Bilateral vocal fold paralysis: causes and treatment – 12 years' experience

Original Article

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Abstract

Aim: To analyse the cases of bilateral vocal fold paralysis (BVFP) diagnosed by the ENT department at Hospital Garcia de Orta. To emphasize rare causes of this entity and its treatment.
Study design: Retrospective study of BVFP cases diagnosed between January 2011 and December 2022.
Materials and methods: Inclusion criteria: diagnosis of BVFP by an ENT with videonasolaryngoscopy documentation. Patients with pharyngolaryngeal neoplasia and insufficient records were excluded.
Results: 109 patients were diagnosed with BVFP. The mean age at diagnosis time was 67 years. The presenting symptoms were: acute high dyspnoea in 92.7%, dysphonia in 19.3% and dysphagia in 7.3%. Rare causes were diagnosed: degenerative neurological diseases, neoplasms (thymus, oesophagus, lung, central nervous system), newly brain metastasis, hypocalcaemia, hypothyroidism, neurosyphilis, acute hepatitis B, meningitis and rheumatoid arthritis. 78% patients were approached surgically: tracheostomy, posterior cordotomy using LASER® and vocal cord lateralization.
Conclusions: The etiological investigation with imaging exams and analytical evaluation allowed the diagnosis of rare causes of BVFP. In some cases, correction of the underlying cause has allowed reversion of vocal fold paralysis.

Keywords: Bilateral vocal fold paralysis; rare causes stridor; hypocalcaemia; hypothyroidism; neurosyphilis; posterior cordotomy; tracheostomy.

Introduction

The paralysis of one or both vocal folds affects all physiological laryngeal functions, including respiratory, sphincter, and phonatory functions. Unilateral paralysis typically presents with varying levels of glottic insufficiency, with the most prevalent symptoms being dysphonia, characterized by a breathy voice, and dysphagia for liquids. Bilateral vocal fold paralysis (BVFP) frequently causes airway obstruction, leading to symptoms such as stridor and severe

dyspnea. The primary objective of BVFP treatment is to restore airway patency, while trying to limit the negative effects of the treatment on vocal quality[1]. Theoretically, any pathological condition capable of causing unilateral vocal fold paralysis can cause BVFP, which has two main etiologies: peripheral nerve damage and functional impairment due to neurological diseases. Thyroidectomy is the most common surgical cause of recurrent laryngeal nerve damage[2], but any surgery involving a cervicotomy or damage to the mediastinal path of the recurrent laryngeal nerves has a risk, including carotid endarterectomy, esophagectomy, tracheal resection, thymectomy, and other mediastinal procedures. Tracheal, esophageal, and thyroid neoplasms and cervical radiotherapy can also cause BVFP. In addition, systemic neurological diseases have been consistently reported as causes of peripheral damage to the recurrent laryngeal nerves. Some examples include amyotrophic lateral sclerosis, Charcot-Marie-Tooth disease, Arnold-Chiari malformation, Guillain-Barré syndrome, Parkinson's disease, and bulbar poliomyelitis[2,3]. A more common cause of BVFP is brainstem stroke; metabolic, inflammatory, and infectious diseases (syphilis, acquired immunodeficiency syndrome) can also cause BVFP. Finally, according to the literature, vocal fold paralysis may have an idiopathic etiology in 10–27% of cases[4].

The diagnosis is therefore based on a detailed clinical history along with an objective examination and laryngeal endoscopy or electromyography; however, some cases may require laryngeal microsurgery to assess the mobility of the cricoarytenoid joint by palpation. The clinical presentation of BVFP varies according to the time of onset, with some patients unexpectedly adapting to the reduced glottic space when the paralysis is due to a progressive neurological disease, becoming more symptomatic as the underlying disease progresses. According to previous studies, 4–14% of patients tolerate BVFP without requiring surgery, with the tolerance influenced mainly by the body weight, physical activity, and presence of other comorbidities[1,2]. Acute severe dyspnea and stridor are the main symptoms in case of sudden onset, typically requiring emergency tracheostomy or other procedures to enlarge the glottic lumen. The treatment of BVFP varies and should be adapted to each patient, since no standard protocol has been established yet. This study aimed to describe the treatment modalities implemented at the otorhinolaryngology service of the Hospital Garcia de Orta over the last 12 years, in addition to highlighting rare causes of BVFP.

Materials and methods

This retrospective study evaluated patients diagnosed with BVFP between January 2011–December 2022 at the otorhinolaryngology service of Hospital Garcia de Orta.

