

Comparison of 3-dimensional and 2-dimensional endoscopic thyroid lobectomy via the trans-thoracoareolar approach

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ABSTRACT

الأهداف: تقييم سلامة وفعالية وجدوى ثلاثية الأبعاد بأثر رجعي لاستئصال الغدة الدرقية بالمنظار عبر الصدر مقارنة مع نهج ثنائي الأبعاد

الطريقة: أجرينا تحليل بأثر رجعي ومستعرض لبيانات 100 مريض الذين خضعوا لاستئصال الغدة الدرقية بالمنظار عبر الصدر في الفترة بين يناير 2014م إلى نوفمبر 2016م. صنف المرضى إلى مجموعتين متساويتين اعتماداً على ما إذا كان استخدام نهج المنظار ثلاثي أو ثنائي الأبعاد. تمت مقارنة المجموعتين لمختلف معاملات أثناء عملية العملية وبعد عملية الجراحية.

النتائج: مجموع وقت العملية واستئصال الغدة والخياطة وكمية فقدان الدم أثناء العملية في مجموعة التنظير ثلاثي الأبعاد أقل من مجموعة التنظير ثنائي الأبعاد. بالإضافة إلى أن معدل حدوث المضاعفات في مجموعة التنظير ثلاثي الأبعاد أقل من مجموعة ثنائي الأبعاد. وبالرغم من ذلك كانت المجموعات مماثلة فيما يتعلق بنقص الكالسيوم في الدم العابر والإحتقان والانصباب تحت الجلد والسعال. حجم الصرف بعد العملية الجراحية ومدّة نزع الأنبوب والإقامة بعد العملية الجراحية في المستشفى ومجموع نفقات الاستشفاء.

الخاتمة: يتطلب استئصال الغدة الدرقية بالمنظار أقل وقت من حيث العملية مما أدى إلى انخفاض خطر الإصابة بالبنى المجاورة دون التسبب أي زيادة في معدل المضاعفات بعد العملية الجراحية مما يشير إلى تفوق تقنية المناظير ثلاثية الأبعاد من مناظير ثنائي الأبعاد.

Objectives: To evaluate retrospectively the safety, efficacy, and feasibility of 3-dimensional (3D) endoscopic thyroid lobectomy via a trans-thoracoareolar approach in comparison with the 2-dimensional (2D) approach.

Methods: We performed a retrospective and cross-sectional analysis of the data of 100 patients who underwent endoscopic thyroid lobectomy via the trans-thoracoareolar approach between January 2014 and November 2016. The patients were classified

into 2 equal groups depending on whether the 3D or 2D endoscopic approach was employed. The 2 groups were compared for various intraoperative and postoperative parameters.

Results: The values of total operative time, lobectomy time, suture time, and intraoperative blood loss in the 3D endoscopy group were significantly less than those in the 2D endoscopy group. Additionally, the incidence rates of complications in the 3D endoscopy group were significantly less than those in the 2D endoscopy group. However, the groups were similar with regard to the incidence of transient hypocalcemia, subcutaneous congestion, subcutaneous effusion, and cough; postoperative drainage volume; extubation time; postoperative hospitalization time; and total hospitalization expenses.

Conclusions: Three-dimensional endoscopic thyroid lobectomy required less operative time and entailed a low risk of injury to adjacent structures, without causing any increase in the rate of postoperative complications, indicating that the 3D endoscopic technique was superior to 2D endoscopy.

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Endoscopic technique has been used in thyroid surgery for nearly 20 years.¹ Since its introduction by Ohgami et al in 2000, endoscopic thyroidectomy via the breast approach has been the most common treatment for thyroid diseases.² Two-dimensional

