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Original Article

Reconstruction of laryngeal function by thyroid cartilage fenestration and draw-out resection followed by internal fixation with titanium microplates for early glottic carcinoma: a novel and efficient surgical approach

Yahong Li*, Shenjiong Ruan*, Yuming Hong, Feiyi Zhuang, Chaohui Zheng, Ming Lu, Xiaofang Chen

*Department of Otorhinolaryngology-Head and Neck Surgery, The Second Affiliated Hospital of Fujian Medical University, Quanzhou 362000, Fujian, China. *Equal contributors.*

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Abstract: Objective: To explore the clinical effectiveness of reconstructing laryngeal function using thyroid cartilage fenestration and "draw-out" resection, supplemented by internal fixation with titanium microplates in early glottic carcinoma. Methods: Data from 99 patients with glottic carcinoma treated in the Second Affiliated Hospital of Fujian Medical University between January 2014 and September 2021 were retrospectively analyzed. Forty-eight patients who underwent thyroid cartilage fenestration and resection followed by internal fixation with titanium microplates for laryngeal function reconstruction were assigned to the thyroid cartilage fenestration group (TCF group), while the other 51 patients who underwent sternohyoid muscle and fascia repair for laryngeal function reconstruction were assigned to the sternohyoid muscle repair group (SMR group). Patients were followed up for 1-8 years. Data on postoperative phonatory function, respiratory function, swallowing function, and survival status were collected. Results: Compared to the SMR group, patients in the TCF group showed better postoperative recovery in phonatory function and verbal communication (all $P<0.05$). In the TCF group, patients demonstrated stable respiration and the extubation rate was 100.00%, which was significantly higher than 82.35% in the SMR group ($P<0.05$). Patients in both groups showed good postoperative recovery of swallowing function ($P>0.05$). Conclusion: One-stage reconstruction of laryngeal function by thyroid cartilage fenestration and "draw-out" resection with adjuvant internal titanium microplate fixation in early glottic carcinoma demonstrates good postoperative recovery and good preservation of the laryngeal function.

Keywords: Glottic carcinoma, phonatory function, respiratory function, swallowing function, postoperative extubation rate

Introduction

Laryngeal carcinoma is one of the most common malignant tumors in the head and neck region [1]. It ranks third after nasopharyngeal carcinoma and sinonasal carcinoma in terms of incidence, and accounts for 3.1%-8.1% of malignant head and neck tumors [2]. Glottic carcinoma is the most common type of laryngeal carcinoma in clinical practice, accounting for more than 60% of all laryngeal carcinoma cases [3]. In recent years, the incidence of laryngeal carcinoma has shown an increasing trend, with squamous cell carcinoma being the most common type of malignancy in the larynx, accounting for approximately 95.7% of all cases [4, 5]. Studies have found that the male-to-female incidence ratio is around 7:1-10:1, and the age of onset is mainly within the range of 50-70 years [2, 6]. The exact causes of laryngeal carcinoma remain elusive, although it is primarily associated with risk factors such as smoking, drinking, long-term inhalation of pollutants (e.g., asbestos, dust, exhaust gas, and tar products), precancerous lesions (e.g., laryngeal keratosis, laryngeal leukoplakia, adult chronic hypertrophic laryngitis, and adult laryngeal papillomas), viral infections, and sex hormones [7-12]. Hoarseness is a common early symptom, especially indicative of glottic carcinoma, which involves lesions confined to the glottic area without affecting surrounding

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muscles or cartilage and without lymph node metastases [13, 14]. This includes Tis, T1, and certain T2 laryngeal carcinomas. At present, there are three main modalities for the treatment of early glottic carcinoma, namely open surgery, minimally invasive surgery such as laser surgery, and radiotherapy.

