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Evaluation of voice function after BABA robotic thyroid lobectomy

A comparative analysis with endoscopic thyroid lobectomy

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Abstract

The purpose of this study was to compare the effect of robotic thyroid lobectomy via Bilateral Axlio-Breast Approach (BABA) and endoscopic thyroid lobectomy on the voice function. A total of 125 patients with thyroid cancer from March 2021 to July 2022 were divided into the robotic thyroid lobectomy group and the endoscopic thyroid lobectomy group. Acoustic index and voice handicap index (VHI-10) were compared between the 2 groups before and after (1 week, 1 month, 3 month) the surgery. In the robotic group, VHI-10 score was not significantly different before and after the surgery. In the endoscopic group, VHI-10 score after the surgery was significantly higher than that before the surgery. In the endoscopic group, the fundamental frequency (F0) declined significantly 1 week and 1 month after the surgery compared with that before the surgery. One week after surgery, F0 in the endoscopic group was (197.91 ± 24.15) Hz, which was significantly lower than that (206.77 ± 20.13) Hz in the robotic group. In the robotic group, there was no obvious decline in F0 and MPT in each follow-up period after surgery compared with those before surgery. In the endoscopic group, MPT declined significantly 1 week after the surgery compared with that before surgery. One week after surgery, MPT in the endoscopic group was (13.02 ± 9.28) s, which was significantly lower than that (17.55 ± 9.25) s in the robotic groups. There were no significant differences in Shimmer, Jitter, DSI and NHR during all postoperative follow-up periods compared with those before surgery in both groups. The voice function of robotic thyroid lobectomy via BABA is superior to endoscopic thyroid lobectomy.

Abbreviations: BABA = bilateral axillo-breast approach, DSI = dysphonia severity index, E = emotional, F = function, MPT = maximum phonation time, NHR = noise-to-harmonic ratio, P = physical, VHI-10 = voice handicap index.

Keywords: endoscopic thyroid lobectomy, robotic thyroid lobectomy, thyroid neoplasm, voice evaluation

1. Introduction

Thyroid cancer is the most common malignancy of the endocrine system, and the incidence of thyroid cancer has increased significantly in the past 20 years, accounting for 3.8% of newly diagnosed cancers.[1] The postoperative prognosis of differentiated thyroid cancer is satisfactory. However, the most important issue after the surgery is the quality of life, which is mainly manifested by neck scarring and changes in voice. Traditional open surgery is the most common treatment for thyroid cancer, but it leaves a significant scar on the patient's neck that affects the appearance. In order to avoid obvious scars, endoscopic thyroidectomy was developed. Yang et al[2,3] carried out endoscopic thyroidectomy in 2003 and the results showed that endoscopic thyroidectomy had less intraoperative blood loss and postoperative pain with better cosmetic effect. However, the operation space of endoscopic surgery is limited, and high technical requirements are needed for the surgeons due to the nature of 2-dimensional imaging. In addition, there are also many restrictions on the choices of endoscopic approach.[4] Subsequently, robotic operation systems were gradually applied to the treatment of thyroid tumors, and the surgical efficacy was comparable to or better than traditional open or endoscopic surgery.[5,6]

Postoperative voice function is an important factor affecting the patients' life qualities. The thyroid is adjacent to the recurrent laryngeal nerve. With the increasing maturity of thyroid surgery techniques and the application of recurrent laryngeal nerve monitors, the function of the recurrent laryngeal nerve can be well protected. However, it is still impossible to completely avoid the damage to the patient's voice function during thyroid surgery.[7] In the present study, we evaluated the impact of robotic and endoscopic surgery on the voice function during the treatment of thyroid cancer.

2. Materials and Methods

2.1. Patients

From March 2021 to July 2022, a total of 125 patients with differentiated thyroid cancer in Panzhihua Central Hospital (Sichuan Province) were randomly divided into endoscopic

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

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group (n = 58) receiving endoscopic thyroid lobectomy and robotic group (n = 67) receiving robot-assisted thyroid lobectomy. This study was approved by the Medical Ethics Committee of the hospital (No. S2021017).

