

# Vertical partial frontolateral laryngectomy with simultaneous pedunculated sternothyroid muscle flap reconstruction of the vocal fold – surgical procedure and treatment outcomes

## Authors' Contribution:

A – Study Design  
B – Data Collection  
C – Statistical Analysis  
D – Data Interpretation  
E – Manuscript Preparation  
F – Literature Search  
G – Funds Collection

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## ABSTRACT:

**Purpose of the study:** The aim of the study was to present the treatment outcomes after vertical partial laryngectomy with or without pedunculated sternothyroid muscle flap reconstruction following the resection of neoplasm-infiltrated vocal fold. The procedure was used in a patient with glottic cancer. Oncological outcomes, morphology of neo-vocal fold and the act of swallowing were evaluated.

**Material and methods:** 45 patients with T1-T2 glottic cancer were subjected to vertical partial laryngectomy with 26 patients undergoing a procedure with pedunculated sternothyroid muscle flap reconstruction and the remaining 19 patients undergoing a procedure without such a reconstruction. Two female and 43 male patients aged 35-82 years (mean age of 62.5 years) were enrolled in the study. Local tumor spread and the condition of reconstructed vocal fold were assessed in sequential videofiberscopy examination conducted each month after surgery whereas the regional spread was assessed in ultrasound scans. Postoperative aspiration was graded according to the Pearson's scale.

**Results:** Six patients experienced local recurrence while 2 patients experienced regional recurrence of the tumor. The pedunculated sternothyroid muscle flap neo-fold was structurally resemblant of the non-affected vocal fold. Episodic, daily dysphagia was observed in 1 patient while normal act of swallowing with no Pearson's scale symptoms was observed in the remaining 44 patients. No necrosis of pedunculated flap was observed.

**Conclusions:** Vertical partial laryngectomy with or without pedunculated sternothyroid muscle flap reconstruction is a good method for the treatment of low- or intermediate-stage glottic cancer, especially when endoscopic access to the tumor is limited and when CO<sub>2</sub> laser cannot be used. No significant functional disorders were observed in operated larynges.

## KEYWORDS:

Glottic cancer, vertical partial laryngectomy, sternothyroid muscle flap

## ABBREVIATIONS:

AJCC – American Joint Committee on Cancer  
HNSCC – Head and Neck Squamous-Cell Carcinoma  
HPL – Horizontal Partial Laryngectomy  
VPL – Vertical Partial Laryngectomy

## INTRODUCTION

Therapeutic methods used in the treatment of T1-T2 N0 M0 glottic cancer include radiation treatment and various types of surgical procedures [1]. Surgical treatment consists

in partial laryngectomies carried out using endoscopic or external approach and including or not including reconstruction of tissue lost after tumor resection [2–4]. External approach partial laryngectomy is one of the methods for the treatment of low- and medium-stage laryngeal tumors that facilitate conservation of the organ and its physiological functions (respiration, phonation, defense and reflective function) [5–10]. Traditionally, laryngectomies are classified into 3 groups:

- 1 - vertical partial laryngectomies (VPL);
- 2 – horizontal partial laryngectomies (HPL); and
- 3 – atypical laryngectomies [2, 10].

In addition, VPLs are subclassified into 4 types, including: a) standard vertical laryngectomy; b) frontolateral laryngectomy; c) anterofrontal laryngectomy; and d) extended laryngectomy [5, 11]. The choice of the appropriate surgical technique depends on the tumor staging; either local, regional, or distant, as well as on the experience of the team of the site where the partial laryngectomy procedure is performed. Indications for VPL include: large T1 glottic cancer T1; small T2 glottic cancer with minor infiltration of subglottis or laryngeal vestibule; T1-T2 glottic cancer that cannot be removed using an endoscopic approach due to difficult patient anatomy and problems with visualization of the tumor; and suspected infiltration of the anterior commissure. VLP is also used as rescue therapy following non-radical radiation treatment of small glottic tumors (rT1-T2) [12, 13]. The tissue loss that follows the procedure may be reconstructed in a number of fashions. These include autologous, allogeneic, and xenogeneic transplants. Autologous transplants of the surrounding tissues (such as the sternothyroid, sternohyoid, or platysmal muscle) or more distant tissues (such as the temporal muscle or buccal mucosa) are most common [7, 14–22]. The objective of this study was to present the surgical technique and discuss the outcomes of the treatment of patients with AJCC TNM staging system stage T1-T2 glottic squamous cell carcinoma subjected to frontolateral vertical partial laryngectomy with simultaneous reconstruction of the resected tissue using pedunculated sternothyroid muscle flap.