In recent years, there has been a gradual increase in the application of minimally invasive laryngeal surgical techniques, such as microwave ablation, low-temperature plasma, radiofrequency ablation, and carbon dioxide lasers. These techniques offer the advantages of minimal trauma, rapid recovery, few complications, good preservation of laryngeal function, and reliable efficacy [15-18]. However, their implementation is hindered by high cost of equipment and high demands on technical skills, which pose difficulty for widespread application in primary health care. There have also been reports on the use of robots in the treatment of early laryngeal carcinoma. The Da Vinci robot is currently the world's most advanced surgical operating platform. Its approval for clinical application by the U.S. Food and Drug Administration in 2000 represented a historic milestone in the field of minimally invasive surgery. In 2005, Hockstein et al. first reported the use of the Da Vinci robot for endolaryngeal surgery [19]. Solares et al. later reported a case of successful treatment of glottic carcinoma using the Da Vinci robot coupled with CO_2 laser technology [20]. Subsequently, the use of minimally invasive robotic surgery for the treatment of early glottic carcinoma was successively reported by Park et al. in 2009, Kayhan et al. in 2012, and Lallemant et al. in 2013 [21-23]. Their results showed that the robotic approach had advantages, such as minimal bleeding, good therapeutic effects, low incidence of complications, and short hospital stays. However, given the spatial constraints associated with otolaryngology head and neck surgery, the development of the Da Vinci robot in this field have progressed slowly. The limited number of patients treated with robotic surgery warrants further study of its therapeutic effects.

Surgical treatment is the preferred treatment for glottic carcinoma. The principle of partial laryngectomy for laryngeal cancer is to achieve thorough tumor removal while simultaneously repairing and preserving key laryngeal functions, ultimately enhancing the quality of life (QOL) for patients [24]. Laryngeal function reconstruction surgery has become a major trend in the development of surgical approaches for laryngeal carcinoma. However, surgical resection may lead to significant defects in the laryngeal cavity, complicating the repair and reconstruction of laryngeal function [25]. Commonly used surgical techniques for partial laryngectomy and laryngeal function reconstruction in laryngeal carcinoma include the modified Arslan technique for repairing tissue defects using an epiglottic flap, myofascial flap, strap muscle flap, hyoid bone flap, cervical door flap, residual pharyngeal or laryngeal mucosal flap, and the internal or external perichondrium of the thyroid cartilage. Often, a combination of these flaps is employed to achieve optimal results [26].

Recently, our department has pioneered a laryngeal function reconstruction technique for early glottic carcinoma, which involves thyroid cartilage fenestration and "draw-out" resection followed by internal fixation with titanium microplates. The technique can accomplish one-stage reconstruction based on the extent of the primary lesion and is tailored to the individual circumstances of each patient. The technique has demonstrated promising therapeutic effects, with patients exhibiting good postoperative phonatory and swallowing functions and high extubation rates. From January 2014 to September 2021, data from a total of 99 patients with early glottic carcinoma treated at our department either by this technique or by sternohyoid muscle and fascia repair were collected and compared to explore the clinical effectiveness of the novel surgical techniques in the reconstruction of laryngeal function.

Patients and methods

Case selection

A total of 99 cases of glottic carcinoma treated in the Second Affiliated Hospital of Fujian Medical University between January 2014 and September 2021 were retrospectively analyzed. All patients underwent electronic laryngoscopy and computed tomography (CT) examination of the neck, and 63 patients underwent magnetic resonance imaging (MRI) of the larynx. Patients who underwent thyroid cartilage

fenestration and resection followed by internal fixation with titanium microplates for laryngeal function reconstruction were assigned to the thyroid cartilage fenestration group (TCF group), while patients who underwent sternohyoid muscle and fascia repair for laryngeal function reconstruction were assigned to the sternohyoid muscle repair group (SMR group). The TCF group and SMR group consisted of 48 and 51 patients, respectively. This study was approved by the Medical Ethics Committee of the Hospital.

The inclusion criteria: (1) Patients with early glottic carcinoma confirmed by imaging and pathological examination; (2) Patients experiencing first-onset and undergoing surgical treatment for the first time; (3) Patients without distant metastases before surgery; (4) Patients who underwent partial laryngectomy, with reconstruction of laryngeal function performed either by thyroid cartilage fenestration and resection followed by internal fixation with titanium microplates or sternohyoid muscle (SM) fascia repair.