Inclusion criteria were unilateral thyroid tumor, with tumor diameter ≤ 3cm; differentiated thyroid carcinoma; no lymph node metastasis in the lateral cervical region; and female patients. Exclusion criteria were patients with preoperative voice disorders, including vocal cord mucosal lesions or dyskinesia; history of neck surgery or radiotherapy; Age < 18 years old or > 70 years old; patients with total thyroidectomy or subtotal thyroidectomy.

The robotic group and the endoscopic group were performed by the same surgeon. All patients underwent voice assessment with informed consent. Both preoperative and postoperative voice assessments were performed under the same conditions by 1 voice specialist using the same assessment techniques. Voice assessments were completed before the surgery and 1 week, 1 month, and 3 months after the surgery.

2.2. Surgical technique

All patients were under general anesthesia. The breast approach was adopted in the endoscopic group. The lower limbs were separated into a "human"-shaped position, and the shoulders were slightly elevated to stretch the neck properly. Detailed surgical procedures were referenced from "Expert consensus on endoscopic thyroid surgery through anterior chest approach" (2017 Edition).[8] In the robotic group, bilateral axillo-breast approach (BABA) was adopted. Patients were in the supine position, with a thin pillow under the shoulders. The head tilted back to expose the neck. The Da Vinci Xi surgical system was used to perform the operation (Fig. 1). Details were referenced from "Expert Consensus on Assisted Thyroid and Parathyroid Surgery with Robotic Surgical System."[9] Both the endoscopic and robotic groups underwent resection of the affected side of the gland and isthmus as well as central lymph node dissection.

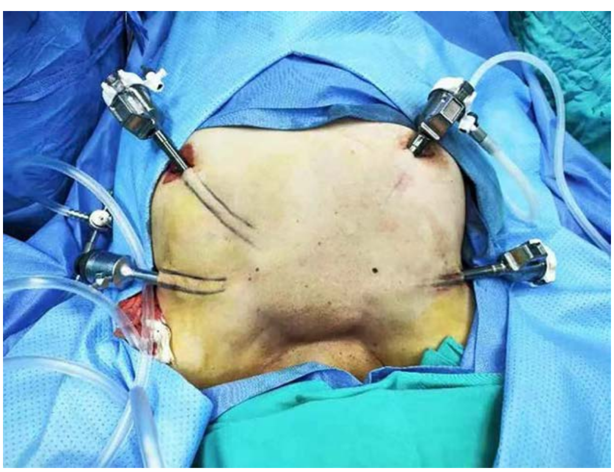

Figure 1. Robotic thyroidectomy via Bilateral Axlio-Breast Approach. Robotic trocars were inserted through bilateral areola and axillary ports.

2.3. Subjective voice assessment: voice handicap index (VHI) scale

Voice was assessed 1 day before surgery, 1 week after surgery, 1 month after surgery, and 3 months after surgery. Voice of all patients were measured using the voice handicap index (VHI-10).[10] The scale is divided into 3 dimensions: function (F), physical (P) and emotional (E), with a total of 10 questions, which were self-assessed by patients. A score of 0 represents "never," 1 represents "few," 2 represents "sometime," 3 is "often," and 4 represents "always" (Table 1). The cutoff value for voice handicap was defined as VHI-10 ≥ 8.[11]

2.4. Objective voice assessment

Voice acoustic analysis was performed 1 day before surgery, 1 week, 1 month, and 3 months after surgery using the German XION divas 2.1 version of voice acoustic analysis software. The patient wore a headset, with a 45° angle between the headset and the low level and a distance of 30 cm between the patient's mouth and the microphone. Voice test was performed in a low-noise soundproof room. The patient pronounces the vowel/a/ for 2 to 5 seconds. Each index was measured 3 times and average value was used. Voice indexes include fundamental frequency (F0), fundamental frequency perturbation (Jitter), amplitude perturbation (shimmer), maximum phonation time (MPT), noise-to-harmonic ratio (NHR), and dysphonia severity index (DSI).