The department of statistics of the Hospital Garcia de Orta provided access to the BVFP Diagnosis Related Group (DRG) for initial patient selection. The data were collected from the patients' electronic medical records and included age, sex, clinical presentation, etiology, concomitant pathologies, laryngoscopic changes, analytical and imaging evaluation, treatment, and results. The inclusion criteria were a diagnosis of BVFP, age over 18 years, otorhinolaryngologic evaluation, and videolaryngoscopy report. The exclusion criteria were laryngopharyngeal cancer, unilateral vocal fold paralysis, lack of etiological investigation, or insufficient clinical data.

A review of the medical literature on the etiology and recommended treatment for BVFP was conducted using the PubMed database. This study primarily aimed at identifying the causes of BVFP, highlighting the importance of ruling out rare etiologies before considering an idiopathic etiology, as well as establishing a diagnostic algorithm. The secondary objective was to evaluate the outcomes of different therapeutic approaches in our study population compared to those published in the literature.

Results

A total of 109 patients met the inclusion criteria (Table 1). The average age at diagnosis was 67 years, with a standard deviation (SD) of ± 16 years, median of 69 years, maximum age of 92 years, and minimum age of 19 years. The sample had a homogeneous distribution between sexes, comprising 50.5% women and 49.5% men. The initial symptoms included acute severe dyspnea in 92.7% of cases (dyspnea in 52.3% and stridor in 40.4%), dysphonia in 19.3%, and dysphagia in 7.3%.

Among the 109 patients included in the study, 20.9% cases of BVFP were related to stroke, 9.2% were due to surgical trauma during total thyroidectomy, 9.2% were attributable to respiratory infection, and 7.4% were considered idiopathic (Table 2). Table 3 lists the least common causes of BVFP described in the literature, including degenerative neurological diseases, neoplasms (thymus, esophagus, lung, central nervous system), de novo brain metastasis, large thyroid mass, calcium metabolism disorders, hypothyroidism, neurosyphilis, acute hepatitis B, meningitis, and rheumatoid arthritis. In patients with metabolic diseases (hypocalcemia, n = 2; hypothyroidism, n = 2), BVFP was reversed after treatment of the underlying pathology. One of the patients with hypothyroidism required a temporary tracheostomy, with subsequent decannulation. Regarding the infectious causes, a patient initially diagnosed with acute hepatitis B (n = 1) required a tracheostomy until BVFP reversal. One of the patients with neurosyphilis (n = 2) required a tracheostomy followed by posterior cordotomy for BVFP reversal. In cases of de novo BVFP, the etiology must be thoroughly investigated because the prognosis will be influenced by the underlying disease[3]. Table 4 presents the battery of tests required to investigate de novo BVFP.

A total of 85 patients (78%) were treated surgically, 77 of them for airway maintenance. One patient who underwent esophagectomy had dysphonia and dysphagia due to BVFP in abduction, and required type I thyroplasty. Patients operated to resolve acute high dyspnea underwent tracheostomy (90.5%, n = 77), CO_2 laser® posterior transverse cordotomy (4.7%, n = 4), and Lichtenberger's vocal fold lateralization (3.5%, n = 3).

Notably, 29% of tracheostomies were performed for BVFP after a stroke. Among the patients who underwent a tracheostomy, 24.7% had BVFP reversal with subsequent decannulation; 43.8% died with the tracheostomy tube, which explains the relatively low decannulation rate; and 28.8% did not meet criteria for tracheostomy weaning, six of them undergoing a second surgical intervention (26%)

Table 1
Characteristics of the study population

Final population	n=109
Age (on the day of diagnosis)	
Mean Median Minimum Maximum	67 (SD +/- 16) anos 69 anos 19 anos 92 anos
Sex	
Female Male	50,5% 49,5%
Symptoms	
Severe dyspnea Dysphonia Dysphagia	92,7% 19,3% 7,3%

Table 2
Common etiologies of Bilateral Vocal Fold Paralysis (BVFP)

Frequent causes described in the literature	Cases in the study population percentage/number of cases
Stroke	20,9% (n=25)
Surgical trauma due to total thyroidectomy	9,2% (n=10)
Respiratory infections	9,2% (n=10)
Idiopathic	7,3% (n=8)

Table 3
Rare causes of Bilateral Vocal Fold Paralysis (BVFP)

