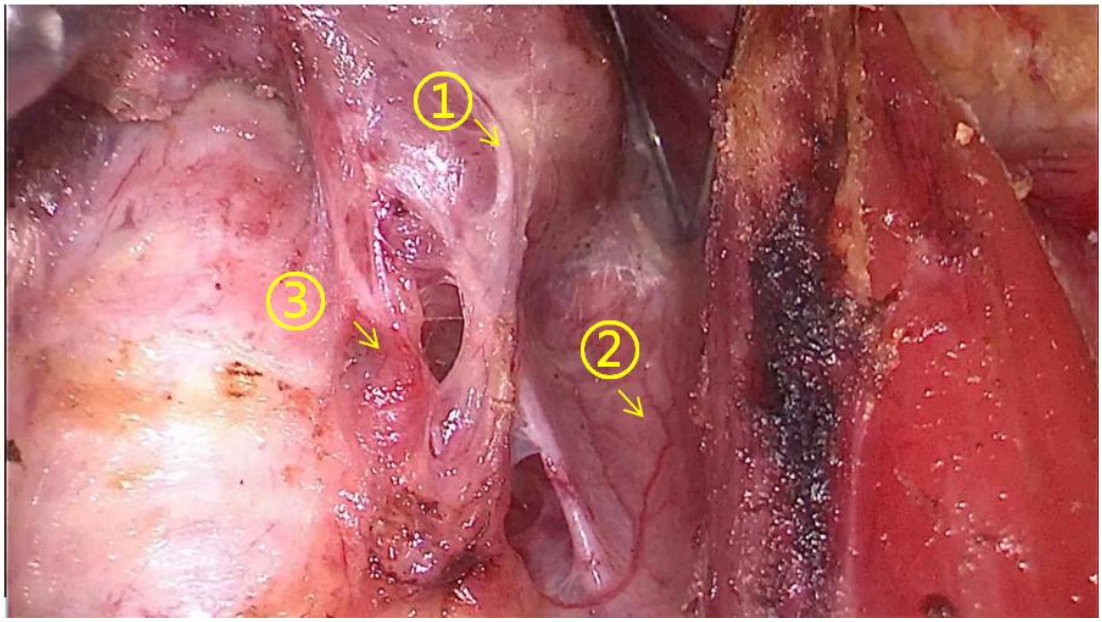

Figure 4 Dissect the lower pole of the thyroid and look for the inferior parathyroid glands.① Second and third level branches of inferior thyroid vessel; ② Common carotid artery; ③ Inferior parathyroid gland.

Until the ligament of Berry was severed, the superior parathyroid gland was retained in situ superior and external the larynx where the recurrent laryngeal nerve (RLN, recurrent laryngeal nerve) enters, afterward the thyroid gland was completely removed (Fig 5).