2.5. Statistical analysis

SPSS 20.0 software was used for statistical analysis. Measurement data were expressed as x ± s, and Student *t* test was used for the comparison of means between the 2 groups. Chi square test was used for the comparison of enumeration data. $P < .05$ was considered statistically significant.

3. Results

3.1. General clinical data for both groups

The general clinical data of the patients were shown in Table 2. A total of 125 patients with differentiated thyroid cancer were enrolled in the study, with 67 patients receiving robotic-assisted

Table 1

The voice handicap index (VHI-10) Scale.

	0 Never	1 Few	2 Sometime	3 Often	4 Always
Because of my voice, it is difficult for others to understand what I say in a noisy environment.					
Because of my voice, I talk less with friends, neighbors or relatives.					
Because of my voice, I feel unable to keep up with the conversation.					
Because of my voice, I feel short of breath when I speak.					
My voice sounds unstable and changes during the day.					
People will ask me, "What's wrong with your voice?"					
My voice clarity is changeable					
I lose my voice when I speak					
People will feel uncomfortable when they hear my voice					
I feel distressed					

VHI-10 = voice handicap index.

thyroid lobectomy, and 58 patients receiving endoscopic thyroid lobectomy. There were no significant differences in age, body mass index, voice risk factors, tumor size, tumor type, operation time, intraoperative blood loss, drainage volume, and perioperative complications between the 2 groups (*P* > .05).

3.2. Results of the subjective voice assessment

The VHI-10 scores of the 2 groups were shown in Table 3. In all periods (before or after surgery), there was no significant difference in the VHI-10 scores between robotic and endoscopic groups. In the robotic group, preoperative VHI-10 scores were not significantly different from those in all follow-up periods after surgery (*P* > .05). However, in the endoscopic group, VHI-10 score in all follow-up period after surgery was significantly increased comparing to those before the surgery (*P* < .05). There was no significant difference in the incidence of voice handicap between the 2 groups after the surgery (*P* > .05).

3.3. Results of the objective voice analysis

The results of the objective voice analysis were shown in Table 4. In the endoscopic group, F0 was significantly decreased 1 week and 1 month after surgery comparing to that before surgery (*P* < .05). In contrast, in the robotic group, F0 in each follow-up period after surgery was not significantly decreased comparing to that before surgery (*P* > .05). One week after the surgery, F0 in the robotic group was (206.77 ± 20.13) Hz, which was significantly higher than that (197.91 ± 24.15) Hz in the endoscopic group (*P* < .05).

In the robotic group, MPT in all follow-up periods after surgery was not significantly different from that before surgery (*P* > .05). In contrast, in the endoscopic group, MPT at 1 week after the surgery was significantly lower than that before surgery (*P* < .05). One week after the surgery, MPT in the endoscopic group was (13.02 ± 9.28) s, which was significantly lower than that (17.55 ± 9.25) s in the robot group (*P* < .05). There was no significant difference in Shimmer, Jitter, DSI and NHR during all postoperative follow-up periods compared with those before surgery in both groups (*P* > .05).

4. Discussion

Voice handicap often occurs after thyroid cancer surgery. Postoperative voice function is an important factor in determining patient satisfaction and the success of thyroid cancer surgery. Voice dysfunction affects the quality of life of patients. Recent guidelines strongly recommend routine assessment of voice function both preoperatively and postoperatively.

Injury to the recurrent laryngeal nerve is the main cause of voice changes after thyroidectomy. However, voice changes may also occur after thyroidectomy without injury to the recurrent

Table 2

Comparison of general data between robotic group and endoscopic group.