Frequent causes described in the literature	Cases in the study population percentage/number of cases
Metabolic	
Hypocalcemia	1,83% (n=2)
Hypothyroidism	1,83% (n=2)
Psychotropic-induced poisoning	0,9% (n=1)
Autoimmune	
Rheumatoid arthritis	0,9% (n=1)
Infectious	
Neurosyphilis	1,83% (n=2)
Acute hepatitis B	0,9% (n=1)
Meningitis	0,9% (n=1)
Others	
Subglottic stenosis	0,9% (n=1)
Sickle cell disease/vaso-occlusive crisis	0,9% (n=1)
Central nervous system	
De novo brain metastasis (breast or prostate cancer)	2,75% (n=3)
Degenerative neurological diseases	11,9% (n=13)
Multiple system atrophy (4)	
Parkinson's disease (3)	
Multiple sclerosis (2)	
Progressive cerebellar atrophy (2)	
Motor neurone disease (2)	
Central nervous system tumors:	4,6% (n=5)
Meningioma (3)	
Glioblastoma (1)	
Pineal germinoma (1)	
Cerebral hematoma	1,83% (n=2)
Subarachnoid hemorrhage	1,83% (n=2)
Cervical/neck pathology	
Thyroid neoplasm (large thyroid mass)	1,83% (n=2)
Cervical chordoma	0,9% (n=1)
Spinal cord trauma with C7 injury	1,83% (n=2)
Thoracic/mediastinal pathology	
Mediastinal mass	1,83% (n=2)
Thymic carcinoma	0,9% (n=1)
Esophageal carcinoma	3,67% (n=4)
Inoperable (2)	
Undergoing thoracic surgery (2)	
Cardiomegaly and decompensated heart failure with pulmonary hypertension	0,9% (n=1)
Lung tumor	5,5% (n=6)

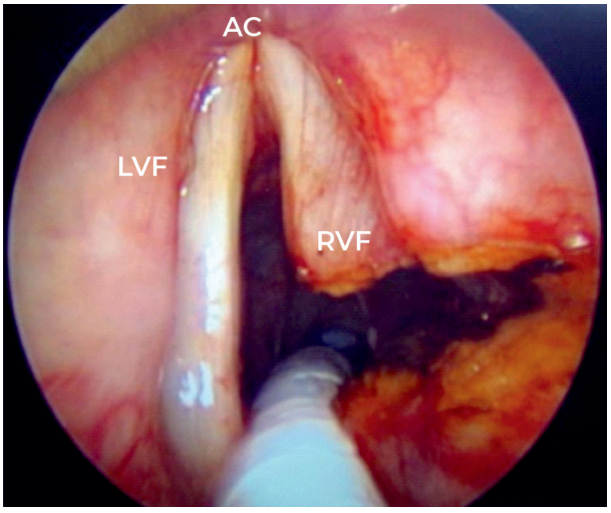
(CO_2 laser® posterior transverse cordotomy, n = 4; and Lichtenberger's vocal fold lateralization, n = 2) to enlarge the glottic lumen, thus maintaining the airway patency. Posterior transverse cordotomy is a surgery performed using microsuspension laryngoscopy, with the vocal folds in the median or paramedian position to enlarge the glottic space[5] (Figure 1). It involves making an incision in the posterior portion of the vocal fold, ligament, and muscle. This procedure was performed in patients with BVFP after thyroid surgery, as well as in two patient with BVFP due to rheumatoid arthritis and neurosyphilis, respectively.

Lichtenberger's vocal fold lateralization is a reversible intervention that involves a

Table 4
Etiological investigation of Bilateral Vocal Fold Paralysis (BVFP)