The exclusion criteria: (1) Patients who had received preoperative radiotherapy or chemotherapy; (2) Patients with incomplete clinical data and follow up data.

Surgical methods

Preoperative preparation: For each patient, the surgical approach was preliminarily determined based on data obtained from preoperative examinations, such as electronic nasopharyngoscopy, pathological biopsy, and contrast-enhanced dual-source CT examination of the neck or contrast-enhanced MRI of the neck, with consideration given to the size, location, and type of tumor and the physical condition of the patient. Our goal was to preserve normal laryngeal tissue and function to the greatest extent under the precondition of complete tumor resection. Routine intraoperative pathological examination of frozen sections was performed for the confirmation of safe margins, and the extent of the surgical resection was determined based on the margin assessment results.

The surgical procedure for TCF group: The patient was placed in a supine position with the shoulders elevated using pads. After routine disinfection and draping, tracheotomy was performed under local anaesthesia. An incision was made between the third and fourth tracheal rings for the insertion of an anaesthesia tube, and the cuff was inflated to induce general anaesthesia. Following re-disinfection and re-draping, a transverse arc-shaped incision was made at the level of the cricothyroid membrane. The skin, subcutaneous tissue, and platysma muscle were cut open, and a muscle flap was raised by dissection under the muscle. Infrahyoid muscles were separated laterally and pulled along the midline of the neck on the thyroid cartilage perichondrium to expose the thyroid cartilage plate, cricothyroid membrane, and thyrohyoid membrane. Anterior laryngeal soft tissue and the nearby lymph nodes were dissected and removed for examination. A transverse incision was made in the cricothyroid membrane (in some cases, a 30° endoscope and imaging system were used to observe the primary site, size, and extent of laryngeal tumor growth). The thyroid cartilage was then cut open longitudinally using an oscillating saw placed over the center of the thyroid cartilage or slightly towards the unaffected side (in patients whose tumors were close to the anterior commissure). Subsequently, the anterior commissural mucosa was dissected at the center with straight scissors and held in place with an automatic retractor to expose the laryngeal cavity. After sufficient hemostasis had been achieved with a 0.1% adrenaline cotton swab, the tumor was visually examined (**Figure 1A**). The supraglottic mucosa, anterior mucosa of the cricoarytenoid articulation, and subglottic mucosa were dissected at the safe margin approximately 0.5-1.0 cm away from the tumor. Using an oscillating saw, the thyroid cartilage was cut open transversely to the posterior quarter at the upper-middle third junction and middle-lower third junction on the thyroid cartilage plate. The middle third of the thyroid cartilage was cut open longitudinally at the junction of the back quarter and front three-quarters of the thyroid cartilage plate (**Figure 1B**). At this point, the middle third of the cartilage could be loosened. Subsequently, the internal perichondrium of the thyroid cartilage was dissected at the corresponding site and converged towards the laryngeal tumor incision, and “draw-out” resection was performed for removal of the tumor, soft tissue of the laryngeal cavity, and middle

