

Paradoxical Vocal Fold Motion

Jessica B. Howell and Jaime Eaglin Moore



Jessica B. Howell



Jaime Eaglin Moore

WHAT IS PARADOXICAL VOCAL FOLD MOTION?

PARADOXICAL VOCAL FOLD MOTION (PVFM) is a laryngeal disorder characterized by paroxysmal episodes of vocal fold adduction (closure) during respiration. It is also commonly referred to as vocal cord dysfunction (VCD). These episodes lead to transient obstruction in airflow, as the vocal folds should normally close only during phonation, cough, or swallow. Sudden closure during PVFM can lead to symptoms of respiratory distress and inspiratory stridor (noisy breathing).¹

This disorder was described first in 1842 under the term “hysterical croup.”² Since that time, a better understanding of the pathophysiology has developed, and it is now known to have multiple etiologies. Patients often are able to identify specific triggers agitated with their episodes, such as exercise, emotional distress, changes in temperature or humidity, “postnasal drip,” singing, talking, laughing, odors, or other inhaled irritants.³ Symptoms also can induce stress and anxiety for patients.⁴

PVFM is underdiagnosed and commonly confused with poorly controlled asthma.⁵ It may take several years to establish a correct diagnosis of PVFM.⁶ For these reasons, the incidence is difficult to assess. It has been shown to represent 22% of patients presenting to the Emergency Department with recurrent dyspnea (trouble breathing), up to 27% of school-aged children with presumed poorly controlled asthma, and approximately 3% of patients presenting to asthma clinics.⁷ PVFM has a female preponderance, with a 2–3:1 ratio. For females, there is a bimodal peak, one around 14 years old and the other 36 years old. The stereotypical presentation is a female, high-achieving student with multiple extracurricular activities, whose symptoms are brought on by strenuous activity such as athletic competition or singing, or other high stress situations.⁸ A singing teacher should suspect PVFM in the presence of noisy inhalation and trouble catching one’s breath occurring in a student after heavy exercise, including singing.

WHAT IS THE ETIOLOGY OF PVFM?

Vocal fold adduction (closing the vocal folds) serves as protective function, preventing aspiration. Glottic closure is controlled by recurrent laryngeal and superior laryngeal nerves, which are branches of the vagal nerves.⁹ Nerve dysfunction in the form of laryngeal sensory neuropathy might play a role in the development of PVFM. Upper respiratory infection, neurologic disorders, previous neck surgery, reflux, trauma, allergens, tobacco abuse, or other inhalational irritants may lead to a generalized laryngeal hyper-responsiveness.

The acid reflux seen in both gastroesophageal reflux disease (GERD) and laryngopharyngeal reflux (LPR) can lead to edema and irritation, triggering reactive laryngeal symptoms.¹⁰ LPR-induced laryngospasms are described typically as acute episodes with sudden onset.¹¹

PVFM can be a manifestation of a neurologic disorder. Respiratory dystonia (uncontrolled movement) is a neurologic cause of PVFM. Respiratory dystonia can be seen as an isolated disorder of the larynx or in association with other abnormalities.¹² Compared to other dystonia, this may resolve with time as patients can outgrow the dystonia by their late teens or early 20s. PVFM also can be found in multisystem atrophy and multiple sclerosis as well as other neurologic diseases, but PVFM in these cases typically is seen later in the disease process.¹³

While associated medical conditions can contribute to the development of PVFM, psychosocial factors such as abuse, anxiety, depression, and emotional distress can be associated with the disorder. Additionally, the symptoms of PVFM can be distressing, leading to anxiety and stress in these patients.¹⁴

HOW DO YOU DIAGNOSE PVFM?