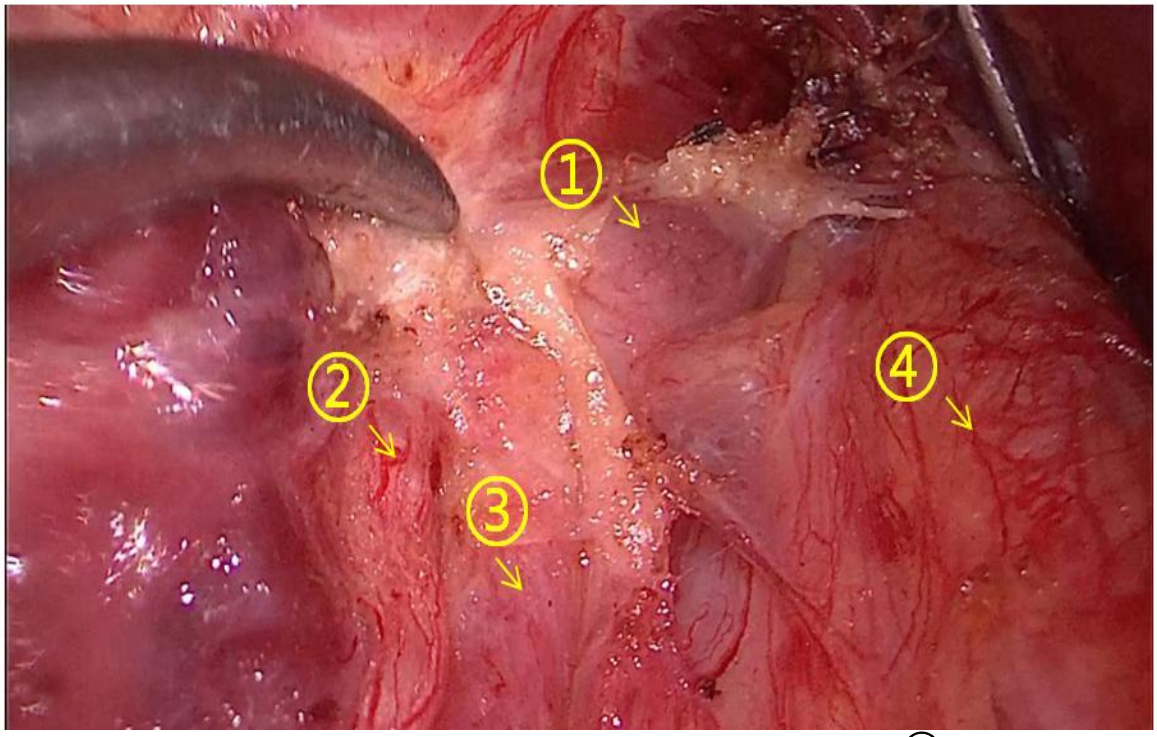

Figure 5 Reveal the relevant structure when thyroid gland is cutted off. ① Superior parathyroid gland; ② Recurrent laryngeal nerve; ③ Esophageal; ④ Common carotid artery.

STAGE 3: The cleaning range of CLND was indicated below: up to the hyoid bone, down to jugular notch, outside to the medial margin of the common carotid artery of both sides. Following rechecking whether the parathyroid glands were ischemic and placing the drainage tube, the neck white line was sutured (Fig 6).