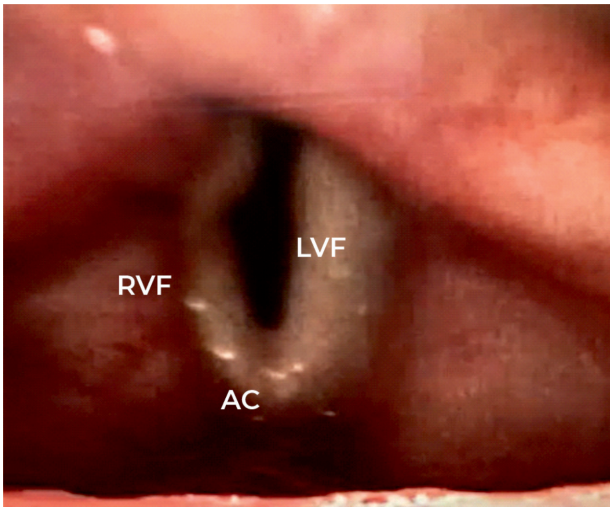
Complementary diagnostic test	Description
Flexible/rigid laryngoscopy	Conducted during the appointment. Evaluates vocal fold mobility and laryngeal lesions affecting mobility.
Analytical evaluation	Rules out metabolic or infectious etiologies. Complete blood count, erythrocyte sedimentation rate, antinuclear antibodies (ANA), antineutrophil cytoplasmic antibodies (ANCA). Blood glucose; serum calcium, sodium, and potassium levels; and thyroid function (thyroid-stimulating hormone [TSH], triiodothyronine [T3], thyroxine [T4]). Syphilis serology (Treponema pallidum hemagglutination assay [TPHA], rapid plasma reagin [RPR]), Hepatitis B and C, human immunodeficiency virus (HIV), and Lyme disease (Borrelia burgdorferi IgG and IgM).
Computed tomography	Brain, neck, and chest. Evaluates the presence of lesions or masses injuring or compressing the vagus or recurrent laryngeal nerves.
Laryngeal electromyography	Evaluates the innervation of the laryngeal muscles and predicts the potential for recovery after neurological injury.
Other complementary tests	Upper gastrointestinal endoscopy, magnetic resonance imaging.

Figure 1
Intraoperative image of a patient undergoing CO2 laser® posterior transverse cordotomy



Legend: AC,anterior commissure; RVF, right vocal fold; LVF, left vocal fold.

Figure 2
Postoperative outcome (videolaryngoscopy) of a patient undergoing right Lichtenberger's vocal fold lateralization



Legend: AC,anterior commissure; RVF, right vocal fold; LVF, left vocal fold.

combined endoscopic and cervical approach aimed at enlarging the glottic space. In this procedure, an incision is made in the neck skin[6] and one of the vocal folds is lateralized using a nonabsorbable suture fixed externally to the sternohyoid muscle, after an incision is made in the neck skin (Figures 2 and 3). This procedure was performed in patients with BVFP after thyroid surgery. Table 5 shows the outcomes of patients who underwent CO_2 laser® posterior transverse cordotomy, with 75% achieving a patent airway (50% with

Figure 3
Cervical approach with left Lichtenberger's vocal fold lateralization by external fixation to the sternohyoid muscle

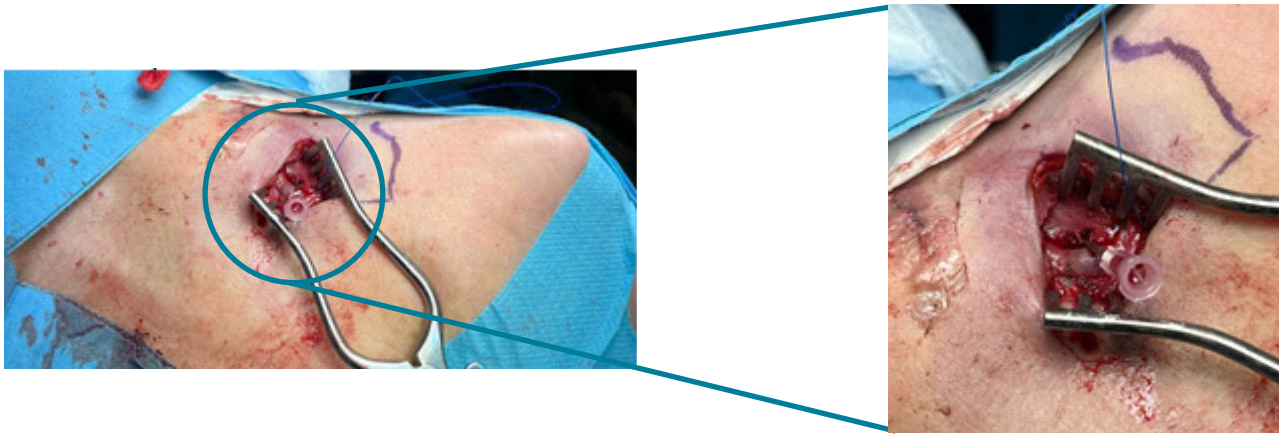


Table 5
Bilateral Vocal Fold Paralysis (BVFP) surgical methods and outcomes

Surgical method	Results
CO2 laser® posterior transverse cordotomy	75% achieved a patent airway 50% achieved satisfactory glottic space 25% required tracheostomy maintenance
Lichtenberger's vocal fold lateralization	100% achieved a patent airway 80% achieved satisfactory glottic space 100% achieved decannulation after tracheostomy 100% without dysphagia

satisfactory glottic space) and 25% (n = 2) still requiring a tracheostomy, one case due to anterior vocal fold synechia and the other due to insufficient glottic space. All patients (100%) undergoing Lichtenberger's vocal fold lateralization achieved airway patency (80% with satisfactory glottic space), and were subsequently decannulated (Table 5). None of the patients developed dysphagia as a complication of the surgical approach.

