



SURGICAL TREATMENT OF BILATERAL VOCAL FOLD PARALYSIS: A 13-YEAR EXPERIENCE

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SUMMARY – This retrospective study reviewed our 13-year experience in surgical treatment of 19 adults with bilateral vocal fold paralysis (BVFP). Symptoms, etiology and surgical methods were analyzed and compared with current medical literature. The primary complaint in all patients was dyspnea. Dysphonia was present in 58% and dysphagia in 32% of patients. The most common cause of BVFP was thyroidectomy, followed by unknown etiology, stroke and lung cancer, and isolated cases of polytrauma, neck abscess, and bilateral carotid artery operation. Tracheotomy as primary surgical intervention was performed in 58% and transoral endolaryngeal procedure in 42% of patients. Among tracheotomized patients, 64% of them underwent transoral endolaryngeal surgical procedure and 55% were decannulated. The most frequent endolaryngeal surgical procedure was subtotal arytenoidectomy (47%), followed by cordectomy and posterior cordotomy. Twenty-six percent of patients were surgically treated more than once. Objective respiratory, phonatory and swallowing evaluation was not performed routinely. The overall clinical features and surgical treatment of BVFP were in accordance with medical literature. Due to a relatively small number of cases in general population and the lack of comparative studies based on algorithmic approach, there is no clear evidence that one surgical technique is functionally superior to the other.

Keywords: *Bilateral vocal cord paralysis; Recurrent laryngeal nerve palsy; Vocal fold; Thyroidectomy; Cordotomy*

Introduction

Bilateral vocal fold paralysis (BVFP) refers to the neurological causes of bilateral vocal fold immobility caused by reduced or absent function of the vagal nerve or its distal branch, the recurrent laryngeal nerve (RLN)¹. It should be clearly distinguished from paresis since the function, prognosis and treatment greatly differ. Paralysis is total interruption of nerve impulse, resulting in no movement; paresis is partial interruption

of nerve impulse, resulting in weak or abnormal motion of laryngeal muscles². Iatrogenic injury of bilateral RLN during thyroidectomy has been proven to be the

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most common underlying cause of BVFP^{1,3-6}. BVFP is a rare but life-threatening condition that causes significant airway narrowing at the glottis level. BVFP can result in acute respiratory distress necessitating urgent airway intervention, or dyspnea can develop gradually after many years. While the main symptom is dyspnea, the severity of dysphagia and dysphonia may vary^{1,3}.

Depending on the cause of paralysis and location of nerve injury, as well as patient age, nutrition and comorbidities such as diabetes, some patients can experience gradual recovery with synkinetic reinnervation or recovery of purposeful vocal fold motion over a period of several months⁷. There is a scarcity of data on the spontaneous vocal recovery from unilateral vocal fold paralysis, and even less for BVFP. The authors of the first evidence-based projection model for the wait time for recoverable vocal fold paralysis recommended that by 9 months, with the probability of recovery less than 5%, it would be reasonable to pursue long-term interventions⁷.

The primary goal of treatment for BVFP is to secure airway. Depending on the time elapsed from the BVFP onset, there are temporary/reversible or permanent treatment approaches. The most common early reversible surgical intervention is tracheotomy. Vocal fold laterofixation is a simple and temporary treatment of early bilateral vocal fold paresis. Arytenoidectomy and cordotomy are the most common permanent endolaryngeal procedures^{8,9}. Surgical methods of widening the posterior part of vocal fissure are the standard way of treatment for BVFP. By using these surgical techniques, otorhinolaryngologists should establish balance between ventilation and preservation of the laryngeal vocal and protective function^{8,9}. Other therapies that have been used with a varying success include reinnervation techniques and botulinum toxin injections into the vocal fold adductors. Recent studies have focused on neuromodulation, laryngeal pacing, gene therapy, and stem cell therapy. These new technologies intend to avoid damage to the laryngeal voicing mechanism and to restore some physiological movement of the affected vocal folds⁸⁻¹¹.