(2D) endoscopy offers the advantage of 4-fold greater magnification of the surgical field, as compared with open surgery. However, this technique still does not allow for stereoscopic vision, which makes the surgery difficult and increases the risk of damage to small blood vessels and adjacent structures. This is particularly relevant in thyroid surgery because of the intricate vascular anatomy and presence of important nerves and blood vessels in the thyroid region. Continuous advancement in medical technology has led to the introduction of 3-dimensional (3D) endoscopic technology in clinical practice. The sense of depth afforded by 3D vision allows for greater magnification, a better surgical field, and higher operative accuracy, thereby reducing the risk of inadvertent injury to adjacent tissues. In many European countries and the United States, 3D endoscopy is widely applied in various surgical fields, including hepatobiliary surgery, urology, and obstetrics and gynecology.³⁻⁷ Thyroid surgery has also progressed in this era of precision, and it would be worthwhile to assess the safety and efficacy of 3D technology compared with more traditional approaches. This retrospective study evaluated the safety, efficacy, and feasibility of 3D endoscopic thyroidectomy performed via the trans-thoracoareolar approach, relative to the 2D endoscopic technique.

Methods. Study design. This was a retrospective investigation of 100 consecutive patients who underwent 3D or 2D endoscopic thyroidectomy via the trans-thoracoareolar approach at our clinic between January 2014 and November 2016. Patients scheduled for endoscopic thyroidectomy were assigned to either the 2D or the 3D group depending on their registration number. Fifty patients were assigned to each group. All surgeries were performed by the same surgeons. The study protocol was approved by the Institutional Review Board and written informed consent was obtained from the patients. This work is in compliance with the principles laid down in the Declaration of Helsinki.

Patient selection. Patients were enrolled into the study only if they were aged between 17 and 62 years; underwent preoperative diagnostic studies such as thyroid ultrasonography or computed tomography (CT), thyroid function tests, and vocal cord function

assessment; had unilateral thyroid lesion(s) of diameter 1-6 cm; had undergone resection of the affected lobe, with intraoperative freezing of the sections and routine pathological examination; and were fit enough to tolerate surgery. The exclusion criteria for this study were as follows: history of neck or cardiopulmonary surgery, radiotherapy, liver or kidney dysfunction, subacute thyroiditis, chronic lymphocytic thyroiditis, or hyperthyroidism; abnormal blood coagulation; inability to tolerate surgery; requirement of preoperative or intraoperative frozen pathological biopsy in patients with thyroid cancer; and presence of substernal thyroid.

Operative methods. Three-dimensional high-definition laparoscopy was performed using a Karl Storz SCB, Xenon 300 light source, whereas 2D high-definition laparoscopy used a Karl Storz Xenon Nova 300 light source. Preoperative preparation was the same as for conventional surgery, including tracheal intubation and placement of the patient in the supine straddle position. The surgeon stood between the patient's legs, with the rotary mirror hand on the right side. Before the start of the operation, the neck midline, thyroid cartilage, and tumor location were marked.

A 1-cm long incision was taken over the sternum at the midpoint of a line joining the nipples. Incisions of length 0.5 cm were also made on the left and right upper quadrant of the areola. Regional injection of saline (expansion liquid) was administered in the manner similar to that routinely used for the adrenal gland.⁸ With an ultrasonic scalpel, the anterior chest and cervical wall were freed at the level of the thyroid cartilage. The sternocleidomastoid muscle on both sides was divided up to the neck white line. A thyroid retractor was used to separate the ipsilateral anterior cervical muscles.

The pole of the lateral border of the isthmus and course of the recurrent laryngeal nerve was identified, and the isthmus was dissected to reveal the trachea. Manipulation of the gland revealed the lower pole of the thyroid, and blood vessels arising from the lower pole under the protection of the parathyroid glands. The gland was freed and the blood vessels were cleared to expose the thyroid gland. The upper pole of the thyroid was pushed downwards for excision of the lobe. The lobe was freed from the posterior side by sharp dissection using the ultrasonic scalpel. The lobe was lifted, with special care to protect the recurrent laryngeal nerve and parathyroid gland. The neck white line was closed with conventional suturing. A negative pressure drainage tube was inserted, and a chest compression bandage was applied. All surgeries were performed by the same surgeon.

