

## Paradoxical vocal fold motion

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**INTRODUCTION** — Paradoxical vocal fold motion (PVFM) describes inappropriate motion of the true vocal folds. PVFM refers to a clinical phenomenon rather than to one specific or strictly defined clinical diagnosis. PVFM is most commonly observed as episodic unintentional adduction of the vocal folds on inspiration [1]. Patients most often present to the emergency department with wheezing, stridor, and apparent upper airway obstruction. Delay in diagnosis is common, and unnecessary treatments such as intubation and tracheostomy are not uncommon. Patients are commonly frequent users of the health-care system, often over prolonged periods [2].

While clinical observations of this phenomenon were described in the 1800s, they began to appear with increasing frequency in the 1970s and 1980s with the greater availability of laryngoscopy [3]. PVFM has unintentionally become a catch-all term for functional laryngeal disorders [4]. However, it is important to explicitly define this functional disorder as “impaired function”, emphasizing that this is not synonymous with a psychogenic disorder.

This topic will review the presentation and treatment of PVFM, also called laryngeal dyskinesia, vocal cord dysfunction (VCD), inspiratory adduction, periodic occurrence of laryngeal obstruction (POLO), Munchausen’s stridor, episodic paroxysmal laryngospasm, psychogenic stridor, functional stridor, hysterical croup, emotional laryngeal wheezing, factitious asthma, pseudoasthma, and irritable larynx syndrome [3-6]. Features of wheezing illnesses other than PVFM are discussed separately. (See ["Evaluation of wheezing illnesses other than asthma in adults"](#) and ["Diagnosis of asthma in adolescents and adults"](#).)

**ANATOMIC FINDINGS** — In the normal larynx, the true vocal folds abduct (open) during inspiration and partially adduct (close) during expiration ([figure 1](#)). In addition to inspiration, abduction can also be induced by sniffing and panting. Normal adduction of the true vocal folds occurs with phonation, coughing, throat clearing, swallowing, and during a Valsalva maneuver. Around 10 to 40 percent adduction is normal during expiration. Normal cough

mechanics involve vocal fold adduction for 0.2 seconds following the end of the inspiratory phase [7].

Paradoxical vocal fold motion (PVFM) can be seen during inspiration, expiration, or both (figure 1) [3,8,9]. The false vocal folds and supraglottic tissue may also dynamically constrict the airway. It is imperative to visualize full abduction during laryngoscopy to rule out other causes of laryngeal obstruction.

**ETIOLOGIES** — Many comorbidities have been associated with paradoxical vocal fold motion (PVFM) as listed below [10]. As PVFM is a descriptive term rather than a specific diagnosis, the etiology is often multifactorial [11]. Occasionally, no specific inciting agent can be clearly identified.

**Asthma** — While PVFM is often misdiagnosed as asthma, PVFM can also be seen concomitantly with asthma [12,13]. In one study of asthmatics referred for a suspected diagnosis of PVFM, 75 percent had a confirmed diagnosis of PVFM on laryngoscopy [11].

**Exercise** — Exercise-associated PVFM accounts for approximately 14 percent of PVFM diagnoses [14]. It occurs predominantly in young female athletes who present with dyspnea and sometimes stridor triggered by exercise [14-18]. In a series of 831 patients with PVFM, 46 were elite athletes and of these, 70 percent were female and 46 percent were noted to have noisy breathing during exercise [18]. Elite athletes with PVFM were less likely to have a history of reflux, psychiatric diagnosis, dysphonia, cough, or dysphagia, compared with nonathletes who had PVFM [18].

**Postextubation** — It should be noted that postoperative onset of acute dyspnea and stridor is much more likely to be caused by laryngospasm rather than PVFM. Laryngospasm is usually an acute onset brief episode of sustained vocal fold adduction, often seen on emergence from general anesthesia (see "[Overview of the management of postoperative pulmonary complications](#)"). PVFM may occur shortly after extubation of patients who have been intubated for surgery or respiratory failure and presents with dyspnea and stridor [19-22]. The use of flexible laryngoscopy in the immediate postextubation period allows differentiation between PVFM or laryngospasm and other pulmonary etiologies of postextubation respiratory distress.