## MATERIAL AND METHODS

Frontolateral vertical partial laryngectomy was performed in years 2011–2015 at the Department of Otorhinolaryngology of the Faculty of Medicine and Dentistry of the Medical University of Warsaw in a total of 45 patients. The study was conducted in 2 female and 43 male patients aged 35 through 82 years (mean age of 62.5 years). Eligibility criteria included histopathological confirmation of TNM stage T1 or T2 glottic squamous cell carcinoma and Karnofsky performance status of above 80. Simultaneous reconstruction of the vocal fold using pedunculated sternothyroid muscle flap was performed in 26 patients. The remaining 19 patients were subjected to frontolateral VPL without simultaneous vocal fold reconstruction. Table I presents the characteristics of patients included in the study.

### Surgical technique

**Step one:** A U-shaped cut was performed on the neck of the patient under general endotracheal anesthesia. Tissues were dissected in layers to reach the anterior surface of the larynx. Next, vertical thyrotomy was performed using a piezoelectric knife to visualize the laryngeal lumen (Fig. 1).

**Tab. I.** Clinicopathological characteristics of patients according to age, sex, Karnofsky's performance scale, and pathological grade.

CHARACTERISTICS	NO. OF PATIENTS (%)	
	VPL WITH RECONSTRUCTION	VPL WITHOUT RECONSTRUCTION
<b>Sex</b>		
Male	24 (92%)	19 (100%)
Female	2 (8%)	0 (0%)
<b>Age</b>		
Range	35–82 lata	43–79 lata
Median	64,84 lata	56,15 lata
<b>Pathological grade</b>		
pT1a	6 (23%)	6 (32%)
pT1b	1 (4%)	5 (26%)
pT2	19 (73%)	8 (42%)
<b>Tumor differentiation</b>		
G1	7 (27%)	2 (11%)
G2	18 (69%)	16 (84%)
G3	1 (4%)	1 (5%)
<b>Stage</b>		
I	7 (27%)	11 (58%)
II	19 (73%)	8 (42%)
<b>Karnofsky's performance scale</b>		
100	25 (96%)	19 (100%)
90	1 (4%)	0 (0%)
80	0 (0%)	0 (0%)

**Tab. II.** Oncological results.

RECURRENCE	NO. OF PATIENTS (%)	
	VPL WITH RECONSTRUCTION	VPL WITHOUT RECONSTRUCTION
Local	5 (19%)	1 (5%)
Regional	1 (4%)	1 (5%)
No. of recurrences	6 (23%)	2 (10%)

**Step two:** The tumor was resected with healthy tissue margins; oncological margins were confirmed in intraoperative histopathological examination. Depending on the tumor size, resected tissues included the vocal fold, the laryngeal ventricle, and/or the vestibular fold. In some patients, arytenoid cartilage and its epithelium was also resected unilaterally in order to maintain an appropriate oncological margin.

**Step three:** The resected vocal fold was reconstructed using pe-

dunculated sternothyroid muscle flap (Fig. 2), introduced into the larynx via a previously opened window within the thyroid cartilage. According to the authors, it is important that the muscle is harvested along with the perimysium and the surrounding fascia as this facilitates subsequent wound healing. The larynx was closed with absorbable sutures. Tissues were sutured in layers. In every case, passive horizontal drainage tube was left in the wound for 2 days. Tracheotomy was performed intraoperatively in selected cases.

### Postoperative care

Microsurgical follow-up examination of the larynx was performed in all patients one month after the procedure. Subsequently, videofiberoptic examinations of the larynx were performed every 6 weeks. Those examinations facilitated morphological assessment of the reconstructed vocal fold as well as the examination of the mucosal membrane for potential presence of inflammatory granulation or local recurrent tumors. Histopathological specimens were collected in all cases of inflammatory granulation or abnormal tissue being observed upon microsurgical follow-up examination.

Lymph node metastases were analyzed on the basis of follow-up ultrasound scans of the neck performed at 3-month intervals for the first 2 years after the procedure.

## RESULTS

Local recurrence was observed in 6 patients. Five of those patients belonged to the group that had undergone laryngectomy with simultaneous vocal fold reconstruction using pedunculated sternothyroid muscle flap while the sixth patient had undergone laryngectomy without simultaneous reconstruction. Two of those patients were qualified for reoperation while the remaining 4 were qualified for total laryngectomy. In addition, regional recurrence was observed in 2 patients (1 in each of the groups); the patients were therefore subjected to cervical lymphadenectomy with subsequent regional radiotherapy (Table II).

One month after the primary surgery, directoscopic image of the reconstructed vocal fold was morphologically resemblant of the resected vocal fold (Fig. 3) while the remaining functionally "mute". Loss of tissues in the resection area was observed in patients undergoing laryngectomy without reconstruction.

No dysphagia could be observed in any of the 44 patients (25 patients after VPL with simultaneous reconstruction and 19 patients after VPL without reconstruction. Episodic daily dysphagia was reported by one patient in the former group (Table III).