Discussion

BVFP is usually caused by a lesion or compression of the recurrent laryngeal nerve or vagus nerve along their course through the jugular foramen, neck, and mediastinum. It can also result from lesions of the lower motor neuron originating from the nucleus ambiguus of the medulla oblongata. Since the muscles responsible for vocal fold mobility are regionally represented within the nucleus ambiguous, an injury in this area can lead to paralysis similar to that caused by recurrent laryngeal nerve section[7]. The average age of BVFP onset in our sample was 67 years, corroborating with that in the literature, which reports a higher incidence between the fifth and sixth decades of life[8]. The clinical presentations also align with those in the published data, with severe dyspnea and dysphonia being the most common symptoms[2,7] and dysphagia being a possible symptom[2,8]. Stroke was the most common cause of BVFP in our study sample, followed by neurodegenerative diseases and recurrent laryngeal nerve trauma after thyroidectomy. This contrasts with the findings of previous studies, which report postoperative trauma as the main cause of BVFP[2]; however, it exhibits a downward trend due to the increase in malignant causes of BVFP.

We also reported rare cases of BVFP secondary to calcium metabolism and thyroid function disorders. Hypocalcemia increases neuromuscular irritability and can lead to paresthesia, muscle spasm, or even

laryngospasm. Laryngeal stridor may be one of the first symptoms of hypocalcemic tetany[9]. Previous studies have associated BVFP due to thyroid function disorders with acute thyroiditis[10,11], but in our study, BVFP was associated with hypothyroidism, with resolution after levothyroxine therapy. This may be because hypothyroidism causes peripheral neuropathy or tissue edema, although no causal relationship was found in the literature[10,11].

Epstein-Barr, varicella-zoster, herpes simplex, hepatitis, and HIV are some of the viruses that have been associated with the onset of vocal fold paralysis[12–14]. Although the pathophysiology of this association is not fully known, it has been related to neuritis, which may be caused by direct inflammation and infection of the nerve or a nonspecific inflammatory response that secondarily involves the nerve[14] .

Syphilis is a sexually transmitted bacterial infection that has a multisystemic presentation that rarely involve the larynx[15]. Neurosyphilis, the tertiary stage of the disease, presents with neurological symptoms such as confusion, delirium, and headache[16], and can lead to paralysis of the cranial nerves, particularly the recurrent laryngeal nerve.

Meningitis can cause paralysis of the cranial nerves, most commonly affecting the vestibulocochlear, trochlear, and oculomotor nerves. It rarely causes BVFP due to involvement of the vagus nerve, but a few cases have been reported in the literature[17] and one case was identified in our sample.

Rheumatoid arthritis is an autoimmune disease characterized by articular and extra-articular presentations. It can affect the cricoarythnoid joint, leading to synovial membrane inflammation, joint damage, and bone destruction. The involvement of this joint results in symptoms of varying severity, ranging from dysphonia to stridor and dyspnea associated with BVFP[18].

Previous studies have reported cases of BVFP associated with vaso-occlusive crisis in patients with sickle cell disease. In our study, one patient with BVFP had this condition, as hypoxemia caused by a vaso-occlusive crisis can present with respiratory and neurological symptoms [19].

Central nervous system diseases can lead to BVFP associated with upper motor neuron disorders[8,20]. Multiple system atrophy is a progressive adult disease characterized by any combination of dysautonomia, parkinsonism, and ataxia not related to medications or other known pathologies. In a more advanced stage, it can lead to laryngeal dysfunction and BVFP, usually in the paramedian position[20].

In contrast to our study, the medical literature[2] attributes most cases of BVFP to surgical trauma, mainly as a complication of thyroid, cardiac, or esophageal surgery. Nerve injury mechanisms include thermal damage, stretching, section, or compression[21]. Similarly, cervical-mediastinal neoplasms or masses (thyroid, thymus, heart, lung, esophagus) can also stretch or compress the recurrent laryngeal nerves, resulting in BVFP[22].

