

Vocal Cord Paralysis

Understanding Vocal Cord Paralysis, Paresis, and Vocal Fold Immobility

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As voice and swallow dysfunctions are important factors in affecting the quality of life, their presence is a source of concern that prompts a search for answers. The purpose of this primer is to provide information related to vocal cord paralysis, vocal cord paresis, and vocal fold immobility. By understanding factors related to these disorders, the possible causes, the natural course, and the treatment options, we can offer guidance to those struggling with the condition.

Understanding the Terminology

You may have been told by a doctor that you have vocal cord or vocal fold paralysis. This is a term that has been used in almost all observations where the vocal cord is not moving appropriately. Other terms used include vocal cord paralysis, vocal fold paresis, vocal fold immobility, recurrent laryngeal nerve paralysis or paresis. Because there are so many terms used to describe impaired movement in the larynx, it can become confusing to those looking for more information.

Physicians who make an observation of a motionless vocal fold often refer to the condition as vocal cord paralysis. Attempts have been made to change this nomenclature to vocal fold immobility, but due to many decades of use of this term, it is not likely to completely go away. When observation of abnormal vocal cord movement is found, it would be more appropriate to describe it as vocal fold motion impairment. This would describe both the vocal cord that is not moving at all, as well as the vocal cord that is not moving as well as it should. The terms vocal

fold motion impairment, vocal fold paralysis, and vocal fold paresis have all been used to describe vocal folds that are not moving correctly by clinical examination.¹

What is the difference between paralysis and paresis?

The terms vocal cord paralysis and vocal fold paresis are used to identify the vocal cord that is not moving at all, versus the vocal fold that is moving but with reduced function. Vocal cord paralysis implies complete loss of nerve input to the vocal folds. In general, such dysfunction of conduction of nerve to the laryngeal muscle will result in an immobile vocal fold or partial loss of vocal fold motion.

The term vocal cord paralysis or vocal fold immobility does not adequately describe the vocal cord that is partially functioning.² In situations where there is partial movement of the vocal fold, the term 'vocal fold paresis' is used. If the vocal cord is partially moving, it may be due to a loss of nerve input and not complete injury of the nerve to the larynx.

Although the diagnosis of vocal fold paresis suggests partial loss of nerve function, many otolaryngologists use the term to describe the presence of abnormal vocal fold movement that may be due to partial paralysis or fixation. Use of the term suggests that vocal fold movement is not completely absent but it does not imply where the injury occurred. Only advanced diagnostic testing of nerve function can determine the cause of paresis.

It is important to note that neurological impairment of nerve function may not be static and can result in a variable degree of vocal function from complete immobility to partial mobility to abnormal mobility. This is because there is an ongoing attempt by the body to achieve nerve regeneration and repair that can result in partial innervation or reinnervation.³

Understanding the Anatomy of the Nerve that Serves the Larynx

The larynx consists of several basic anatomic parts: cartilaginous skeleton, intrinsic muscles, extrinsic muscles, nerves, and a mucosal lining. The *intrinsic* muscles, which start and end in the voice box, are responsible for the production of sound and comprise the core of the vocal cords. In contrast, *extrinsic* muscles help to support the larynx and have their termination points elsewhere in the throat. They change the position of the larynx within the throat. The mucosa lines the vocal tract and the vibratory surface of the vocal cords. The combined actions of these cartilages and related muscles create bodily movements associated with the throat, including swallowing, breathing, and voicing. Each of the laryngeal muscles plays a critical role in the production of voice.

Stimulation of the larynx is supplied by the recurrent laryngeal nerve and the superior laryngeal nerve from each side. Each of these nerves carries both afferent sensory fibers as well as efferent motor nerve fibers to the larynx, in other words, the impulse from the brain to perform a certain movement and the message back to the brain that the movement

was completed. Motor fibers to the larynx are responsible for vocal fold movement that allows adjustment of vocal fold tension during phonation as well as vocal fold movement during breathing.

The 10th cranial nerve, called the vagus nerve, has an extensive distribution network and serves the chest, abdomen, and the head and neck area. The recurrent laryngeal nerve is a branch off the vagus nerve which on the right side goes into the neck and around the subclavian artery. On the left side, the nerve dives down into the chest, around the arch of the aorta and ascends between the trachea and the esophagus and then into the larynx.