**Irritants** — Patients sometimes attribute PVFM to inhalational exposure to a variety of irritants (eg, ammonia, soldering fumes, cleaning chemicals, aerosolized machining fluids, construction dust, and smoke) [8]. The onset of PVFM symptoms typically occurs within 24 hours of the exposure. Patients may feel that ongoing problems with PVFM are related to a previous inhalational irritant exposure. While an acute exposure might cause temporary laryngeal irritation, it is unclear how a previous remote exposure would cause ongoing laryngeal irritation.

**Laryngopharyngeal reflux** — Reflux of gastric contents to the larynx and pharynx, also known as laryngopharyngeal reflux (LPR), is associated with PVFM. However, it is unclear whether there is a causal relationship between LPR and PVFM. Laryngoscopic findings

consistent with LPR were present in 19 of 22 juveniles with confirmed PVFM [23]. However, other studies have questioned the reliability of laryngoscopy in making the diagnosis of LPR [24]. (See "[Laryngopharyngeal reflux](#)".)

**Neurologic injury** — PVFM has been demonstrated in patients after thyroid and cervical spine surgery and in one patient after a polycranial neuropathy from herpes simplex. In this setting, the presumed etiology is aberrant reinnervation or synkinesis [25].

**Psychosocial disorders and stress** — PVFM has been associated with a variety of psychosocial disorders. However, it is not considered to be a form of malingering as patients do not intentionally produce their condition for secondary gain. In a prospective cohort of 45 patients, 18 patients were found to have conversion disorder and 11 patients were found to have no psychopathology [26]. In a series of military personnel with PVFM, 52 percent reported symptoms related to high stress and anxiety, while 39 percent reported symptoms during exertion [27].

PVFM patients with a previous psychological history are prone to symptoms of depression and anxiety. Several studies have reported an association of PVFM with a history of prior psychiatric illness, including depression, personality disorders, posttraumatic stress disorder, or a history of childhood sexual abuse [26,28-31]. In a case-control study comparing adolescents with PVFM to those with asthma, PVFM patients had higher levels of anxiety and more frequent diagnoses of generalized anxiety disorder and separation anxiety [32]. (See "[Factitious disorder imposed on self \(Munchausen syndrome\)](#)".)

**CLINICAL PRESENTATION** — Most studies note a female predominance, but paradoxical vocal fold motion (PVFM) is also well documented in males [11]. PVFM affects all ages, occurring in the pediatric population and in adults [9,33]. The hallmark of PVFM is inspiratory stridor accompanied by respiratory distress [17]. Often the diagnosis is suspected after multiple visits to the emergency department for these episodes, or during an evaluation for severe asthma [9,34]. (See "[Evaluation of severe asthma in adolescents and adults](#)".)

In addition to dyspnea, patients may complain of throat tightness, a choking sensation, dysphonia, and cough. Less often, patients report gastroesophageal reflux, dysphagia, and rhinosinusitis [18,35]. Onset of symptoms may be spontaneous or associated with triggers such as exercise, irritant exposure, or anxiety.

Stridor (noisy breathing) may be inspiratory, expiratory, or both [4]. Stridorous sounds are usually loudest over the anterior neck and less audible through the chest wall. Typically, [albuterol](#) has minimal to no beneficial effect.

While there is little information in the literature regarding the specific duration of PVFM episodes, episodes requiring emergency department evaluation last anywhere from several hours to several days. This distinguishes the episodes from laryngospasm which usually last seconds to a few minutes. (See '[Differential diagnosis](#)' below.)

Some patients with PVFM experience dysphonia during or between attacks [14]. On examination this is often associated with vocal fold hyperfunction (eg, excessive false vocal fold adduction and anterior-superior laryngeal compression during phonation). There are no reports of formal voice analysis in these patients. (See "[Hoarseness in adults](#)".)