Currently, there is no clear evidence that one surgical technique is functionally superior to the other, due to a relatively small number of cases in general population and the lack of comparative studies based on standardized algorithmic approach protocols⁸.

We present our 13-year experience in surgical treatment of BVFP.

Materials and Methods

This retrospective study included all patients surgically treated for BVFP from 2007 until 2020 at the Department of Otorhinolaryngology and Head and Neck Surgery, Zagreb University Hospital Center. Patient data were collected from hospital information system and included patient age and sex, etiology of vocal fold paralysis, symptoms, time elapsed from BVFP diagnosis to surgical treatment, primary surgical treatment, and number and type of reoperations. Patients with BVFP treated with other than surgical methods were not included in the study. Data analysis included only descriptive statistical methods, with continuous variables presented as median and range, and categorical variables as percentages.

Results

During a 13-year period, 19 patients were surgically treated for BVFP at the Department of Otorhinolaryngology and Head and Neck Surgery, Zagreb University Hospital Center. Median patient age at first surgical treatment was 62.5 (range 36-75) years. There were 11/19 (58%) female and 8/19 (42%) male patients.

Thyroidectomy was the most common cause of BVFP, recorded in 10/19 (52%) patients, followed by stroke and metastatic lung cancer in 2/19 (11%) patients. In addition, the etiology of BVFP was unknown in 2/19 (11%) patients. Another 3 patients had BVFP due to polytrauma, neck abscess or bilateral carotid artery operation (Fig.1).

In all patients surgically treated for BVFP, the primary complaint was dyspnea that included stridor, intolerance of supine position, and aggravation of symptoms during even slight physical exertion. Dysphonia was the presenting complaint in 11/19 (58%) and dysphagia in 6/19 (32%) patients. Objective respiratory, swallowing and phonatory evaluations and self-evaluation questionnaires were not performed routinely either preoperatively or postoperatively.

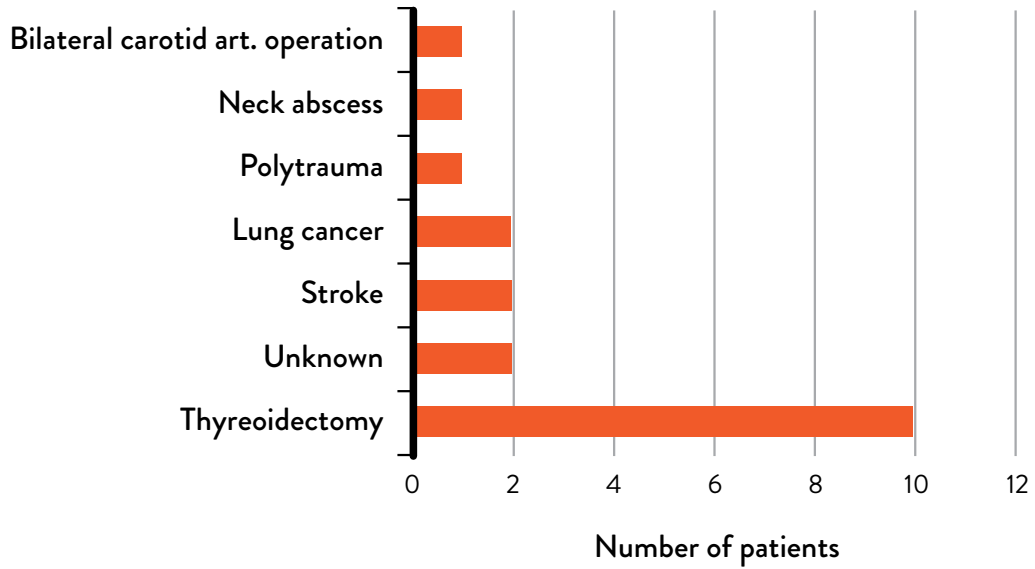


Fig. 1. Etiology of bilateral vocal fold paralysis.