**Tab. III.** Swallowing function and breathing function by procedure.

	TREATMENT	
	VPL WITH RE-CONSTRUCTION	VPL WITHOUT RE-CONSTRUCTION
<b>Swallowing function</b>		
Normal, asymptomatic	25 (96%)	19 (100%)
Episodic/daily dysphagia	1 (4%)	0 (0%)
Compensated abnormal function	0 (0%)	0 (0%)
Uncompensated abnormal function,	0 (0%)	0 (0%)
Non-oral feeding	0 (0%)	0 (0%)
<b>Breathing function</b>		
Normal, asymptomatic	24 (92%)	19 (100%)
Episodic/ daily dyspnea	0 (0%)	0 (0%)
Compensated abnormal function, no tracheotomy required	0 (0%)	0 (0%)
Uncompensated abnormal function, tracheotomy required	1 (4%)	0 (0%)

**Tab. IV.** Treatment complications

	LECZENIE	
	VPL WITH RECONSTRUCTION	VPL WITHOUT RECONSTRUCTION
<b>Acute</b>		
Bleeding	0 (0%)	0 (0%)
Wound infections	1 (5%)	1 (4%)
Oedema	1 (5%)	0 (0%)
<b>Late sequelae</b>		
Granulation	5 (19%)	4 (21%)
Pharyngostoma	0 (0%)	0 (0%)
Flap necrosis	0 (0%)	0 (0%)
Bronchopneumonia	0 (0%)	0 (0%)
Laryngeal stenosis & concrescence	2 (7%)	0 (0%)
No. of complications	9 (35%)	5 (26%)

Tracheotomy was performed intraoperatively in 8 patients undergoing VPL with simultaneous pedunculated flap reconstruction and in 4 patients undergoing VPL without reconstruction. Tracheotomy tubes were removed on day 14 after the surgery. Only 1 patient required the tracheotomy to remain in place due to the experience of dyspnea (Table III).

The total rate of early postoperative complications amounted to 3/45 patients (7%). Cases of wound infection and skin oedema were observed (Table IV). No perioperative deaths occurred. Late sequelae, including inflammatory granulation and laryngeal concrescence and stenosis, were observed in 11



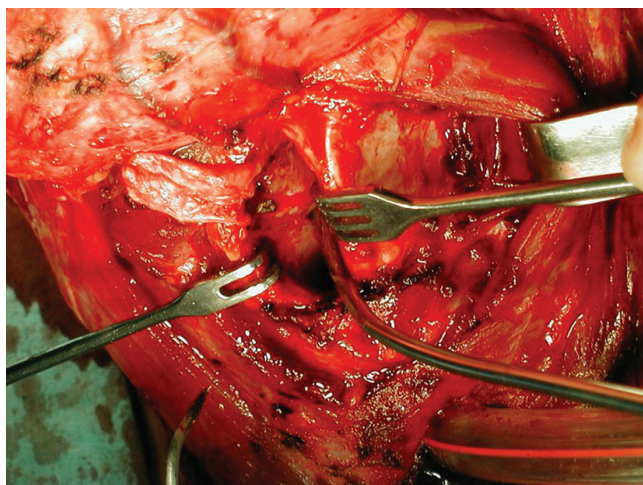


Fig. 1. Vertical thyroectomy.

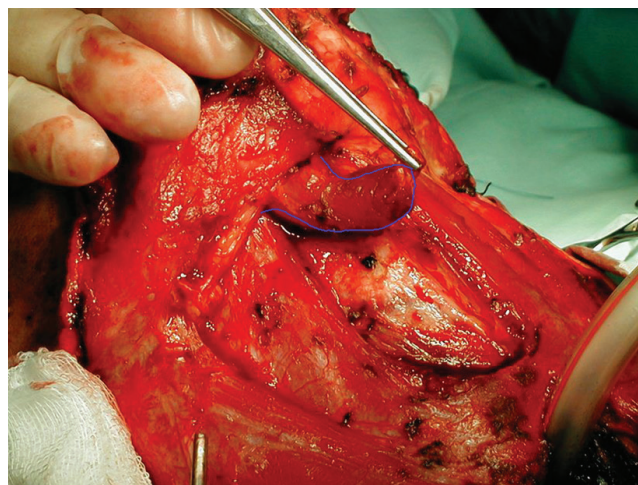


Fig. 2. Myofascial flap.

patients (24%) (Table IV).