The degree of respiratory distress and anxiety of patients with PVFM can occasionally lead clinicians to perform endotracheal intubation or tracheotomy to restore airway patency before diagnostic tests are completed. Immediately afterwards, cessation of wheezing and stridor is noted, suggesting that the airflow limitation was due to an upper airway process instead of asthma.

**EVALUATION AND DIAGNOSIS** — Laryngoscopy is the gold standard for the diagnosis of paradoxical vocal fold motion (PVFM). However, pulmonary function tests and imaging may be performed prior to laryngoscopy depending on the clinical presentation and degree of clinical suspicion for the diagnosis. As examples:

- Patients who report intermittent exercise-related symptoms should undergo pulmonary function tests (eg, flow volume loops, pre and postbronchodilator spirometry) to evaluate for asthma and PVFM. Laryngoscopy is then performed in patients with inspiratory slowing on the flow volume loop, poor response to medications for asthma, or a prominent report of stridor at the time of symptoms [14]. If the diagnosis remains unclear after laryngoscopy, repeat laryngoscopy may be performed after an exercise or bronchoprovocation challenge.
- Patients who present to the emergency department with stridor will likely undergo laryngoscopy and possibly upper airway and chest imaging prior to pulmonary function tests.
- Some patients who have laryngoscopic evidence of PVFM, but did not have adequate subglottic visualization, may need tracheal imaging to exclude a subglottic stenosis or mass.

**Pulmonary function tests** — Most patients with PVFM have normal expiratory spirometry, although a few have mild restrictive physiology. In contrast, the inspiratory loop of the flow-volume curve may show flattening, and the ratio of forced expiratory flow to forced inspiratory flow at 50 percent vital capacity may be >1 (normal is <1), consistent with extrathoracic airway obstruction ([figure 2](#)) [36]. However, flow-volume loops may be normal when the patient is asymptomatic between episodes or may show expiratory airflow limitation if PVFM occurs during expiration.

PVFM can be induced with [methacholine](#) inhalation, presumably through an irritant mechanism [37]. However, normal flow volume loops after methacholine do not rule out PVFM. Methacholine inhalation challenge may be most helpful in conjunction with laryngoscopy to confirm that airflow limitation is due to PVFM and not asthma [37,38]. (See "[Bronchoprovocation testing](#)", [section on 'History suggestive of asthma, atypical spirometry pattern'](#).)

**Laryngoscopy** — Visualization of the larynx using a flexible laryngoscope is imperative to confirm abnormal adduction of the true vocal folds and to exclude other laryngeal pathology. Full visualization of the vocal folds with complete abduction is also necessary to rule out supraglottic or subglottic obstruction and bilateral vocal fold immobility. In some but not all patients, PVFM is apparent on laryngoscopy even when the patient is asymptomatic [14]. Some patients may only have findings of PVFM on laryngoscopy after provocation. Tracheoscopy may be possible during flexible laryngoscopy. If tracheoscopy is not possible, a patent central airway must be confirmed by another method, such as an adequate chest x-ray or high resolution computed tomography with reconstruction.

The diagnosis of PVFM is made when laryngoscopy reveals abnormal adduction of the true folds (solely during inspiration, throughout the respiratory cycle, or rarely, solely during expiration); the glottic aperture may be obliterated except for a posterior diamond-shaped passage, as seen in the figure ([figure 1](#)) [3,10]. There may also be adduction or bunching of the false vocal folds [3,10,39]. Although these findings are normally seen only during an acute episode, they can often be reproduced on examination when the patient is asked to mimic what happens during an attack.

It is important that the procedure is performed by an experienced laryngoscopist who is aware of this disorder to avoid misdiagnosis of bilateral true vocal fold fixation or paralysis. Normal vocal fold motion may be restored by asking the patient to cough or breathe in a panting manner [39].

**Provocation with exercise challenge** — In patients with exercise-related symptoms, resting laryngoscopy may not identify findings of inappropriate vocal fold adduction, but laryngoscopy immediately following exertion may identify the abnormality. As an example, in a series of 104 patients with exercise-related PVFM, 52 percent had no evidence of PVFM on flexible laryngoscopy at rest, but PVFM was visible on laryngoscopy after exercise [14]. Exercise testing can be performed with a stationary bike, running, or stair climbing until the patient is symptomatic. Laryngoscopy can be performed immediately after exertion, when the patient is symptomatic, or in a continuous fashion [40,41]. We typically introduce the laryngoscope without topical anesthesia and begin recorded laryngoscopy when the patient is symptomatic.