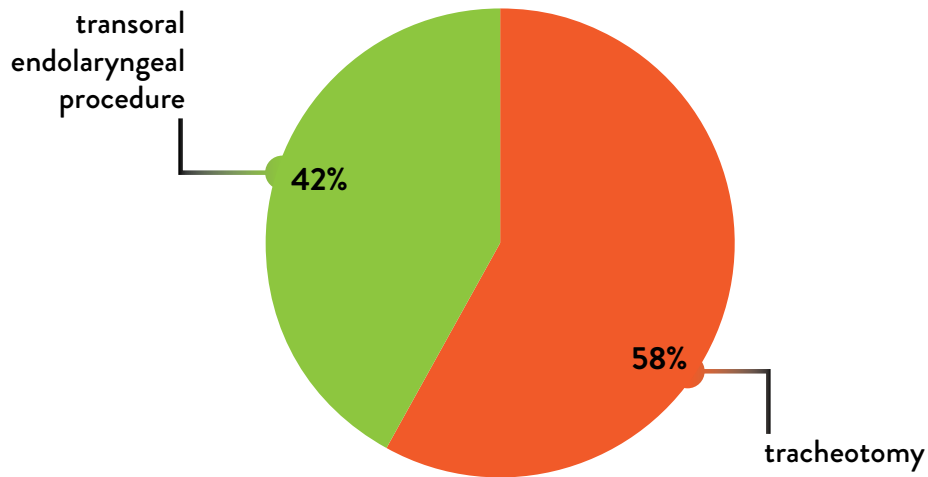


Fig. 2. Distribution of primary surgical interventions for treatment of bilateral vocal fold paralysis.

At the time of presentation, the severity of dyspnea differed among patients. In 4/19 (21%) patients, severe dyspnea developed immediately after thyroidectomy, and patients underwent emergency tracheostomy. In 5/19 (26%) patients, severe dyspnea developed 10 and more years after BVFP diagnosis.

Tracheotomy as primary surgical intervention was performed in 11/19 (58%) and transoral endolaryngeal surgery in 8/19 (42%) patients (Fig. 2). Out of 11 tracheotomized patients, 7/11 (64%) patients underwent transoral endolaryngeal surgical procedure, 6/11 (55%) patients were decannulated, 2/11 (18%) patients died

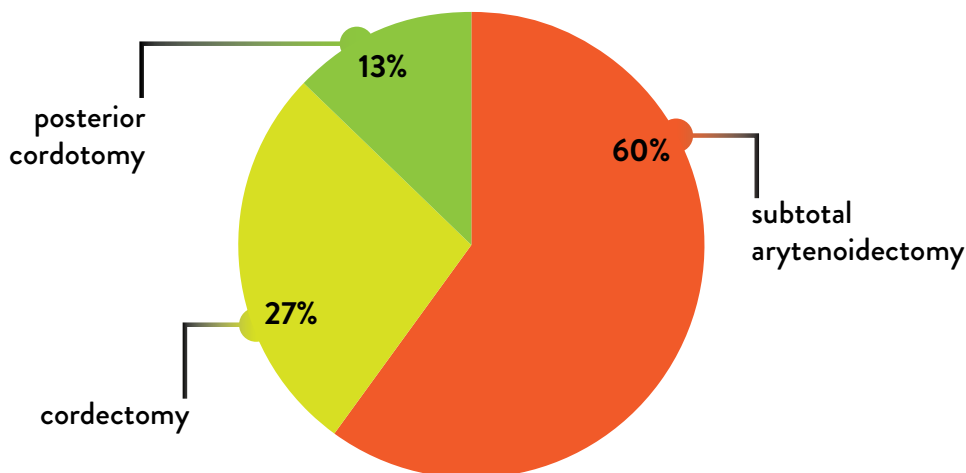


Fig. 3. Distribution of transoral endolaryngeal surgical interventions for treatment of bilateral vocal fold paralysis.

several months after tracheotomy, and 3/11 (27%) patients did not meet the criteria for decannulation even after endolaryngeal procedures.