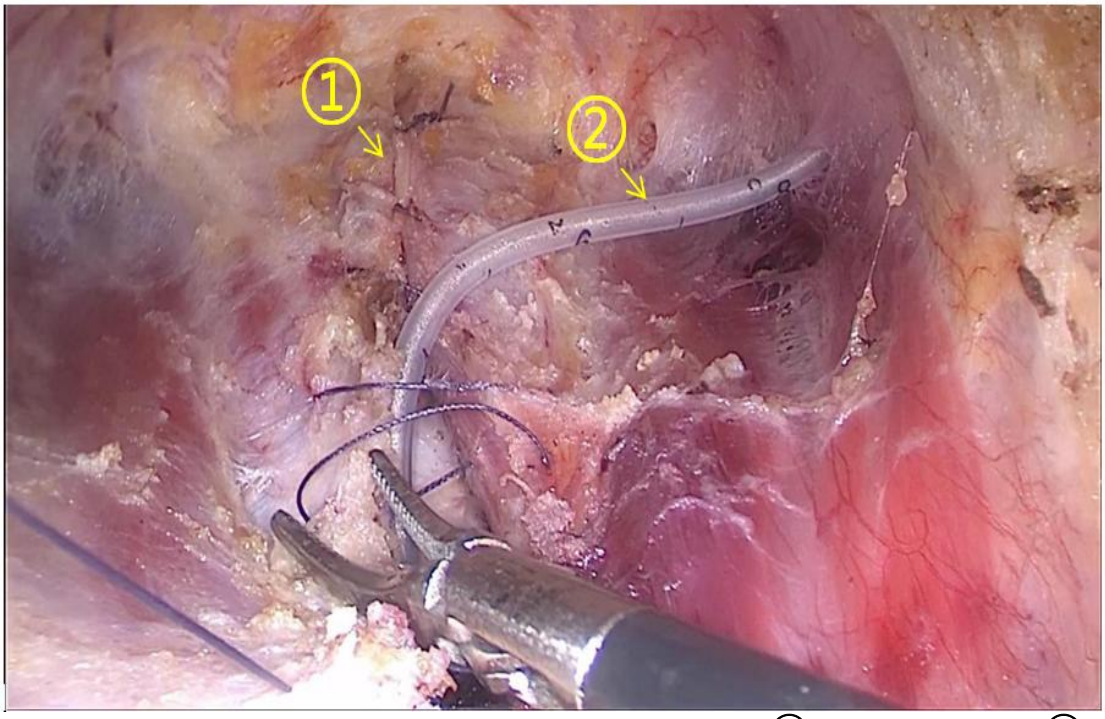

Figure 6 Place the drainage tube and suture the neck white line. ① Neck white line; ② Drainage tube.

If we observe that the parathyroid gland has turned black or has become completely detached, autologous transplantation was performed. Finally, the carbon dioxide gas is evacuated and the periareolar incision was sutured (Fig 7).

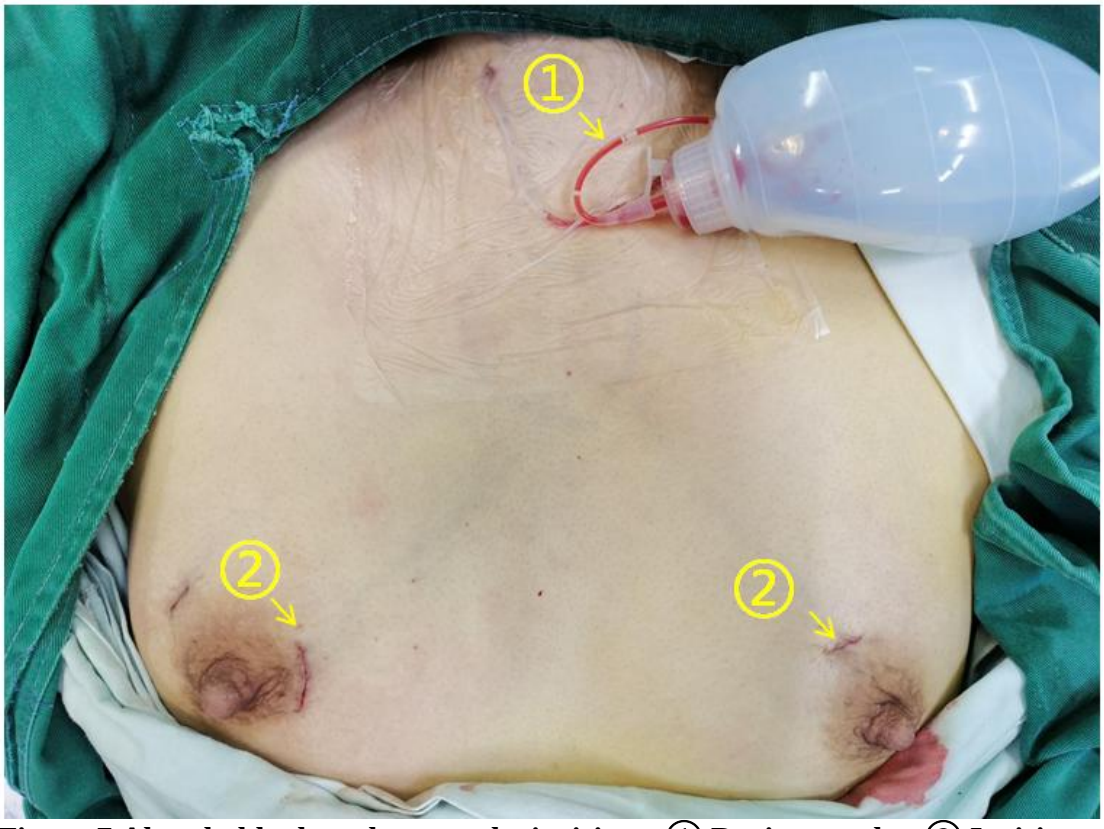

Figure 7 Absorbable thread suture the incisions. ① Drainage tube; ② Incisions.