**Imaging** — Imaging is predominantly used to exclude other causes of dyspnea. Chest radiographs are often obtained in patients presenting to the emergency department to exclude an intrathoracic cause of dyspnea. If examination of the trachea is not possible during laryngoscopy, high resolution computed tomography of the upper airways can be used to exclude subglottic stenosis, tracheal and extratracheal (eg, thyroid) masses, or tracheomalacia. (See "[Evaluation of wheezing illnesses other than asthma in adults](#)", [section on 'Imaging'](#).)

Diagnosis of PVFM by fluoroscopy and by color flow Doppler has been reported, but these techniques have not been standardized against direct visualization with flexible fiberoptic laryngoscopy [42,43].

**Arterial blood gases** — In general, arterial blood gases (ABGs) are only obtained in patients presenting with severe respiratory distress. ABGs usually do not show significant abnormalities, although mild hypercapnia may occur. The alveolar-arterial oxygen difference remains normal [3].

**DIFFERENTIAL DIAGNOSIS** — In patients suspected of having paradoxical vocal fold motion (PVFM), a thorough evaluation for asthma and causes of upper airway obstruction is essential [44]. (See ["Diagnosis of asthma in adolescents and adults"](#) and ["Asthma in children younger than 12 years: Initial evaluation and diagnosis"](#) and ["Evaluation of wheezing illnesses other than asthma in adults"](#).)

Clues that suggest PVFM rather than asthma:

- Subjectively more difficulty on inspiration than expiration
- Minimal response to aggressive asthma treatment
- A flattened inspiratory flow-volume loop
- Normal expiratory spirometry, lung volumes, and arterial blood gas measurements

PVFM should also be differentiated from other causes of upper airway obstruction including:

- **Laryngospasm** usually occurs in an older patient population than does PVFM. Patients describe the abrupt onset of complete airway obstruction (the sensation of choking) and aphonia initially without any stridor. Laryngospasm may be triggered by laryngopharyngeal reflux, and it sometimes awakens the patient from sleep. In addition, laryngospasm can be seen in the setting of a viral upper respiratory infection, or in a pediatric population in the setting of general anesthesia [45]. Unlike PVFM, the time course of laryngospasm is so limited (eg, seconds to minutes) that it is rarely observed by the clinician. (See ["Laryngopharyngeal reflux"](#).)
- **Laryngeal angioedema** due to anaphylaxis, angiotensin converting enzyme inhibitor therapy, and C1 inhibitor deficiency. (See ["An overview of angioedema: Pathogenesis and causes"](#).)
- **Bilateral vocal fold paresis** from central or peripheral causes, such as motor neuron disease, brainstem compression, neuropathy of the vagus or recurrent laryngeal nerve, or adductor laryngeal breathing dystonia [46]. (See ["Treatment of dystonia"](#), section on ["Other focal dystonias"](#).)
- **Mass lesions** causing upper airway obstruction (eg, glottic and tracheal neoplasms or stenosis). (See ["Clinical presentation, diagnostic evaluation, and management of central airway obstruction in adults"](#).)
- **Dynamic upper airway obstruction**, such as prolapse of supraglottic tissue, laryngomalacia, or tracheomalacia [4,47]. Exercise-induced laryngomalacia can be differentiated from exercise-induced paradoxical vocal fold motion upon exercise testing with laryngoscopy that shows paradoxical arytenoid motion rather than paradoxical true vocal fold motion [47]. (See ["Evaluation of wheezing illnesses other than asthma in adults"](#), section on ["Extrathoracic upper airway causes of wheeze"](#) and ["Tracheomalacia and tracheobronchomalacia in adults"](#).)