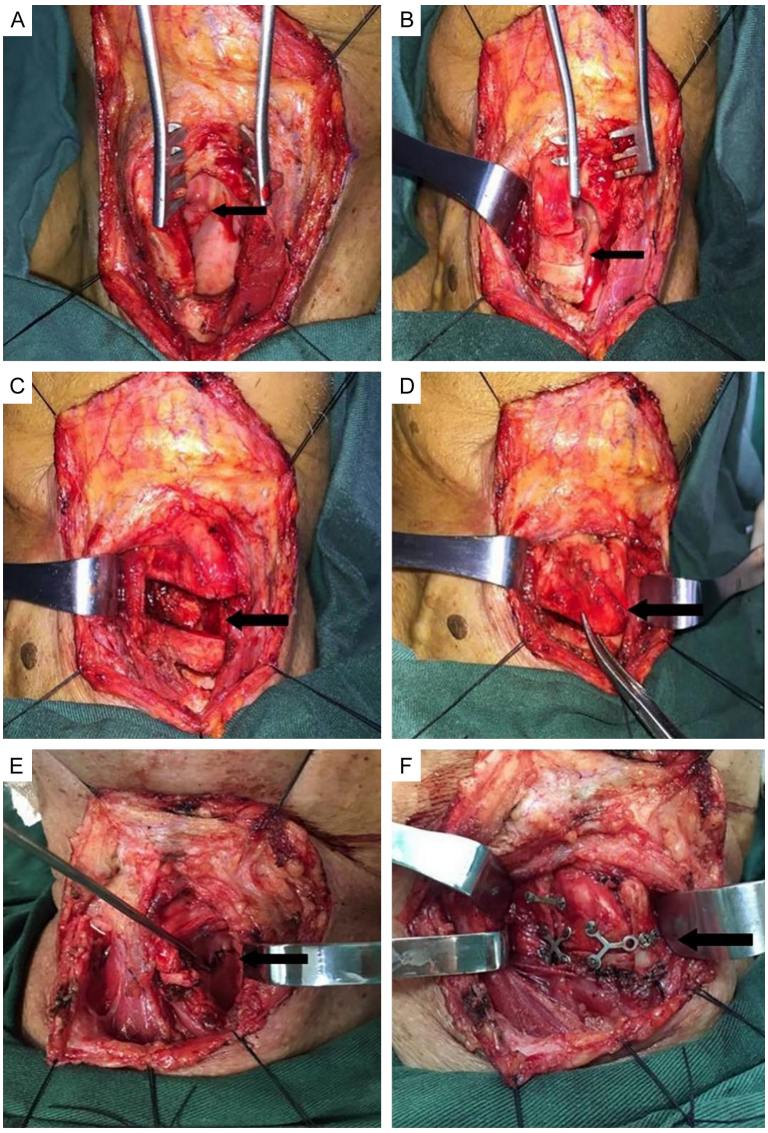

Figure 1. The surgical procedure for TCF group. A. Splitting the thyroid cartilage (arrow) to reveal the laryngeal cavity; B. Cutting affected side (arrow) with saw; C. "Drawer" (arrow) to remove thyroid cartilage, soft tissue of laryngeal cavity, and tumor; D. Lowering the upper third of the thyroid cartilage flap (arrow); E. Suturing the supraglottis and subglottic tissue (arrow); F. Titanium plate fixed to the cartilage with screws (arrow).

third of the thyroid cartilage (**Figure 1C**). After saline rinsing and the achievement of haemostasis by electrocautery, frozen sections were prepared with the superior, inferior, anterior (anterior commissural or contralateral anterior laryngeal mucosa), and posterior mucosal margins for pathological examination to ensure the absence of residual tumor. The upper third of the thyroid cartilage was longitudinally dissected at the back quarter of the thyroid cartilage using the oscillating saw, and the surrounding soft tissue was released. The upper third of the thyroid cartilage was moved downwards in a parallel direction, and the supraglottic tissue was moved downwards (**Figure 1D**). Using size 0 sutures, mucosal margins of the supraglottic and subglottic regions were sutured in apposition for the repair of tissue defects in the laryngeal cavity on the affected side (**Figure 1E**). Fixation of the thyroid cartilage was performed using straight, Y-shaped, or X-shaped titanium microplates at the following locations: between the upper third and lower third, between the back quarter and front three-quarters of the upper third, and between the upper third, the lower third, and the contralateral thyroid cartilage (**Figure 1F**). The laryngeal cavity was closed by suturing the cricothyroid membrane, and the bilateral anterior laryngeal strap muscles were sutured. After the placement of a negative pressure drainage tube, the skin incisions were sutured.