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Statistical analyses. All statistical analyses were performed using the Statistical Package for the Social Science (SPSS) Version 19.0 (IBM Corp., Armonk, NY, USA). The data are expressed as mean \pm standard deviation and were analyzed using the independent samples t-test. The detection values were determined according to the results of the homogeneity of variance test. The numerical data were analyzed with the chi-squared test or Fisher's exact test. A p -value < 0.05 was considered statistically significant.

Results. The endoscopic unilateral thyroid lobectomy was successfully completed in all 100 patients, without any need for conversion to open surgery. The 2 patient groups were comparable with regard to gender ($p=0.499$), age ($p=0.774$), tumor size ($p=0.644$), and tumor location ($p=0.423$) (Table 1).

Compared to the 2D endoscopy group, the 3D endoscopy group required significantly less total operative time ($p=0.000$), time to excise the gland ($p=0.000$), and time to suture the neck white line ($p=0.000$), and also had significantly less blood loss ($p=0.000$) (Table 2). However, the 2 groups were comparable with regard to postoperative drainage ($p=0.462$), extubation time ($p=0.655$), hospital stay ($p=0.825$), and total costs ($p=0.101$) (Table 3).

The rates of postoperative complications were significantly lower in the 3D endoscopy group than in the 2D endoscopy group (Table 4): intraoperative injury to blood vessels (6% cf. 20%; $p=0.037$), parathyroid injury (0% and 8%; $p=0.042$), and laryngeal nerve injury (temporary hoarseness; 0% and 8%; $p=0.042$). However, the 2 groups were similar with regard to incidence of postoperative hypocalcemia ($p=0.558$); subcutaneous congestion ($p=0.464$); subcutaneous effusion ($p=1.000$); cough ($p=1.000$); postoperative drainage volume ($p=0.462$); extubation time ($p=0.655$); and postoperative hospitalization time ($p=0.825$).

Discussion. Endoscopic thyroid surgery for the treatment of diseases has grown in popularity during the last few years due to its cosmetic benefits, making it one of the most commonly used methods for thyroid surgery. In this paper, we compared the 3D and 2D endoscopic techniques for thyroidectomy in terms of intraoperative parameters and postoperative complications. We found that the 3D endoscopic technique required significantly less time than did the 2D endoscopic technique.

Chen et al⁹ showed that the high-definition amplification and stereoscopic vision afforded by 3D technology enables the clear visualization of the thyroid and branching of peripheral vascular vessels into the

Table 1 - Basic clinical characteristics of the 3D and 2D endoscopy groups.

Characteristics	3D	2D	P-value
Subjects, n	50	50	
Age, y	36.7 \pm 7.5	37.3 \pm 7.8	0.774
Gender, n			
Male	12	15	0.499
Female	38	35	
Tumor diameter, cm	3.41 \pm 0.91	3.34 \pm 0.86	0.644
Tumor location, n			
Left	22	26	0.423
Right	28	24	

Table 2 - Intraoperative observation indices of the 3D and 2D endoscopy groups.

Indices	3D	2D	P-value
Establishment of operative space, min	21.6 \pm 1.8	22.1 \pm 1.9	0.127
Unilateral thyroidectomy, min	25.6 \pm 3.07	29.8 \pm 2.37	0.000
Suture time, min	9.54 \pm 1.18	12.9 \pm 2.17	0.000
Total operative time, min	80.8 \pm 3.35	89.3 \pm 4.04	0.000
Blood loss, mL	10.3 \pm 1.4	11.7 \pm 2.1	0.000

Table 3 - Postoperative observation indices of the 3D and 2D endoscopy groups.

Indices	3D	2D	P-value
Postoperative drainage, mL	74.6 \pm 5.7	75.5 \pm 6.0	0.462
Extubation time, d	3.38 \pm 0.88	3.46 \pm 0.91	0.655
Postoperative hospitalization, d	3.78 \pm 0.89	3.82 \pm 0.83	0.825
Total cost, thousand RMB	11.3 \pm 0.83	11.0 \pm 0.86	0.101

ml - milliliter, d - day, RMB - RenMinbi

Table 4 - Complications of the 3D and 2D endoscopy groups, n (%).