**TREATMENT** — Various treatment strategies have been used for paradoxical vocal fold motion (PVFM), although none have been studied in a controlled fashion. The treatment of PVFM can sometimes be guided by medical management of the possible underlying etiology, such as irritant-induced or laryngopharyngeal reflux [11]. It should be noted that because the underlying etiology is rarely known, such treatments are empiric rather than evidence-based. (See ['Etiologies'](#) above.)

In general, therapies for asthma such as beta-adrenergic agents and inhaled or systemic glucocorticoids are not beneficial. It is helpful to separate treatment approaches into acute management and long-term prevention.

**Acute management** — Acute management strategies that may be useful include:

- Reassurance and supportive care until the episode spontaneously resolves. Asking patients to pant can sometimes abort an episode; panting activates the posterior cricoarytenoid muscle causing abduction of the true vocal folds [48].
- Use of continuous positive airway pressure (CPAP) [10,49]. (See ["Noninvasive ventilation in acute respiratory failure in adults"](#).)
- While rarely used, inhalation of a helium oxygen mixture (heliox) has been reported to be helpful [3,50]. In a case series, four of five PVFM patients experienced an improvement in symptoms, including anxiety, with heliox inhalation during acute episodes [50]. (See ["Physiology and clinical use of heliox"](#).)
- Endotracheal intubation or tracheostomy is not needed for PVFM and should only be performed when the patient is at risk for airway obstruction from causes other than PVFM [49].

**Long-term prevention** — Long-term prevention strategies employ a multidisciplinary approach to minimize laryngeal irritation while combining treatment by a speech-language pathologist [33,51].

**Communicating the diagnosis** — The first step is to convince the patient of the validity of the diagnosis, which may be difficult since the diagnosis is often delayed, and some patients have been treated chronically and aggressively for asthma. Many such patients strongly believe that their health depends upon continuing their longstanding asthma medications. When PVFM coexists with asthma, medications for asthma should be continued during treatment for PVFM and coordinated with the treating asthma specialist.

The diagnosis of PVFM should be explained in a nonjudgmental fashion that strives to maintain patient dignity. A useful analogy is to describe how muscle spasms in the neck and shoulder can be related to stress; the muscle spasm isn't under conscious control; and nothing is structurally wrong with the neck. Similar to neck muscle spasm, muscle relaxation and psychological counseling to reduce stress are appropriate treatments for PVFM.

**Behavioral speech/voice therapy** — The speech-language pathologist (SLP) may assist with the **diagnosis** during the acute management stage, provide **treatment** during longer-

term management, and **coordinate** communication of patient care when multiple health-care providers are involved.

The SLP's role in treatment of PVFM also includes:

- Behavioral speech/voice therapy to address vocal use issues, perilaryngeal tension, and respiratory retraining
- Supporting and educating patients who are prescribed medical treatment of any underlying reflux-associated vocal fold lesions and/or allergies
- Education of family members, school personnel and coaches in the case of adolescent athletes, as appropriate

A typical SLP therapy plan is designed to help the patient regain laryngeal control. Strategies often include:

- Respiratory retraining, focusing on rescue breathing for use during an episode, rhythmic low abdominal breathing to help with prevention, coordination of timing between respiration and phonation
- Whole-body relaxation techniques
- Relaxation techniques for the extrinsic laryngeal muscles, neck, shoulders, and thoracic area
- Vocal hygiene
- Phonatory retraining when appropriate, to eliminate vocally-abusive and tension-causing behaviors

Success has been reported with speech/voice therapy that uses breathing, voice, and neck relaxation exercises to abort the onset of PVFM episodes [[3,6,10,33,52-58](#)]. A speech therapy intervention focusing on respiratory control in 20 adolescent female athletes yielded symptom control for six months and allowed continued participation in athletic endeavors [[15](#)]. In another study, all five patients with documented PVFM improved with respiratory retraining [[59](#)]. Techniques including focusing attention away from the larynx and inspiration, using abdominal muscles for breathing, and relaxing the neck muscles were helpful in another series of five patients [[3](#)].

Preliminary data suggest that a newly-developed Vocal Cord Dysfunction Questionnaire (VCDQ) may be useful in monitoring responses to speech-language therapy in patients with a confirmed PVFM diagnosis [[60](#)].