The surgical procedure for SMR group: The bilateral SMs were dissected using the same method. A transverse incision was made in the cricothyroid membrane to examine the extent of tumor invasion within the laryngeal cavity. Subsequently, the tumor was resected at a safe margin of 0.5-1.0 cm around the tumor, with the extent of resection including a unilateral thyroid cartilage plate and the vocal cord and part of the laryngeal tissue attached to its inner surface. The pedicled sternothyroid muscle and its fascial flap on the affected side were folded into the laryngeal cavity at the defect of the thyroid cartilage plate margin, and sutured to the superior, inferior, and posterior laryngeal mucosal margins to repair the surgical wound.

Table 1. Comparison of baseline data between the two groups

Indicator	TCF group	SMR group	t/χ^2	P
Cases (n)	48	51		
Male/Female (n)	47/1	50/1	-	>0.999
Age (range, years)	43-82	43-82		
Average age (years)	60.33±5.21	61.54±8.44	0.852	0.396
TNM staging			4.905	0.861
T1aN0M0	24	23		
T1bN0M0	10	20		
T2N0M0	14	8		

Note: TCF, thyroid cartilage fenestration; SMR, sternohyoid muscle repair.

Data collection and follow-up

Data related to primary indicators including phonatory function, swallowing function, respiratory function, and secondary indicator including survival status were collected through a follow-up of patients during their hospital stay, at the outpatient clinic, and by telephone. (1) Phonatory function: the phonatory function of patients was rated as normal, good, fair, and poor based on the following criteria [27]: Normal, Patients exhibited normal voice clarity and continuity, understandable by others; Good, Good voice clarity and continuity with slight hoarseness; Fair, the voice clarity and continuity of patients may affect their normal life and work; Poor, the voice clarity and continuity severely affects their normal life and work; speech is not understandable. (2) Swallowing function: the timing of gastric tube removal and the incidence of aspiration and coughing were recorded. In the evaluation of postoperative swallowing function, patients were rated as having no aspiration, mild aspiration, moderate aspiration, or severe aspiration based on the following criteria [27]: No aspiration, no coughing during intake of liquid food; Mild aspiration, coughing during intake of liquid food, but not with pureed and semi-liquid food; Moderate aspiration, coughing during the intake of pureed, semi-liquid food; Severe aspiration, unable to perform oral intake. Effective rate (%) = [patients with no aspiration + patients with mild aspiration]/total number of patients *100%. (3) Respiratory function: respiratory status was observed after the tracheostomy tube was temporarily closed with the rubber stopper for 24 h; successful extubation rate and average extubation time were used as indicators of respiratory function. (4) Survival status: the recurrence, metastasis, and death of patients were recorded during the follow-up period.

Statistical analysis

Data were processed using SPSS software (v21.0; IBM Corp., Armonk, NY, USA). Measured data were expressed as mean ± standard deviation and were analyzed using the t-test. Counted data were expressed as percentages and were analyzed using the chi-square test or Fisher's exact test. Differences were considered significant when $P<0.05$.

Results

Basic data

Postoperative pathological examination revealed that 98 patients had squamous cell carcinoma and 1 patient had carcinosarcoma. The 99 patients included in this study comprised 97 men and two women aged 43-82 years (average age: 61.54±8.44 years). Disease duration ranged from 1 month to 1 year, and the initial symptom was hoarseness in all patients. According to the 2012 American Joint Committee on Cancer staging atlas, 47 patients were at stage T1aN0M0, 30 patients in stage T1bN0M0, and 22 patients in stage T2N0M0. 77 patients had stage I disease and 22 patients had stage II disease. There was no significant difference in gender, age or TNM stagging between the two groups (all $P>0.05$, **Table 1**).

Comparison of phonatory function

Among the 99 patients included in the present study, nine had normal phonatory function (nine in TCF group and zero in SMR group), 62 had good phonatory function (39 in TCF group and 23 in SMR group), 28 had fair phonatory function (zero in TCF group and 28 in SMR group), and none had poor phonatory function. The TCF group demonstrated better phonatory function recovery than the SMR group ($P<0.05$; **Table 2**).