The most frequent endolaryngeal surgical procedures were subtotal arytenoidectomy, performed in 9/15 (47%) patients, followed by cordectomy and posterior cordotomy (Fig. 3). Although different surgeons performed endolaryngeal procedures, they did not combine surgical procedures during the first endolaryngeal treatment in order to gain airway competency and to preserve protective and phonation laryngeal function as much as possible. All permanent transoral endoscopic laryngeal procedures were performed using carbon dioxide (CO₂) laser *via* the micromanipulator in intubated patients under general anesthesia.

Median time from the onset of paralysis to tracheotomy was 2 (range 1-60) days, and median time from the onset of paralysis to permanent transoral endolaryngeal procedure was 9 (range 6-180) months.

Postoperative antibiotics and proton pump inhibitor were not administered routinely. In 5/19 (26%) patients, transoral endolaryngeal procedure was performed more than once. Two patients with BVFP due to thyroidectomy underwent ipsilateral cordectomy after subtotal arytenoidectomy. One patient underwent subtotal arytenoidectomy 7 months after polytrauma, but airway competency was established only after both left and then right total arytenoidectomy. Two

patients with BVFP required 4 surgical procedures. One of them had BVFP of unknown etiology. She was initially treated with left posterior cordotomy. Second operation included left cordectomy and bilateral resection of ventricular folds. On third occasion, the patient underwent revision of left cordectomy and left arytenoidectomy, and the fourth procedure included right arytenoidectomy and right partial cordectomy. Another patient had post-thyroidectomy BVFP; after right subtotal arytenoidectomy, she underwent right posterior cordotomy, then right cordectomy, and finally after the fourth procedure, i.e., left posterior cordotomy, the patient was relieved of dyspnea.

Discussion

The primary cause of BVFP is post-surgical nerve injury, and although number of head and neck surgical procedures, especially thyroidectomies, raises each year, it is still a rare complication. BVFP is predominantly present in adults with a history of thyroid surgery, as seen in this study^{1,3-6}. In our study, most of the patients developed BVFP after thyroid surgery, followed by lung cancer, stroke, and unknown etiology. Brake *et al.* also showed that idiopathic BVFP represented a significant minority of adult BVFP. Benninger *et al.* estimated that the cause of BVFP was surgical trauma

in 44%, malignancy in 17%, endotracheal intubation in 15%, neurological disease in 12%, and idiopathic causes in 12% of cases^{1,12}.

At the time of presentation, the severity of dyspnea differed among our patients from immediate postoperative severe dyspnea that required emergency tracheotomy to dyspnea that developed 15 years after BVFP identification. RLN lesion affects both abduction and adduction. Since adductor muscle fibers are four times greater than abductor muscle fibers, the vocal folds may be located in the median or paramedian position right after the lesion¹³. However, the location can also change over time depending on reinnervation, synkinesis, atrophy, and fibrosis of denervated laryngeal muscles. Previous studies have shown that respiratory difficulties can occur years after BVFP was diagnosed¹⁴.

The primary aim of BVFP surgical treatment is to ensure breathing, and each technique mentioned above has its advantages and disadvantages.

In our study, tracheotomy was the most common procedure performed in patients with BVFP in an early period, mostly immediately after the onset of BVFP. Tracheotomy provides the greatest airway diameter and preserves the laryngeal structure. It provides several advantages such as immediate relief of dyspnea, easier pulmonary hygiene, improved patient comfort and better ventilation, and it can be reversible¹⁵. Despite being very effective, tracheotomy is associated with significant chronic care burden, cost, psychosocial impairment, and increased mortality¹⁵⁻¹⁷. Patients experience a reduced quality of life and must undergo continuous management of their tracheostomies¹⁵⁻¹⁷. Naunheim *et al.* report that endoscopic surgical interventions are more cost-effective compared to tracheotomy in the management of permanent BVFP¹⁸. Still, tracheotomy is a life-saving procedure for patients with acute airway obstruction.