SLPs who are trained in the use of videolaryngoscopy may employ this tool for biofeedback during a therapy session, so the patient can observe the result of measures to control breathing.

Psychotherapy may be suggested as a part of a comprehensive treatment plan and may help patients identify psycho-social triggers and gain control of perfectionist

tendencies and/or emotional responses to stress. Psychotherapy alone is not an effective treatment for a diagnosis of PVFM.

Exercise-associated PVFM may respond to the above described psychological counseling and speech therapy with relaxation exercises. In addition, pretreatment with an anticholinergic medication prior to exercise or use of inspiratory resistive training may be beneficial. In an uncontrolled case series, exercise-induced PVFM was prevented in six of seven patients who used [ipratropium](#) prior to exercise [61].

Successful use of inspiratory resistive training with a pressure-loaded respiratory muscle trainer has been described in case reports [62-64]. As an example, an 18-year old soccer player experienced resolution of PVFM symptoms after five weeks of a five day per week regimen (five sets of 12 breaths) of inspiratory muscle training [63]. The inspiratory resistance was set at 75 percent of maximum inspiratory capacity.

Handouts and internet resources are often helpful for supervisors (in the case of adults) and parents, school personnel, and coaches (in the case of children and adolescents), so they will understand the challenges of someone with a diagnosis of PVFM. Patients (or their parents) may request that the SLP communicate with other care providers regarding strategies for coping with an episode, or to report progress or reasonable expectations for a return to activity.

## **ADDITIONAL RESOURCES**

American Academy of Asthma Allergy and Immunology

[AAAAI Vocal Cord Dysfunction](#)

American Thoracic Society: Patient Information

[American Thoracic Society Vocal Cord Dysfunction](#)

National Jewish Health

[National Jewish Health Vocal Cord Dysfunction](#)

## **SUMMARY AND RECOMMENDATIONS**

- Paradoxical vocal fold motion (PVFM) refers to an inappropriate adduction of the true vocal folds, most prominently on inspiration. This results in dyspnea and stridor, typically inspiratory. Rarely, vocal fold adduction will be worse on expiration. (See '[Introduction](#)' above.)
- PVFM may be triggered by exercise or may occur spontaneously. (See '[Etiologies](#)' above.)
- PVFM is often mistaken for asthma because it is episodic, may be brought on by exertion, and the stridor may sound similar to wheezing. Some patients have both

asthma and PVFM. In asthma, however, the wheezing is typically expiratory. (See '[Clinical presentation](#)' above.)

- Flow-volume curves may show flattening of the inspiratory loop consistent with extrathoracic airway obstruction ([figure 2](#)). Between episodes, spirometry is often normal. (See '[Evaluation and diagnosis](#)' above.)
- The diagnosis is confirmed by flexible laryngoscopy during an episode by visualization of abnormal adduction of the vocal folds and exclusion of other causes of glottic and subglottic obstruction. In some patients, the glottic aperture may be obliterated during inspiration except for a posterior diamond-shaped passage ([figure 1](#)). (See '[Evaluation and diagnosis](#)' above.)
- The differential diagnosis of PVFM includes asthma, angioedema, bilateral vocal fold palsy, glottic and tracheal neoplasms or stenosis, laryngotracheomalacia, and laryngospasm. (See '[Differential diagnosis](#)' above.)
- In patients with an acute episode of PVFM, we suggest initially using a combination of reassurance and panting maneuvers ([Grade 2C](#)). If this is not effective, continuous positive airway pressure (CPAP) may be helpful; inhalation of a helium-oxygen mixture would be another alternative. (See '[Treatment](#)' above.)
- In patients with recurrent PVFM, we suggest a long-term management strategy that combines speech therapy, psychological counseling, and avoidance of perceived laryngeal irritants ([Grade 2C](#)). Patients with exercise-related PVFM may benefit from using an inhaled anticholinergic agent prior to exercise. When PVFM coexists with asthma, medications for asthma should be continued during treatment for PVFM. (See '[Treatment](#)' above.)

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