Table 2. Comparison of phonatory function between TCF group and SMR group

Group	Phonatory function (n)					X^2	*P*
	Normal	Good	Fair	Poor	Total		
TCF group	9	39	0	0	48		
SMR group	0	23	28	0	51	41.076	<0.05

Note: TCF, thyroid cartilage fenestration; SMR, sternohyoid muscle repair.

Table 3. Comparison of swallowing function between TCF group and SMR group

Group	Patients (n)	No aspiration (n)	Mild aspiration (n)	Effective rate (%)	X^2	*P*
TCF group	48	48	0	100		
SMR group	51	48	3	100	2.912	>0.05

Note: TCF, thyroid cartilage fenestration; SMR, sternohyoid muscle repair.

Table 4. Comparison of respiratory function between TCF group and SMR group

Indicator	TCF group	SMR group	t/χ^2	P
Cases (n)	48	51		
Successful extubation rate (n, %)	48 (100)	42 (82.35)	9.318	0.002
Extubation time (days)	12.34±3.44	17.42±6.32	5.007	<0.001

Note: TCF, thyroid cartilage fenestration; SMR, sternohyoid muscle repair.

Table 5. Comparison of survival status between TCF group and SMR group

Group	Patients (n)	Postoperative recurrence (n)	Recurrence rate (%)	X^2	*P*
TCF group	48	1	2.1		
SMR group	51	5	9.8	0.759	0.384

Note: TCF, thyroid cartilage fenestration; SMR, sternohyoid muscle repair.

Comparison of swallowing function

In the TCF group, all patients showed no postoperative aspiration, indicating complete recovery of normal swallowing function. In the SMR group, 48 patients experienced no postoperative aspiration and three experienced mild aspiration. Their normal swallowing function was recovered at 3 months postoperatively. The difference in swallowing function between TCF group and SMR group was not statistically significant (P>0.05; **Table 3**).

Comparison of respiratory function and extubation time

In the TCF group, all patients underwent successful tracheostomy tube removal (100%) with an average extubation time of 12.34±3.44 days (range: 10-14 days) postoperatively. While in the SMR group, 42 out of 51 patients underwent successful tracheostomy tube removal (82.35%) with an average extubation time of 17.34±3.44 days (range: 13-20 days) postoperatively. Extubation was not successful in nine patients due to laryngeal stenosis and damage to the arytenoid cartilage on the unaffected side. The TCF group had a higher successful extubation rate and shorter average extubation time than the SMR group (all P<0.05; **Table 4**).

Comparison of survival status

Among the 99 patients, six exhibited local recurrence, including one from TCF and five from SMR group. The patient in TCF group was re-admitted for cervical lymph node dissection and total laryngectomy. For those in the SMR group, one patient underwent partial laryngectomy, and the remaining were subjected to total laryngectomy, of whom one eventually died of systemic metastatic disease. The difference in survival status between TCF group and SMR group was not significant (P>0.05; **Table 5**).