## DISCUSSION

The main objective of partial laryngectomy procedures is to ensure radical resection of the tumor while maintaining the primary function of the larynx. Currently, due to the advances in endoscopic methods involving CO<sub>2</sub> lasers being used for the resection of laryngeal tumors as well as to the development of novel radiotherapeutic techniques, frontolateral vertical partial laryngectomy is becoming somewhat less important as the method for the treatment of laryngeal tumors. Still, however, it constitutes an alternative in cases when endoscopic access is impossible and laser surgery cannot be performed. Partial open surgeries ensure broad view of the operated region as well as cancer cell-free resection margins [6, 8, 9, 11–22, 24]. With no doubt, the experience of the team at the site where the surgeries are performed is very important. At the Department of Otorhinolaryngology of the Faculty of Medicine and Dentistry of the Medical University of Warsaw, various types of partial laryngectomies have been performed from external or intralaryngeal access points for nearly 20 years. The site is one of the few Polish centers performing this type of partial laryngectomies making use of external approach and combined with simultaneous reconstruction of the resected tissue with pedunculated sternothyroid muscle flaps. The innovative character of this surgery consists in the use of pedunculated muscle flap along with the perimysium and the fascia surrounding the sternothyroid muscle as a reconstruction material. This solution brings about numerous benefits. Being a connective tissue, the fascia is rich in stem cells that facilitate the remodelling of the flap into a tissue fold structurally similar to the vocal fold



Fig. 3. Glottis - status post-VPL with sternohyoid muscle flap reconstruction of the vocal fold.

[25]. In addition the perimysium and the fascia increase the transplant's resistance to saliva as well as protect the transplant from infection. Moreover, the pedunculated muscle flap acts as a dressing ideally matching the surgical resection site in terms of size and shape. The close proximity between the harvested transplant tissue and the resected region facilitates easy dissection of the flap followed by its implantation in the resection area. Pedunculation ensures appropriate blood supply and reduces the risk of flap necrosis. With no doubt, an advantage of the presented surgical method consists in the ability to simultaneously perform reconstruction of the vocal fold. This facilitates quicker vocal rehabilitation as compared to patients not subjected to reconstruction as well as improves the quality of phonation as demonstrated in a previous study [8]. After healing, the reconstructed vocal fold is placed in the medium position, allowing for partial glottal stop that makes the voice acceptable for patients while preventing them from choking. The larger number of local recurrences observed in patients in the reconstruction group as compared to the non-reconstruction group may be due to the higher local stage of the tumor in patients qualified for the former procedure which requires a larger extent of tissues being resected.

Literature reports different types of laryngeal reconstructions performed simultaneously with partial laryngectomies to replace the resected tumor-infiltrated tissues. Numerous articles describing reconstruction of the glottis using vicinal or distant tissues are available. Most commonly, reconstruction involves the use of closest muscles and tissues. Pressman et al. were the first to describe the method for reconstructing the larynx following partial laryngectomy using infrahyoid muscles i.e. the sternohyoid and sternothyroid muscle. They observed that the close vicinity of the transplanted tissues as well as the high number of vessels ensure good flap engraftment rates [26]. Dursum et al. described a method for reconstructing glottic tissue loss following vertical partial laryngectomy using a platysmal flap in 15 patients with T2 stage glottic tumor. Similar as in the case of patients hospitalized in our Department, the newly formed vocal fold ensured glottal stop without disturbing respiration and swallowing functions [18]. Apostolopoulos et al. described a method for reconstructing glottic tissue loss fol-

lowing vertical partial laryngectomy using superficial cervical fascia in 40 patients with T1-T2 glottic tumor. Nine patients in this group were subjected to adjuvant radiation therapy. Local recurrence was observed in as few as 4 patients while regional recurrence was observed in 2 patients translating into a high (95.1%) 3-year survival rate [14]. Distant oncological outcomes reported by the authors were comparable to these observed at our Department.

Finally, the importance of the qualification of patients for the procedure should also be highlighted. As in all partial laryngectomies, the procedure described herein requires precise preoperative and intraoperative assessment of the anatomy and function of the larynx. The "sociological factor" is also of importance when qualifying patients for the procedure. The term is used to describe the likelihood of patient's compliance in the postoperative period. Besides oncological follow-up, phoniatric rehabilitation is also required in patients who have undergone glottic reconstruction; when properly performed, it facilitates virtually complete restoration of physiological laryngeal function. Collaboration with the phoniatrician is one of the most important elements of the recovery process which starts already long before the surgery itself.

## CONCLUSIONS

Frontolateral vertical partial laryngectomy with or without vocal fold reconstruction using pedunculated sternothyroid muscle flap is an effective method for the treatment of low- and medium-stage laryngeal tumors, particularly when endoscopic access to the tumor is restricted.

- The incidence of local or regional recurrences following the procedure is low.
- The reconstructed vocal fold does not differ macroscopically from a healthy vocal fold.
- Essentially no swallowing problems are observed in patients following the procedure.
- Simultaneous vocal fold reconstruction shortens patient's recovery period and has a positive effect on the quality of phonation.

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