Since the beginning of the 20th century, numerous operative techniques for treating BVFP have been published in the literature, indicating the lack of one effective method. They all have the ability to produce permanent changes of the larynx that may cause lifelong aspiration and dysphonia. In order to ensure breathing and preserve protective and phonatory laryngeal functions, modifications of surgical techniques are constantly reported, differing in location

and extent of resection from localized cordotomies to extended arytenoid cartilage resections. All surgical techniques strive to enlarge posterior 1/3 of the rima glottidis area, the respiratory segment, and preserve anterior 2/3 of the vocal folds, the phonatory segment^{7-9,16}.

In this study, subtotal arytenoidectomy was the most frequent permanent surgical procedure, followed by cordectomy and posterior cordotomy. All permanent surgical procedures were performed in a period not less than 6 months after the onset of BVFP. Permanent surgical solutions can be divided into conservative procedures such as transverse cordotomy and medial or subtotal arytenoidectomy, and a radical procedure such as total arytenoidectomy. Arytenoidectomy is an irreversible surgical technique whereby the laryngeal inlet is extended in its transverse diameter, providing a larger airway for breathing. Arytenoidectomy is commonly performed with a CO₂ laser. The main advantage of arytenoidectomy is effective treatment of dyspnea. The main disadvantages are frequent granuloma formation, aspiration, and permanent voice change¹⁹⁻²¹. Cordotomy is a permanent technique providing a larger airway for breathing. It can be combined with arytenoidectomy and also performed with a CO₂ laser. It is more cost-effective than tracheotomy and is less associated with food and liquid aspiration. This method is precise, provides good hemostasis, and causes less intraoperative edema. However, the techniques are not ideal, as they may lead to the development of granulation tissue, adhesions, vocal deterioration, dysphagia, aspiration, and inflammation of the cricoid cartilage perichondrium^{16,22,23}. These complications usually require revision surgery and a combination of different endolaryngeal surgical procedures. Among our patients, revision surgery was required in 26% of patients. Unfortunately, due to a small number of cases, it is hard to conclude what is the cause of complication, whether some patients are more prone to granulation formation or endolaryngeal stenosis, or surgical procedure was inadequate, etc.

Laterofixation of arytenoid was not performed in our study population. Laterofixation of the arytenoid and/or the attached vocal fold using a combination of endoscopic and external means has emerged as an alternative surgical approach for BVFP²⁴. In recent years, it has been performed in adult and pediatric patients

with good results^{25,26}. Laterofixation is a temporary, reversible procedure that improves airway function, it can be combined with other surgical procedures mentioned above, and is related to better voice quality and lesser revision rate. The main complications are dysphagia and aspiration²⁷⁻²⁹.

New technologies intend to preserve the laryngeal voicing mechanism and to restore some physiological movement of the affected vocal folds. Some other techniques that have been used are lateralizing the vocal cord with biological substance such as botulinum toxin (Botox) and recurrent laryngeal nerve re-innervation. Both techniques have uneven and varying success reported^{30,31}. Botox injections are a temporary, short-term but less invasive method with no impact on voice or swallowing. On the other hand, there is not enough human trials and repeated injections are often required^{32,33}. One of the most promising procedures for patients with non-atrophic muscles is laryngeal nerve reinnervation. This method leads to potential diaphragmatic paralysis³⁴. Patients with non-atrophic muscles can be treated with laryngeal pacing. This method improves ventilation better than any other approach and has no influence on voice or swallowing³⁵. It is still experimental, and so are neuromodulation, gene and stem cell therapy^{35,36}.