Once the recurrent laryngeal nerve enters the larynx, it supplies motor function to intrinsic muscles of the larynx. The intrinsic muscles of the larynx are divided into abductor muscles and adductor muscles. The abductor muscles are responsible for opening of the vocal folds during respiration. The adductor muscles are responsible for closing of the vocal folds during cough, voice, and protection of the airway.

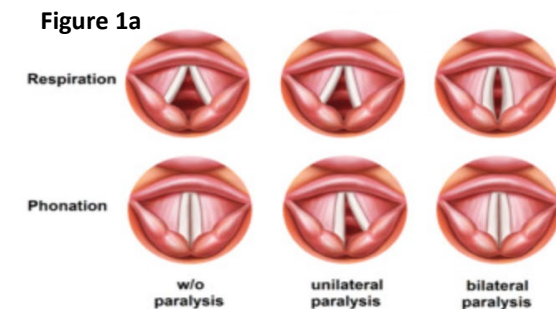


Figure 1a is a schematic drawing of normal vocal fold movement during voicing and during inspiration. The closed position of the vocal fold is in the adducted position while the open position is in the abducted position. Any injury to the vagus nerve or the recurrent laryngeal nerve can result in vocal cord paralysis or paresis. Typically, this results in reduced mobility or immobility of the vocal fold. If it involves only one side it would cause an asymmetric movement of the vocal fold compared to the normal

side. If it involves both sides, this may result in both vocal folds not moving appropriately.

The second nerve that supports the larynx, the superior laryngeal nerve, splits off the vagus nerve much earlier and does not go into the chest. This nerve enters the larynx and provides the messaging for both the sensory and motor branches of the nerve. The motor branch controls the cricothyroid muscle, which is the primary tensor of the larynx and is responsible for pitch adjustment.

Symptoms of Paralysis and Paresis

The signs and symptoms typically associated with each of these conditions will depend on the severity of the injury, the site of the injury, whether one side or both sides are involved, and the final position of the vocal folds after injury. In addition, if the damage is limited to the recurrent laryngeal nerve, the symptoms may be different than damage from the superior laryngeal nerve. The table includes the general symptoms associated with nerve damage affecting the larynx:

Symptoms associated with unilateral recurrent laryngeal nerve damage	Symptoms associated with superior laryngeal nerve damage	Symptoms associated with bilateral recurrent laryngeal nerve damage
Breathy voice quality	Chronic cough or choking	Weak voice
Decreased vocal fold stamina with vocal fatigue	Swallowing difficulties	Noisy breathing with any exertion
Change in power of the voice with reduced projection and loudness	Loss of voice especially in the high notes	Shortness of breath
Throat pain with speaking	Limited ability for projection of voice	Night-time noisy breathing
Choking		Stridor (a harsh vibrating noise when breathing)
Shortness of breath with speaking		Swallow dysfunction
Choking or aspiration on swallowing of water or solids		

Abnormal laryngeal nerve function with loss in the transmission of nerve impulses results in the loss of spontaneous muscle contraction to the muscles controlling the vocal folds. This can result in loss of function. The most common way this manifests itself is loss of vocal function due to incomplete closure of the vocal folds during voicing. This can also manifest as a breathy voice with the inability to project the voice. The cough can be affected and is usually weak with difficulty in effective elimination of mucus from the trachea or lung. If the nerve dysfunction is severe or involves multiple nerves to the larynx, both the swallow and breathing dysfunction may be present.

Since the nerve to the larynx contains both muscle control as well as sensory input from the larynx, symptoms of abnormal sensory function can also be present in patients with vocal cord paralysis or paresis. Sensory related symptoms include cough, coughing spasm, choking on secretions, airway spasm, or breathing dysfunction. The combination of loss of motor or sensory function related to the larynx is often taken for granted but can be frightening. It often prompts the patient to visit their physician for additional information and examination.

Examination and Diagnosis

The diagnosis of vocal cord paralysis, paresis, or vocal fold motion impairment is usually made in the otolaryngologist office. An otolaryngologist is a subspecialty within medicine that deals with conditions of the ear, nose, and throat and related structures of the head and neck. Sometimes the abbreviation 'ENT' is used for this specialist. An ENT doctor has the tools and the training to make the diagnosis of vocal cord paralysis or vocal fold movement impairment. The doctor will capture a thorough health history, perform a physical examination and note all symptoms.

The physical examination can be carried out using a mirror examination of the larynx, by a fiber-optic instrument placed through the nose, or by using a rigid endoscope. The images are routinely recorded for analysis. During the examination, the patient is asked to voice, cough, swallow, and perform other tasks that are appropriate to evaluate vocal cord function. Laryngeal imaging by fiber-optic and rigid laryngoscopy are now routine in most otolaryngologists' offices.