The most common surgical procedures to enlarge the glottic lumen are the removal of laryngeal tissue (arytenoidectomy, cordotomy) or displacement of anatomical structures (vocal fold lateral fixation, arytenoid abduction). Other techniques such as botulinum toxin injections, reinnervation, or laryngeal stimulation cay be indicated in the presence of concurrent laryngeal synkinesis[4,23].

BVFP often results from neuropraxia of the recurrent laryngeal nerve, with possible regeneration when the nerve is not sectioned[23,24]. BVFP reversal is unanimously considered possible within 6–12 months, with permanent paralysis after this period[24]. Consequently, definitive surgical interventions such as CO_2 laser® posterior transverse cordotomy are postponed until 12 months, when the possibility of functional reinnervation is ruled out[23–25].

Lichtenberger's vocal fold lateralization is a reversible procedure that enlarges the glottic lumen in cases of BVFP in adduction. It can be performed at the time of diagnosis and may prevent the need for a tracheostomy in some cases[6,7,23,24]. The optimal time to perform this

procedure is within six months, after which its effectiveness may decrease due to reduced lateral mobilization[23,24]. In case of BVFP recovery, the sutures that lateralize the vocal fold can be easily removed[6,23,24]. If the BVFP becomes permanent, the patient can still undergo a definitive surgical technique[23,25].

At our institution, the most common procedures to enlarge the glottic lumen are CO_2 laser® posterior transverse cordotomy and Lichtenberger's vocal fold lateralization. The main disadvantage of cordotomy is that it affects the vocal quality, despite excellent results in maintaining glottic patency, consequently preventing prolonged tracheostomy. Its other advantages include being a simple and short procedure with satisfactory outcomes, reduced risk of complications, and an easy second surgery if necessary[21,25]. In our study population, decannulation failed in 25% of patients undergoing CO_2 laser® posterior transverse cordotomy, a percentage slightly higher than that reported in the literature. Studies by Dennis and Kashima, Ferri et al., Reker and Rudert, Manolopoulos et al., Segas et al., and Remacle et al. have reported decannulation rates between 89–100%[25].

Lichtenberger's vocal fold lateralization is a more complex procedure that demands greater surgical experience. Its main disadvantage is the risk of aspiration[6,21,23]. This intervention is potentially reversible and results in better glottic closure, thus improving the vocal quality[6,23]. Lichtenberger et al. reported reintervention rates between 10–30%. Our study population exhibited a high success rate, with no need for reintervention in 100% of cases. In recent years, specialized centers have developed methods to restore vocal fold mobility and tonus, with promising results[21,23]. These include laryngeal reinnervation and laryngeal pacing with stimulation of the paralyzed muscles[4,23]. Experimental methods under investigation[4,23] include neuromodulation, gene therapy, and stem cell therapy.

Conclusion

Etiological investigation is essential for determining the cause of BVFP. Analytical evaluation, including biochemistry, immunology, and serology, along with imaging evaluation such as computed tomography and magnetic resonance imaging, can help to diagnose rare causes of vocal fold paralysis, with few cases described in the literature. Potentially reversible causes are hypocalcemia, hypothyroidism, rheumatoid arthritis, neurosyphilis, and acute hepatitis B.

Laryngeal electromyography is a crucial tool for predicting the potential recovery of vocal fold innervation, and can aid in deciding between temporary or permanent treatment options.

Severe dyspnea and stridor are the most worrisome symptoms, requiring emergency treatment for airway maintenance, preferably tracheostomy due to its easy and rapid implementation.

The relatively low (≈ 25%) decannulation rate may be attributed to the study population's older age, comorbidities, and prevalence of central nervous system diseases (stroke, brain metastasis, central nervous system tumors, and degenerative neurological diseases) in 40% of the cases.

Surgical approaches to maintain the patency of the glottic space had a success rate of 75% with CO_2 laser® posterior transverse cordotomy and 100% with Lichtenberger's vocal fold lateralization, concurrent with the rates in the literature.

Conflict of Interests

The authors declare that they have no conflict of interest regarding this article.

Data Confidentiality

The authors declare that they followed the protocols of their work in publishing patient data.

Human and animal protection

The authors declare that the procedures followed are in accordance with the regulations established by the directors of the Commission

for Clinical Research and Ethics and in accordance with the Declaration of Helsinki of the World Medical Association.

Privacy policy, informed consent and Ethics committee authorization

All the processed data were based in published reports that fulfilled privacy policy and ethical considerations.

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Scientific data availability

There are no publicly available datasets related to this work.

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