Discussion

In recent years, our department has advanced a laryngeal function reconstruction technique for early glottic carcinoma, which involves thyroid cartilage fenestration and "draw-out" resection followed by internal fixation with titanium microplates. This technique enables effective recovery of the phonatory, respiratory, and swallowing functions of the larynx. During the surgical procedure, the laryngeal cavity is fully exposed to ensure precise tumor resection within safe margins. The upper third of the thyroid cartilage lamina on the affected side is preserved and moved downwards for fixation in apposition with the lower third of the thyroid cartilage plate using titanium microplates. Subsequently, the remaining mucosal tissue in the larynx is sutured in apposition intermittently to achieve effective reconstruction of the vocal cord. The newly formed vocal cord is of the same length as the opposite vocal cord, which enables the greatest possible restoration of the isosceles triangle form of the glottic fissure and effectively improves the postoperative phonation quality of the patient. After reconstruction and reduction, micro titanium plates are used for fixation in the anterior-posterior, superior-inferior, and left-right directions, preventing thyroid cartilage displacement - a common issue with silk suture fixation. With this technique, the thyroid cartilage plate framework is preserved, which provides good support to the laryngeal cavity and restores the physiological anatomy of the laryngeal cavity to the greatest extent. Besides ensuring good stability and patency in the laryngeal cavity, this also prevents soft tissue collapse due to accumulation and negative pressure during inhalation, which may otherwise affect postoperative extubation. The indwelling tracheostomy tube is changed to a size 9 or 10 metallic tracheostomy tube at 1 week postoperatively, and the tracheostomy tube is plugged at 10-14 days postoperatively. At this point, patients are capable of unobstructed breathing, which allows for successful extubation. Our surgical procedure can shorten the time to extubation, which will contribute to the reduction of the length of hospital stay and hospitalization cost. At 7-10 days postoperatively, the nasogastric tube inserted preoperatively is removed, and patients can consume semi-liquid food orally without swallowing issues. Compared with repair using a SM myofascial flap, this surgical approach shortens the time required for intraoperative preparation of the myofascial flap. The intraoperative use of titanium plates and screws provides strong internal fixation effects, which sgreatly reduces tension in the laryngeal cavity and promotes appositional growth of tissue surrounding the wound. This contributes to the achievement of stage 1 healing, thereby reducing the occurrence of complications such as pharyngocutaneous fistula and wound infection.

In a previous study, Wang et al. reported the use of window partial laryngectomy in glottic carcinoma, and Zhang et al. demonstrated the use of vertical partial laryngectomy for preservation of the laryngeal cartilage framework [28, 29]. In another study, Shu et al. combined endoscopy with window partial laryngectomy to preserve the integrity of the thyroid cartilage framework [30]. However, the reported technique involves a relatively complicated surgical procedure that requires endoscopic observation for localization and repair using a pedicled muscle flap. In our developed technique, the thyroid cartilage is split vertically from the center or slightly towards the affected side to fully expose the laryngeal cavity. Subsequently, the tumor is resected at a safe margin under direct visualization. The resection of the tumor, laryngeal tissue, and middle third of the thyroid cartilage on the affected side also conforms to the no-touch principle of tumor resection. This reduces the incidence of postoperative recurrence and increases patient survival rates. Laryngeal repair involves moving the upper third of the thyroid cartilage plate on the affected side and associated supraglottic soft tissue downwards and suturing the mucosal margins of the supraglottic and subglottic regions in apposition. This prevents postoperative granulation tissue growth within the laryngeal cavity and contributes to good postoperative wound healing, unobstructed breathing, shortening of the time to extubation, and enhancement of patient QoL. The disadvantage of this surgical technique is the use of a mandibular oscillating saw and titanium plates and screws during the surgical process, which increase the cost of the procedure, but the higher cost is generally acceptable among patients and their family members. In addition, there are also some operational considerations for this technique:

(1) This technique is suitable for early glottic carcinoma patients with T 1a and T1b tumors and T2 stage patients whose tumors do not exceed the superior edge of the ventricular folds and 0.5 cm below the glottic region. (2) The upper third of the thyroid cartilage is cut open for sufficient loosening of the surrounding soft tissue. Subsequently, the cartilage is moved downwards in parallel with the supraglottic laryngeal tissue to facilitate suturing. (3) Care should be taken to protect the cricoarytenoid articulation on the unaffected side to avoid damage that may result in restricted joint movement or even fixation, which can affect the phonatory function. (4) Pathologic examination of frozen sections should be performed intraoperatively to ensure that the extent of resection is adequate. (5) The supraglottic and subglottic mucosal margins are to be sutured in apposition intermittently with size 0 silk sutures.