The diagnosis of vocal fold movement abnormality is made when there is reduced or abnormal movement of the vocal folds during breathing, coughing or speaking. The clinician will examine the larynx to determine a suspected diagnosis of vocal cord paralysis or paresis (no movement versus limited movement). This diagnosis does not imply whether the nerve is permanently or temporarily injured. These conditions are made by more in-depth electrodiagnostic testing. There are a number of potential tests that may be used:

- The use of videostroboscopy and voice assessment by a speech language pathologist may be used to perform voice

If the cause of the vocal fold paralysis or paresis is not clear from the physical exam and tests, it is often necessary to perform additional tests to determine

diagnostics in order to evaluate the severity of the issue.

- Stroboscopy allows for more detailed view of the vibratory characteristics of the vocal fold and assess the severity of vocal cord closure.
- Acoustic in airflow measurements measure air pressure, airflow, frequency, intensity, and other characteristics of sound produced by the vocal folds. By quantifying the underlying aerodynamic forces driving phonation, the clinician has better information with which to evaluate and measure the severity of the abnormality.
- Laryngeal electromyography (EMG) is a study of the muscles that are supplied by the nerves to the larynx. The assessment of the electrical activities from the intrinsic muscles of the larynx allows the clinician to differentiate between unilateral versus bilateral vocal fold involvement. By testing the different muscles, the clinician can determine whether the issue involves just the recurrent laryngeal nerve, the superior laryngeal nerve or the vagus nerve.
- Laryngeal electromyography may be used to differentiate between a physical impairment of the vocal cord versus vocal cord paralysis due to nerve dysfunction. Electrical evaluation of nerve function can also help to be more precise in identifying the site where the nerve is injured and it can also provide an indication of the duration of the nerve injury as well as the prognosis for return of nerve function. In this way, the test can help to guide treatment. The laryngeal EMG is often used during the nerve repair process to check for abnormalities.⁴

the root cause. The causes that may contribute to vocal cord paralysis include thoracic malignancy or any mass or lesions along the course of the vagus

nerve. A CT scan with contrast of the neck and chest from skull base to the aortic arch is used to evaluate for most of the malignancies that could impair nerve function. If the clinical findings on physical examination suggest higher vagal nerve involvement, an MRI (magnetic resonance imaging) of the brain and skull base may also be considered. If there is swallow dysfunction and aspiration, a barium swallow and evaluation for dysphagia including esophagoscopy may also be recommended. Occasionally, specialized blood tests may be ordered to test for systemic diseases that may cause nerve injury. These tests may look for Lyme disease, and include serology, screening for diabetes, and autoimmune diseases.

Who gets vocal cord paralysis?

Any adult or child may be at risk for sudden onset of signs and symptoms that may be attributed to vocal cord paralysis.

- Sometimes the onset of breathy voice is related to a recent viral illness. Many viral infections have been associated with vocal fold paresis. These include herpes simplex virus, cytomegalovirus, coxsackie virus, and simple upper respiratory infections. Bacterial infections including Lyme disease and syphilis have also been reported to cause vocal fold paralysis and paresis. Once the viral illness is improved, the voice and swallow dysfunction should improve.
- In patients who undergo cranial, head and neck, thyroid, thoracic, cardiac and esophageal surgery, the nerve to the larynx is placed at risk because of the proximity of the nerve near where the surgeon is working. Some of the common surgical-related traumas include: thyroidectomy, spine surgery, skull base surgery, thoracic surgery for aneurysm repair, and carotid endarterectomy.
- Occasionally, other factors can cause injury to the nerve. These causes include radiation therapy, intervention by angiography, or neurotoxic drug administration.

- Some patients, especially the elderly with risk factors for cancer of the lungs, esophagus, thorax, or thyroid, are at risk for developing vocal cord paralysis.
- Vocal cord paralysis may be the initial sign and symptom in patients that are eventually identified to have neoplasm along the course of the vagus nerve. Some of the neoplastic conditions that may cause vocal cord paralysis include lung cancer, mediastinal tumors, thyroid cancers, and tumors of the neck and skull base.

After completing the evaluation for the cause of the condition, the appropriate prognosis and a course of treatment can be determined.