Variables	Robotic Group (n = 67)	Endoscopic Group (n = 58)	P value
Age	45.24 ± 8.32	42.66 ± 9.85	.115
BMI (kg/m^2)	24.78 ± 3.84	23.82 ± 4.12	.180
Voice risk factors			
Smoking	2	2	1.000
Drinking	2	3	.662
Size of the tumor (mm)	13.18 ± 6.96	12.45 ± 6.55	.549
Type of the tumor			1.000
Papillary carcinoma	63	55	
Follicular carcinoma	4	3	
Surgery time (min)	125.74 ± 48.52	121.68 ± 42.79	.623
Blood loss during surgery (mL)	19.11 ± 9.42	18.85 ± 12.14	.893
Drainage volume (mL)	33.96 ± 17.12	35.74 ± 19.55	.588
perioperative complications			-
Hypoparathyroidism			
Short-term	3	4	0.703
Permanent	0	0	NA
Seroma	2	4	0.415

BMI = body mass index.

Table 3

Comparison of VHI-10 scores between robotic group and endoscopic group.

Variables	Robotic Group (n = 67, A)	p vs pre-op	Endoscopic Group (n = 58, B)	p vs pre-op	p A vs B
VHI-10 score					
Preop	0.31 ± 1.12		0.34 ± 0.81		0.866
1 wk post-op	0.72 ± 1.56	0.083	0.97 ± 1.89	**0.021***	0.420
1 mo post-op	0.65 ± 1.48	0.136	1.05 ± 1.91	**0.010***	0.190
3 mo post-op	0.57 ± 1.25	0.207	0.75 ± 1.28	**0.041***	0.429
VHI-10 score ≥ 8					
Preop	0		0		NA
1 wk post-op	1		1		1.000
1 mo post-op	1		2		0.596
3 mo post-op	0		0		NA

NA = non-applicable, post-op = postoperative, pre-op = preoperative, VHI-10 = voice handicap index.
*$P < 0.05$.

Table 4

Comparison of acoustic parameters between robotic group and endoscopy group.

Variables	Robotic group (n = 67, A)	p vs pre-op	Endoscopic group (n = 58, B)	p vs pre-op	p A vs B
F0 (Hz)					
Pre-op	209.48 ± 19.24		213.87 ± 20.76		0.222
1 wk postop	206.77 ± 20.13	0.427	197.91 ± 24.15	0.0002*	0.027*
1 mo postop	205.61 ± 23.54	0.299	201.22 ± 35.32	0.020*	0.410
3 mopostop	210.47 ± 24.56	0.796	215.03 ± 24.14	0.782	0.299
Jitter (%)					
Pre-op	1.20 ± 0.41		1.22 ± 0.75		0.851
1 wk postop	1.17 ± 0.35	0.650	1.16 ± 0.96	0.708	0.937
1 mo postop	1.21 ± 0.57	0.907	1.20 ± 0.88	0.896	0.939
3 mo postop	1.23 ± 0.45	0.687	1.17 ± 0.86	0.739	0.619
Shimmer (%)					
Pre-op	3.19 ± 1.22		3.24 ± 1.35		0.828
1 wk postop	3.30 ± 1.85	0.685	3.41 ± 1.52	0.526	0.720
1 mo postop	3.37 ± 1.64	0.472	3.32 ± 1.81	0.788	0.871
3 mo postop	3.15 ± 1.77	0.879	3.20 ± 1.62	0.885	0.870
NHR (dB)					
Pre-op	0.131 ± 0.32		0.133 ± 0.52		0.979
1 wk postop	0.142 ± 0.48	0.876	0.145 ± 0.81	0.925	0.980
1 mo postop	0.147 ± 0.36	0.786	0.138 ± 0.63	0.963	0.921
3 mo postop	0.143 ± 0.55	0.878	0.144 ± 0.53	0.910	0.992
MPT (s)					
Preop	20.17 ± 7.24		19.89 ± 8.02		0.838
1 wk postop	17.55 ± 9.25	0.070	13.02 ± 9.28	<0.0001*	0.007*
1 mo postop	18.80 ± 10.36	0.377	16.94 ± 10.27	0.087	0.317
3 mo postop	17.99 ± 14.10	0.262	18.02 ± 9.33	0.250	0.989
DSI					
Preop	1.79 ± 0.65		1.81 ± 0.49		0.848
1 wk postop	1.65 ± 0.36	0.125	1.64 ± 0.61	0.101	0.910
1 mo postop	1.76 ± 0.88	0.823	1.73 ± 0.75	0.498	0.839
3 mo postop	1.84 ± 0.60	0.644	1.80 ± 0.67	0.927	0.725