Although some of our patients complained of dysphagia and dysphonia, standardized and routine voice and swallowing evaluation was not performed, either preoperatively or postoperatively. The objectification of voice and swallowing problems was not performed routinely because dyspnea was such an important problem that voice and swallowing problems were of secondary concern and did not demand immediate action; also, most of the times, instrumental methods or experts were not available at the moment of patient admission to the department. Functional analysis concerning voice, swallowing and respiratory parameters is crucial in objectification of functional surgical outcomes, although there is still no international standardized protocol on respiration and swallowing evaluation. Preoperative and postoperative evaluation available to assess airway function includes physical examination with endoscopy, pulmonary function testing, sleep studies, and validated quality of life questionnaires. Some studies showed higher correlation of body plethysmography (airway resistance) to the

patient perception of breathlessness than spirometry measurements (ratio of forced expiratory flow at 50% to forced inspiratory flow at 50% and peak inspiratory flow)³⁷. The four most common approaches for clinical voice evaluation are auditory perceptual assessment of voice quality, acoustic assessment of voice sound production, aerodynamic assessment of subglottal air pressures and glottal airflow rates during voicing, and endoscopic imaging of vocal fold tissue vibration³⁸. The most known methods used to assess swallowing difficulties are the self-evaluation dysphagia questionnaires, clinical evaluation of swallowing, instrumental tests of video-fluoroendoscopy and swallowing video-endoscopy. Although the risk of aspiration is higher in patients with BVFP due to upper esophageal sphincter dysfunction and raises with glottal insufficiency after endolaryngeal surgical procedures, only a few studies included swallowing evaluation as part of diagnostic protocol, mostly using self-evaluation questionnaires and clinical scale^{9,39}.

Conclusion

The overall clinical features and surgical treatment of BVFP were in accordance with medical literature. Due to the relatively small number of cases in general population and the lack of comparison studies under universal protocols, there is no clear evidence that one surgical technique is functionally superior to the other. Future studies should provide a standardized framework for clinical evaluation of abnormal voice quality, swallowing, and respiratory difficulties preoperatively and postoperatively in order to objectify functional surgical outcomes.

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Sažetak

KIRURŠKO LIJEČENJE OBOSTRANE PARALIZE GLASNICA: TRINAESTOGODIŠNJE ISKUSTVO

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Ovim retrospektivnim istraživanjem prikazali smo naše trinaestogodišnje iskustvo kirurškog liječenja obostrane paralize glasnica u odraslih. Od 2007. do 2020. prikupili smo podatke 19 bolesnika te analizirali i usporedili simptome, etiologiju i kirurške metode s aktualnom medicinskom literaturom. Vodeći simptom svih bolesnika bila je dispneja. Disfonija je bila prisutna u 58%, a disfagija u 32% bolesnika. Najčešći uzrok obostrane paralize glasnica bila je tireoidektomija, zatim slijedi moždani udar, rak pluća i paralize nepoznate etiologije te izolirani slučajevi uslijed politraume, apscesa vrata i obostranog kirurškog zahvata na karotidnim arterijama. Kao primarna kirurška intervencija traheotomija je učinjena u 58%, a transoralni endolaringealni kirurški postupak u 42% bolesnika. Od 11 traheotomiranih bolesnika, 64% ih je naknadno liječeno endolaringealno, a 55% ih je dekanilirano. Najčešći endolaringealni kirurški zahvat bila je subtotalna aritenoidektomija (47%), a zatim slijede kordektomija i stražnja kordotomija. Dvadeset i šest posto bolesnika liječeno je kirurški više puta. Objektivna procjena respiracije, fonacije i gutanja nije rađena rutinski. Sveukupne kliničke značajke i kirurško liječenje obostrane paralize glasnica bolesnika u našem istraživanju bilo je u skladu s medicinskom literaturom. Zbog malog broja slučajeva obostrane paralize glasnica u općoj populaciji i nedostatka usporednih studija prema univerzalnim protokolima nema jasnih dokaza da je jedna kirurška tehnika funkcionalno superiornija drugoj.

Ključne riječi: Obostrana paraliza glasnica; Ozljeda povratnog laringealnog živca; Glasnica; Kordotomija; Tireoidektomija