The larynx is a sound-producing organ and the gateway to the respiratory tract. Its main physiologic functions include respiration, phonation, protection, and swallowing. Patients who undergo partial laryngectomy may suffer unilateral vocal cord loss, leading to a significant decline in phonation quality. Several methods for vocal cord reconstruction have been developed clinically. Although laryngeal defects can be repaired by tissue material transplantation, the weight, volume, and tension of the reconstructed vocal cord are fundamentally different from those of normal vocal cords. During the phonation process, the surface mucosa of reconstructed vocal cord also does not vibrate like that of normal vocal cords. Therefore, phonation quality is inevitably affected. Partial laryngectomy alters the normal anatomical structures and physiological functions of the larynx and neck and causes damage to important structures such as the vocal cord on the affected side and the anterior commissure. This exerts a severe impact on the QoL of patients. Therefore, the maintenance of normal glottic morphology after surgery is of ultimate importance for phonatory function. In the TCF group of the present study, the upper third of the thyroid cartilage plate on the affected side and the associated supraglottic soft tissue were moved downwards, and the mucosal margins of the supraglottic and subglottic regions were sutured in apposition. The ventricular fold tissue that remained intact in certain patients served as a substitute for the vocal cords, which resulted in good postoperative phonatory effects. Our results indicate that the phonatory function of TCF group was significantly better than that of SMR group, indicating the presence of obvious advantages in postoperative phonatory function recovery and verbal communication.

Postoperative partial removal of the thyroid cartilage support, growth of granulation tissue in the laryngeal cavity, and scar formation can cause glottic stenosis, resulting in breathing difficulty and affecting the extubation rate. Given that the larynx and pharynx are closely connected, local excision of laryngeal tissue during surgery may affect the swallowing function of the patient and result in postoperative aspiration [31-33]. Therefore, important indicators for postoperative evaluation of laryngeal function include phonation, success or failure of extubation, recovery of respiratory function, and swallowing function [4, 34, 35]. In this study, we preserved the upper and lower third of the thyroid cartilage plate on the affected side and performed anterior-posterior, superior-inferior, and left-right fixation using titanium microplates. This resulted in good stability and enabled the preservation of the thyroid cartilage framework, which provided adequate support for the laryngeal cavity, prevented soft tissue from collapsing due to negative pressure during inhalation, and ensured ventilation through the laryngeal cavity. Our results showed that the extubation rate of TCF group was significantly higher and the time to extubation was significantly shorter than those of the SMR group. An increase in extubation rate is a key marker of the improvement of QoL in patients, as the functions of the larynx can be completely restored only after removal of the tracheostomy tube. All patients in the present study underwent successful postoperative gastric tube removal, with only three patients experiencing mild aspiration. However, normal swallowing function was recovered at 3 months postoperatively. TCF group patients exhibited good swallowing function and did not experience aspiration and coughing. These all indicate the safety and efficiency of the TCF approach.

Regardless of the repair method adopted, the treatment principle for early glottic carcinoma

is the repair and reconstruction of laryngeal function on the basis of complete tumor resection. In this study, one patient in the TCF group showed local recurrence at 8 months postoperatively, and five in SMR group suffered a recurrence between 6 months and 2 years postoperatively and were re-admitted for surgical treatment. Although the survival status of the two groups did not differ significantly, the laryngeal tissue and middle third of the thyroid cartilage on the affected side were removed during tumor resection in the TCF group patients, which conforms more closely to the no-touch principle of tumor resection compared with SMR group.

In conclusion, one-stage reconstruction of laryngeal function by thyroid cartilage fenestration and "draw out" resection with adjuvant internal fixation using titanium microplates demonstrates good postoperative recovery and good preservation of the laryngeal cavity in patients with early glottic carcinoma. However, this was a single center retrospective study with limited cases. In the future, more prospective multicenter studies with lager sample volume are needed to verify the advantages of this approach.

Disclosure of conflict of interest

None.

Address correspondence to: Xiaofang Chen, Department of Otorhinolaryngology-Head and Neck Surgery, The Second Affiliated Hospital of Fujian Medical University, Quanzhou 362000, Fujian, China. Tel: +86-13400886282; E-mail: cxf6611-026@163.com

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