Objectives

The volume of intraoperative blood loss, the time of three stages in the operation, the indwelling time of drainage tube, and postoperative hospitalization time were compared before and after the improved endoscopic lens holding technique. Postoperative complications included temporary hoarseness, transient hypoparathyroidism, postoperative bleeding, postoperative infection and postoperative subcutaneous effusion were also compared between the two groups. Transient hypoparathyroidism refers to the postoperative occurrence of numbness and stiffness in the fingers or toes, accompanied by a decrease in postoperative blood calcium levels. Postoperative infection refers to the occurrence of redness and swelling of the surgical site, elevated skin temperature, or the presence of purulent discharge from the drainage tube. The three stages were introduced in detail as follows: STAGE 1: From the trocar were established to the neck white line was ready to be cut. STAGE 2: From cutting the neck white line to removal of the thyroid gland. STAGE 3: From dissection of central lymph node to the neck white line was sutured.

Statistical Analysis

SPSS 23.0 was used for statistical analysis in this study. The measurement data were expressed as mean and standard error and were calculated with independent-sample t test. Enumeration data was expressed as ratio (%) and performed adopting chi-square test. $P<0.05$ was referred to statistically significant.

Results

All 200 patients enrolled in the study were all women, with 100 patients in each group, including 68 patients who underwent fine-needle aspiration cytology before operation, and Seventy-eight patients underwent autotransplantation of parathyroid glands, all of which were transplanted into the right forearm muscle. Thyroid peroxidase levels were elevated in 40 patients. The enrolled patients were set to be women because their breasts were more fluid, which made the operation easier. In order to completely remove the tumor, the RLN which went through the tumor in two patients was cut off, and then Sutured it with endoscopic technique rather than open suturing. There was no tracheal injury and permanent hypoparathyroidism due to hypocalcemia after surgery occurred.

Clinical characteristics of patients and general data of tumor were listed in Table 1.

Table 1 Clinical characteristics of patients and general data of tumor

	the control group (n=100)	the improved group (n=100)	P value
Gender			
men	0	0	
women	100	100	
Age (year)(mean, SD)	45.35 SD6.57	45.25 SD5.35	0.906
Tumor location			0.669
left	57	54	
right	43	46	
Tumor diameter (cm)(mean, SD)	0.96 SD0.66	0.83 SD0.38	0.078
Number of central lymph node (mean, SD)	9.03 SD3.97	8.81 SD3.48	0.677

There were no significant differences in the diameter of tumor registered from the pathological reports (P=0.078), tumor location (P=0.669), age (P=0.906) and the number of CLND in the operation (P=0.677)(Table 1). The time of stage 1 (P<0.001), stage 2 (P<0.001) and stage 3 (P<0.001) were all shorter in the improvement group. The intraoperative blood loss (P=0.197), length of hospital stay (P=0.507), and drainage tube duration (P=0.105) in the experimental group were similar to those in the control group. There were no significant differences in temporary hoarseness (P=0.674), transient hypoparathyroidism (P=0.521), postoperative subcutaneous effusion (P=0.552), postoperative hemorrhage (P=0.477) and infection (P=1.000) between the two groups (Table 2).

Table 2 Data on patient's operative time, perioperative data and postoperative complications(mean, SD)

	the control group (n=100)	the improved group (n=100)	P value
STAGE 1[a] (min)	47.61 SD8.65	28.83 SD4.87	<0.001
STAGE 2[b] (min)	65.86 SD8.07	42.35 SD7.49	<0.001
STAGE 3[c] (min)	50.23 SD7.65	35.75 SD7.21	<0.001
Intraoperative blood loss (ml)	30.65 SD7.48	29.20 SD8.34	=0.197
Postoperative hospitalization time (days)	3.32 SD1.00	3.23 SD0.91	=0.507
Indwelling time of drainage tube (days)	3.12 SD0.87	2.93 SD0.78	=0.105
Temporary hoarseness	14	12	0.674
Tetany	14	11	0.521
Postoperative bleeding	0	2	0.477
Postoperative infection	1	0	1.000
Postoperative subcutaneous effusion	7	5	0.552

[a], from Trocars were built to the neck white line was ready to be cut. [b], from cutting the neck white line to completing thyroidectomy. [c], from dissection of central lymph node to the neck white line is sutured.