Endoscopy groups	3D	2D	P-value
Intra-operative injury			
Anterior vessel	1 (2.0)	2 (4.0)	0.037
Inferior vessel	1 (2.0)	4 (8.0)	
Middle vessel	0 (0.0)	2 (4.0)	
Superior vascular	1 (2.0)	2 (4.0)	
Parathyroid	0 (0.0)	4 (8.0)	0.042
Postoperative			
Hoarseness	0 (0.0)	4 (8.0)	0.042
Hypocalcemia	1 (2.0)	2 (4.0)	0.558
Subcutaneous congestion	2 (4.0)	3 (6.0)	0.646
Subcutaneous effusion	4 (8.0)	4 (8.0)	1.000
Cough	1 (2.0)	1 (2.0)	1.000

laryngeal branch, thereby avoiding vascular hemorrhage and reducing the total operative time. In addition, since 3D visualization enables precise spatial evaluation, the operator can accurately determine the position and direction of the needle, which improves the efficiency of the suture.¹⁰ In the present study, we also found that the improved visibility provided by the 3D technique significantly shortens the time to perform neck white suturing, although no obvious differences were noted between the 2 groups in the time needed to establish the operative space, including clearance of the chest and anterior cervical space.

Some of the most important concerns associated with thyroid surgery, irrespective of whether it is open or endoscopic, are laryngeal exposure and protection of the laryngeal nerve, peripheral vascular amputation, and in situ protection of the parathyroid and recurrent laryngeal nerve. In the current study, injury to the recurrent laryngeal nerve did not occur in either group.

Recurrent laryngeal nerve injury is a common complication in thyroid surgery, occurring in 1.3% to 5.0% of patients and is mainly caused by the thermal conduction of the ultrasonic scalpel and traction of the instrument.¹¹ Because of the complexity of the vascular structures surrounding the gland, maneuvering to avoid injury to this nerve and small blood vessels is both difficult and time consuming. Joliat et al¹² reported that the incidence of recurrent laryngeal nerve injury in thyroid surgery is transient (10.6%) and permanent (1.1%), which is comparable to the incidence of postoperative hoarseness (4%) noted in the present study.¹² Similarly, the rate of injury to the parathyroid gland was also significantly lower in the 3D endoscopy group than in the 2D endoscopy group.

In the current study, compared with the 2D endoscopy group, the 3D endoscopy group had lower rates of complications, including hypocalcemia, subcutaneous congestion, subcutaneous effusion, and cough; postoperative drainage volume; extubation time; and postoperative hospitalization. The total cost of hospitalization in both the groups was almost the same, thereby indicating that the use of 3D technology did not incur any additional expense.

The present study did not compare the 3D and 2D groups with regard to the learning curves of the endoscopists. However, the majority of endoscopists who begin 3D laparoscopic surgery have already attained a certain level of mastery in operative technique through experience in 2D endoscopic surgery. Therefore, a comparison in learning curves would have little validity.

Limitation of study. There are some limitations associated with the implementation of 3D endoscopy

in actual clinical practice. These include lack of sufficient academic knowledge, vertigo, nausea, and the discomfort due to dry eyes on the part of the operator, possibly due to an inability to adjust the surgical visual angle since the light source is cold and the lens is fixed.¹³ Since this was an experimental study, its main limitations include its relatively small sample size and its retrospective nature. Prospective randomized case-control studies with more cases performed by more surgeons are required to clarify its statistical strengths and weaknesses.

In conclusion, our study indicates that for endoscopic thyroidectomy, the 3D technique can achieve the same safety and efficacy as 2D endoscopy. The 3D endoscopy provides surgeons with a good sense of stereoscopy and depth, which facilitates the easy identification of important anatomical markers. We found that, compared with the 2D endoscopic technique, the use of 3D technology for endoscopic thyroid lobectomy reduces the operative time and the rate of injury to adjacent structures, without any increase in the risk of postoperative complications. Thus, 3D technology for thyroid surgery offers the advantages of 2D endoscopy, but with better safety and accuracy and in less time.

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