DSI = dysphonia severity index, MPT = maximum phonation time, NHR = noise-to-harmonic ratio, post-op = postoperative, pre-op = preoperative.
$^*P < 0.05$.

laryngeal nerve. Voice changes are often temporary, including sound fatigue, roughness, low tones, and reduced volume. The mechanism of voice changes after thyroidectomy without recurrent laryngeal nerve injury is unclear. It could be due to the postoperative laryngotracheal fixation vertical movement impairment, cricothyroid muscle dysfunction, surgical injury, or temporary dysfunction of the extralaryngeal band muscle, and tracheal intubation leading to laryngeal edema, local neck pain, psychological disorders.[12]

In the present study, we showed that in the endoscopic group VHI-10 scores at 1 week, 1 month, and 3 months after surgery were significantly increased comparing to those before surgery. F0 at 1 week and 1 month after surgery was significantly reduced comparing to those before surgery. The MPT at 1 week after surgery was significantly decreased comparing to those before surgery. However, in the robotic group, VHI-10, F0 and MPT had no significant changes in all follow-up periods after surgery comparing to those before surgery. After surgery, the subjective voice function and objective acoustic indexes in the robotic group were significantly better than those in the endoscopic group. Robot-assisted thyroid lobectomy could better protect the recurrent laryngeal nerve and reduce surgical trauma.[13] Robot-assisted thyroid lobectomy has the following advantages. First, the robot system provides 3-dimensional images, which can magnify the target structure by 10 to 15 times, with a clear and stable field of vision. No assistants are required to adjust the field of vision during the operation, which can reduce misoperations and improve the safety of the operation. Endoscopic thyroid surgery provides 2-dimensional images and requires an assistant to adjust the lens in real time to ensure a clear surgical field, which could lead to unstable visual field or misoperations. Second, compared with endoscopic thyroid lobectomy, robotic thyroid lobectomy physicians can easily obtain the best field of view and access deep and narrow spaces, which is more beneficial to identify and protect the deep recurrent laryngeal nerve during the dissection of the central lymph nodes. Third, the robotic arm provides a stable field of view, which can reduce the fatigue of the surgeon and avoid the vibrations caused by the hand tremor of the surgeon. Fourth, surgeons can use 3 robotic arms during the operation, among which the Maryland forceps have multiple joints with "snake motion," which is beneficial to the flexibility of operations.[14] However, in the endoscopic system, the surgical instruments are all non-articulated arms, and the surgeon's ability to operate is restricted. Fifth, the robotic system is completely controlled by the surgeon, thereby reducing the operation errors caused by inexperienced assistants during the endoscopic surgery.

The strength of our study is that we only included female patients and the surgical procedure was unilateral thyroidectomy. Chung et al,[15] compared endoscopic thyroidectomy and open thyroidectomy, and the results showed that the physiological, emotional and VHI scores in the endoscopic thyroid group were worse than those in the open thyroid group at 3 months after surgery. Lee et al,[16] compared endoscopic thyroidectomy and open thyroidectomy, and showed that the VHI score recovery time after surgery in the endoscopic group was shorter than that in the open thyroidectomy group. In addition, the highest pitch in the endoscopic group was higher than that in the open thyroidectomy group. These results were not completely consistent with the results of Chung et al, which could be due to the following 2 reasons. First, both female and male patients were included in the study, and the voice parameters, especially the pitch and fundamental frequency, were significantly different between female and male patients.[17] Second, the inclusion of patients with unilateral thyroidectomy and total thyroidectomy results in the lack of study homogeneity.

5. Conclusions

In conclusion, in the treatment of thyroid cancer, the postoperative voice function of robotic thyroid lobectomy via BABA approach is superior to of endoscopic thyroid lobectomy.

Author contributions

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Writing – review & editing: Peigen Liu, Yinghong Yang.

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