Rarely one case of postoperative infection in the control group in the form of redness and local pain in the skin. No abscess was found by ultrasound and puncture, cephalosporin was given for 1 week and the effect was good. Postoperative hemorrhage occurred in 2 patients, manifested as subcutaneous congestion and swelling of neck and chest, and the drainage volume reached 200 ml. After full communication with the patients, endoscopic therapy was resumed. It was found that the bleeding site in both patients was small veins of the superficial cervical fascia. All patients with temporary hoarseness recovered within 6 months. In the improved group, when the recurrent laryngeal nerve was exposed, the cases of temporary hoarseness would be greatly reduced if the surface fascia and blood vessels were preserved (Fig 5②). All transient hypoparathyroidism patients caused by hypocalcemia were given calcium tablets and alfacalcitol and recovered within 2 months.

Discussion

Surgical Approach

With the popularization of color doppler ultrasound screening, more and more thyroid cancers were being detected [5], and the development of thyroidectomy was changing rapidly. In most hospitals, extracorporeal lens transplantation had replaced open surgery as a routine procedure, so it was necessary for auxiliary staff to master the technique of holding the lens as soon as possible. There were various surgery approaches for ET, including transthoracic [6], trans-axillary [7], trans-oral [8], retroaural [9] and mixed approach [10], each approach had its own advantages and disadvantages. But there is no relevant guidelines or consensus to regulate the surgical method. Considering the difficulty and quality of the operation, combined with the patient's cosmetic needs, the bilateral areola approach was finally determined as the preferred approach for most patients.

Once a patient is diagnosed with cancer, regardless of preoperative examination showing lymph node metastasis, CLND is necessary, although postoperative pathology often reveals that most patients who undergo dissection do not have lymph node metastasis. This perspective is supported by some published literature [11-14], but it has also been contested by other studies [15-18]. The necessity of CLND for patients with no apparent lymph node metastasis on preoperative imaging remains a subject of debate [19]. We advocate for CLND based on the following reasons: firstly, Patients often believe that not cleaning the lymph nodes is an incomplete treatment. Secondly, national guidelines recommend CLND. Lastly, approximately 1/3 of postoperative pathology reports in patients with preoperative cN0 status indicate lymph node metastasis [20].

Skills of Holding the Endoscopic Lens

Although the same system and instruments were

applied, ET was barely distinguishable from laparoscopic surgery for gastrointestinal. There were three apparent differences between them. The first was the space and pressure. ET had a small surgical space and low carbon dioxide maintenance pressure, while laparoscopic surgery has a larger space and higher pressure. It made endoscopic lens prone to fog, making it difficult to maintain clear vision. The second was a laparoscopic instrument. A longer trocar was employed in ET, which meant a longer subcutaneous distance. Due to the "leverage effect", it was difficult for the surgeon to operate, especially during CLND. The third was the assistant. Laparoscopic surgery requires an assistant to expose the surgical area with forceps and pull the tissue to maintain tension. It is impossible for ET to achieve this because there were only two operating holes. The "Chopsticks effect" caused by the establishment of parallel instruments can result in frequent collisions between the left hand of the lead surgeon and the endoscopic lens of the assistant on basis of incisions around the right areola.

Combined with the aforementioned points, endoscope stents play a rather substantial hole in surgery. But lack of experience at the beginning made ET more time-consuming, bleeding and traumatic. Therefore, how to quickly improve the lens holding technique level of endoscope stent and the tacit cooperative with the surgeon was an important topic. By watching the video after the surgery, this article summarized the experience and skills. In particular, an iterative study was carried out on the unexpected situation in the course of operation. Finally, we summarized our experience into 8 tips.