Treatment and Recovery

A damaged nerve to the larynx has the potential for complete or partial recovery. In patients who have inflammation of the nerve or where the nerve was only stretched, the nerve can be expected to recover without major disability. However, the natural course of nerve recovery is variable.⁵ The time to complete recovery can be from several weeks to one year. If the nerve is expected to recover, many clinicians will treat the symptoms of temporary vocal cord paralysis or paresis using temporary vocal fold injection or voice therapy or with observation alone. If the nerve is permanently damaged, intervention may be considered sooner. Some of the prognostic information for recovery of the nerve function can be gained from laryngeal electromyography. The determination of whether to intervene is based on severity of symptoms and the likelihood of recovery based on the clinical history. The following represents intervention procedures for vocal cord paralysis:

1. Voice therapy and referral to a speech language pathologist can be an important alternative to surgical intervention in patients with symptomatic vocal cord paralysis. They can help to educate patients regarding better laryngeal function. They can use therapeutic intervention

approaches to improve the voice as well as swallow dysfunction. In patients with mild breathy voice quality, therapy can include strategies for vocal exercises to improve glottic function. The speech pathologist is also an integral part of the voice rehabilitation team after surgical intervention for vocal cord paralysis.

2. 'Wait and see' is a conservative way to treat vocal cord paralysis or paresis. This is appropriate for people with minimal symptoms or for those who do not wish to pursue intervention. There is a possibility that the contralateral vocal fold will spontaneously migrate to the midline and compensate for the dysfunction to provide adequate glottic closure. In patients whose dysfunction is expected to improve, a wait-and-see approach may be appropriate.
3. Office injection laryngoplasty is the injection of a temporary or permanent material into the vocal fold to push and/or enlarge the vocal cord that is paralyzed or has thinned out. The purpose is to improve the volume and position of the affected vocal fold to allow better approximation with the contralateral side. The injection of materials can now be done in the office setting using a variety of materials. These materials are also used in facial plastic procedures, and can be injected through a small needle. Some of the materials are temporary and can be used to help symptomatic patients during the vocal cord paralysis recovery period. Where the nerve injury is expected to be temporary, a temporary injectable material is preferred and often offered as an office-based procedure.
4. Operative injection laryngoplasty is appropriate when the vocal cord cannot be easily accessed using an office-based approach or if the material that is to be injected is very viscous or large volumes may be needed. The contents of the material that is injected may include fat or fascia from the patient.
5. Laryngeal framework surgical procedures include medialization laryngoplasty with and without arytenoid adduction. This surgery aims to

reposition the paralyzed vocal fold into the midline so that the other side can meet the paralyzed vocal cord. Medialization laryngoplasty pushes the vocal fold towards the midline by inserting an implant lateral to the vocal cord. Arytenoid abduction rotates the arytenoid cartilage in order to reposition the vocal fold towards the midline by tension on the joint and pulls the vocal cord towards the midline simulating the action of the muscles that act on and pulls the vocal fold towards the middle. Both operations are usually done in the operating room under local anesthesia with minor sedation. It has an advantage over injection laryngoplasty in that it is more adjustable and it is considered permanent.

6. Reinnervation is a procedure where the nerve that is paralyzed is connected to another nerve that is active and thereby results in reinnervation. Reinnervation can be done for both movement deficits as well the sensory deficits. Multiple different types of reinnervation procedures have been performed for both one-sided and both side vocal cord paralysis. The most common type of reinnervation for unilateral vocal cord paralysis is to take one of the nerves going to the muscle of the neck. The choice of whether to proceed with reinnervation is dependent on the prognosis for nerve return, the patient's age, and functional deficit. Sometimes, laryngoplasty is done in conjunction with reinnervation procedures.⁶

Why is vocal cord paralysis an important finding in health?

Early identification of vocal cord abnormality that may be due to vocal cord paralysis or paresis is important for the following reasons:

1. It can be early sign and symptom of systemic disease. Vocal cord motion disturbance may occur due to tumor, systemic illness or inflammation.

2. In patients who have had surgery of the upper airway, identification of nerve injury or mechanical injury to the larynx resulting in vocal fold movement abnormality may be reversed by appropriate early surgical intervention.
3. Identification of the presence of vocal cord paralysis and paresis helps to direct the symptomatic patient to early rehabilitation and treatment.

Conclusion

Any person experiencing symptoms of vocal cord paralysis or paresis is encouraged to discuss the issue with their doctor. It is important to determine the cause quickly to insure proper treatment. With proper treatment, a damaged nerve to the larynx has the potential for complete or partial recovery.

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