Position the instruments: The purpose of placement was to avoid the entanglement of instruments and wires throughout the procedure, and to improve the smoothness of the procedure by not limiting the surgeon when changing instrument. The optical fiber and endoscopic lens are placed on the top layer, leaving enough length for the lens to freely exit the trocar. Pneumoperitoneum tube and the suction tube connected to the trocar on the right were placed on the bottom, they won't be moved during the whole surgery. The ultrasonic knife and suction device in the right hand of the lead surgeon should be placed in a suitable position with the aim of replacing quickly when bleeding (Fig 1).

Heat the lens: As mentioned earlier, the surgery space was small, and a large amount of mist can be generated during the operation, so the lens was easy to be contaminated. Before surgery, the endoscopic lens was immersed in hot water at 70 degrees Celsius for several minutes to make the lens temperature higher than that of the operating space. At the same time, the trocar is connected to the right suction tube to accelerate the exhaust, which can maintain the surgery picture clear for a long time (Fig 1 ③).

Wipe the lens: Wiping is a method adopted when an electric hook or ultrasonic knife produces a large amount of aerosol or blood during the operation, which is easy to contaminate the lens. The entire lens wiping process must be rapid to avoid prolonged exposure to the air to cool the lens. This action requires "make use of every bit of time", and is frequently performed when the lead surgeon is changing instruments to improve the smoothness of the operation. When wiping the lens, first wet the lens with iodophor, and then use gauze to wipe the lens once from the bottom to the top. Repeated wiping does not make the lens cleaner. Watch for blood in the trocar, as it may contaminate the lens. When the mist was just generated, controlling the exhaust of the right suction tube is a common way to reduce the number of lens cleaning, because the lens is not contaminated at this time. The pursuit of coherent operation is our purpose. Frequent wiping of the lens will not only greatly prolong the operation time, but also affect the mood of surgeon.

Maintain levelness: Horizontal picture was the guarantee of entering the correct anatomical level. Remain at the level of the deep thoracic fascia until passing through the jugular notch. After crossing, the bilateral sternocleidomastoid muscles remained horizontally symmetrical (Fig 8).

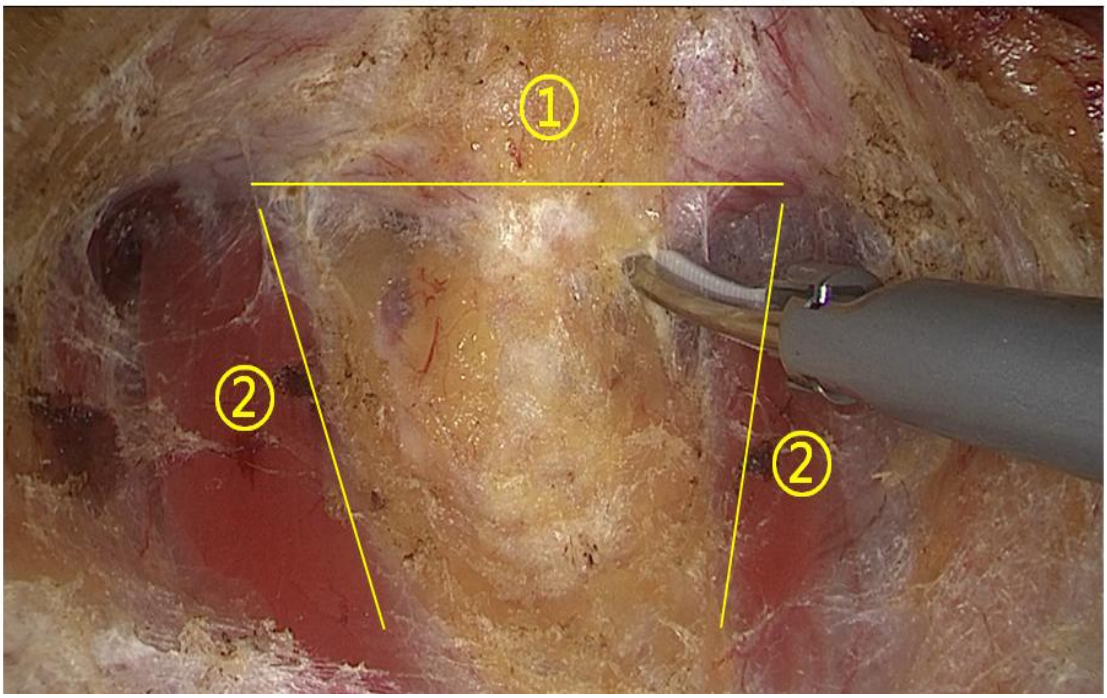

Figure 8 Ensure symmetry of the sternocleidomastoid muscle on both sides and maintain the horizontal position of the superficial cervical fascia. ① Superficial cervical fascia; ② Sternocleidomastoid muscle.

The tilt of the picture will cause incorrect separation level of the surgeon, damage the fascia, sternocleidomastoid and anterior cervical muscles, trigger bleeding, prolongs the operation time. Even the quality of surgery was affected, need to switch to open surgery. In addition, incorrectly gaps mean greater trauma and more post-operative exudate, resulting in increased drainage fluid volume and longer drainage tube indentation.

Adjust the focus: This is important for novices. Laparoscopic gastrointestinal surgery, with a wide field of view, and basically at the same depth without focusing. However, the intraoperative situation of ET was just the opposite. ET was vertical, from near to far. As the operation progress, the field of view will inevitably become blurred. When revealing the RLN, the focus needed to be adjusted to see the small vessels above. To observe whether the parathyroid gland is ischemia, we also need to adjust the focus to accurately judge.

Moderate retract: When separating the space of the bilateral sternocleidomastoid muscle, the ultrasound knife swings considerably. At this time, the lens should be retracted to expand the observation range so that the lead surgeon can observe bilateral symmetry and avoid bleeding caused by the error of the separation level. During the entire operation, when the electric coagulation and ultrasound knife separates the adipose tissue or stops bleeding, a lot of mist and splashing liquid or blood will be produced, which can readily blurred lens. Particular in CLND, the surgical site was close to the trocar, and due to the vaporization effect of the ultrasonic knife, the lens was easily contaminated by adipose droplets. We found that when the main surgeon uses the ultrasonic knife to clamp the adipose tissue or the bleeding site, it can be properly retracted into the trocar and protect the lens, which can reduce the chance of contamination of the lens, but you should keep the operative site inside the screen (Fig.9).

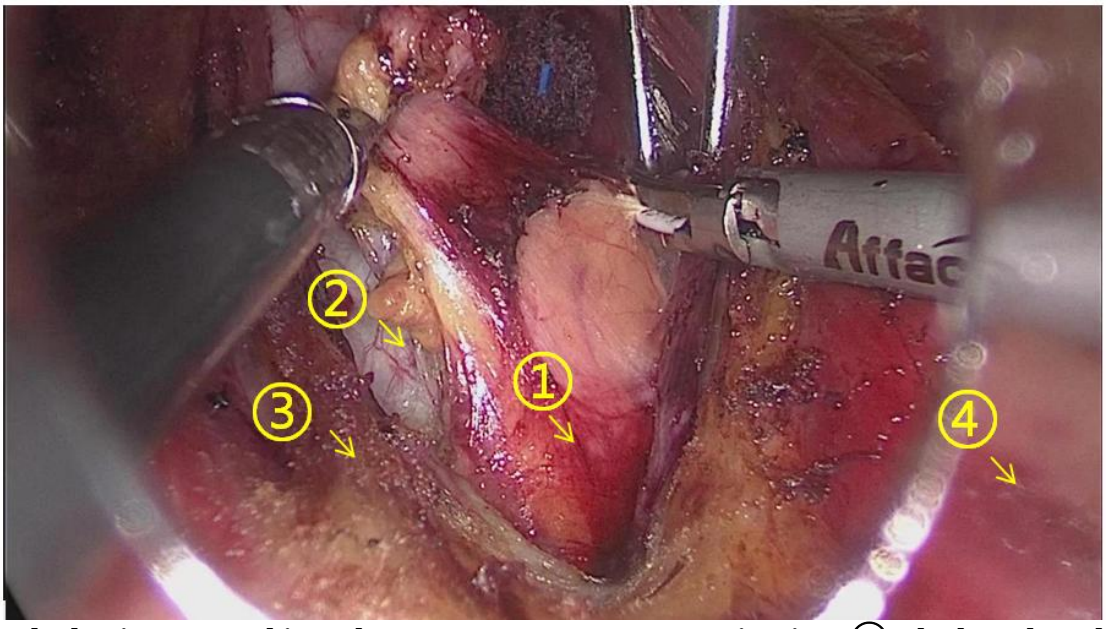

Figure 9 The len is retracted into the trocar to prevent contamination. ① The lymph nodes of the 6C group; ② Trachea; ③ Sternocleidomastoid muscle; ④ Trocar.

If the visual field was blur, thymus was hard to identify. Type B2 and B3 parathyroid glands were more easily removed in CLND, which may lead to postoperative hypoparathyroidism. More seriously, inadvertent injury to the upper mediastinal vessels, bleeding leads to catastrophic thoracotomy results.

Follow the surgeon: The endoscope holder was the eye of the lead surgeon. Only understand the surgical habits, proactively try to figure out the thought during the operation and long-term stability and tacit cooperation can be an eligible assistant. In addition, the assistant should be a predictable one, moving immediately to the position of the next step when the surgeon's procedure has just been completed, rather than moving after the surgeon's ultrasound knife has moved. It was considered important to increase the continuity of the lead surgeon operation. The upper pole and dorsal side of the thyroid gland are often difficult to expose when the tumor was large and located in the upper middle. It was often combined direction from the medial, the anterior side across the tumor and the lateral, flexibly manipulate the 30-degree lens to cooperate the lead surgeon to deal with the upper pole.

Maintain stability: A good video with visibility requires a steady picture. Shaking the lens all the time or moving suddenly and sharply were forbidden, because these activities were not only cannot observe the field normally, but also dizzy the main surgeon. When bleeding occurs, the main knife should use the ultrasonic knife to stop the bleeding at the first time, while the assistant ensured that the lens doesn't move and is not contaminated, and locked the bleeding site to successfully stop bleeding. If the lens was contaminated by blood, the sternoclavicular joint or thyroid gland can be wiped temporarily to buy time for hemostasis. Because once it exit the lens and enter again, a large amount of blood would cover the bleeding point which cannot be accurately identified, and the space is difficult to maintain when using the aspirator, which increases the difficulty of hemostasis. If the lens was withdrawn, blood was likely to enter the lens trocar, which makes it impossible to enter for transitory time, and the potential of conversion to open surgery was particularly high. The assistant can also apply hand pressure to the skin corresponding to the bleeding site to buy time for the lead surgeon to replace the aspirator.

Limitation

The biggest limitation exists of this study is that it may be affected by the technical maturity of the surgeon. Therefore, in designing this study, we tried our best to minimize this impact. Sixty cases of endoscopic thyroidectomy have reached the early stage of the learning curve, and 150 cases have reached the advanced level of proficiency and stability of the surgery [21]. For endoscope holder, there were 30 cases in early stage and 60

cases in advanced-level [22]. The lead surgeon came into contact with ET 15 years ago. Before the patients began to be enrolled in June 2015, he had completed more than 150 surgeries.

Conclusion

The 8 techniques of holding the endoscopic lens can quickly shorten the operation time, which is very suitable for novices to learn.

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Conflicts of Interest and Source of Funding

The authors of this work have nothing to disclose. Funding information is not available.

Authors' Contributions

JXW, EZL conception and design. QSL administrative support. XLW collection and assembly of data. JXW, XLW data analysis and interpretation. All authors wrote the manuscript and approved the final manuscript.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Highlights

1. This article is a summary of the experiences and techniques of the endoscopic assistant in thyroidectomy.

2. The article aims to assist novice doctors in better collaborating with the primary surgeon to jointly complete the surgery.

3. These techniques can help them better deal with challenges and difficulties during surgery, improve their confidence and surgical skills.

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Abbreviations

Abbreviation	Full Form
ET	endoscopic thyroidectomy
PTC	papillary thyroid carcinoma
CLND	central cervical lymph node dissection
RLN	recurrent laryngeal nerve