Diagnosis of PVFM typically should include a detailed clinical history and laryngeal examination. These patients may report symptoms of dyspnea (shortness of breath), throat tightness, aphonia (loss of voice), hoarseness, anxiety, cough, globus sensation, and possibly a choking sensation. In some cases, violent coughing episodes may be the primary complaint. Classically, the patient will report trouble inhaling with neck tightness and voice changes during episodes. Nighttime symptoms are rare. The patient, teachers, or family members frequently report hearing inspiratory stridor (noisy breathing) during the episodes.¹⁵

Normal vocal fold motion should be documented between episodes. During episodes, greater than 50% closure of the glottis is seen on inspiration with the classic finding of posterior glottic “chink” (a diamond-shaped opening at the posterior third of the vocal folds). Abnormal vocal fold closure during inspiration is required for the diagnosis of PVFM, but some patients have been noted to have closure with exhalation, as well. This is a somewhat controversial finding, as during nor-

mal exhalation the vocal folds may adduct slightly.¹⁶ If a patient presents with a known trigger, an episode can be provoked and the larynx visualized during the episode to confirm the diagnosis. Techniques to provoke the episodes during an exam can include fast, loud counting on one breath, running up and down stairs (or in place), or other provoking maneuvers. Visualization of an episode is not required to make a diagnosis, but it is helpful specifically if the clinical history is not clear. Abnormal objective voice parameters also have been found in patients with PVFM, specifically an increased shimmer and jitter.¹⁷

The diagnosis can be supported further by spirometry and flow-volume loop analysis (lung function tests).¹⁸ This is particularly important given that up to 50% of patients with PVFM have been given concurrent diagnosis of asthma.¹⁹ While asthmatic patients tend to display blunting of expiratory loops on flow volume analysis, patients with PVFM show a flattening of the inspiratory flow loop.²⁰ In fixed obstructions (i.e., laryngeal stenosis), there is truncation of both inspiratory and expiratory loops. Pulse oximetry (blood oxygen level) can be helpful in the diagnosis, as unlike patients with asthma, those with PVFM will have normal oxygenation during acute attacks.²¹

Allergic reaction, infection, pulmonary disease, foreign body inhalation, and fixed airway obstruction such as vocal fold immobility should be ruled out.²² PVFM is often misdiagnosed as asthma. Asthma may co-exist with PVFM, but with isolated PVFM failure to respond to asthma medications such as β 2-agonists and corticosteroids is typical.²³

Laryngeal electromyography (LEMG) may help in the diagnosis of respiratory dystonia as well as assist in biofeedback, which can be used for treatment. In many patients with PVFM paradoxical adduction may be detected electrically even when it is not apparent clinically.²⁴ Evaluation by a neurologist should be considered especially if other neurologic symptoms are reported. For LPR, pH testing may be helpful in diagnosis and management. Allergy testing may be considered for those patients with the appropriate history, with management including antihistamine, nasal steroids and immunotherapy, to name a few.

PVFM can be difficult to diagnosis with multiple contributing factors; so, interdisciplinary approach with a

pulmonologist, allergist, neurologist, otolaryngologist, psychiatrist, and speech pathologist should be used.

HOW DO YOU TREAT PVFM?

Similar to the diagnosis, PVFM treatment should be multidisciplinary. This should include patient education. Patients' comprehension of the disorder can be enhanced by biofeedback. This involves the patient visualizing the episode on laryngoscopy and controlling the episodes with techniques discussed below. Treatment of comorbid factors also should be addressed. If psychosocial triggers are noted, cognitive behavioral therapy and involvement of a mental health specialist are helpful. Additionally, control of reflux, asthma, and allergies is important.²⁵ Control of allergies includes improving nasal breathing, as laryngeal dryness from oral breathing may make patients more prone to episodes.

The mainstay of PVFM treatment is respiratory retraining and utilization of escape strategies as taught by a speech-language pathologist. These techniques work to decrease laryngeal muscle tension and create more regular and efficient breathing patterns.²⁶ Exercises focus on creating a steady flow of air utilizing abdominal breathing over chest breathing and a rhythmic pattern to the breath with equal time for inhalation and exhalation.²⁷ A straw can be utilized for respiratory retraining exercises. Other techniques commonly employed include exhaling against resistance. This may involve either a sustained pattern (e.g., phonating "sh" as long as possible) or a pulsed pattern (e.g., phonation such "shh-shh-shh"). These exhalations are broken-up with a nasal sniff.²⁸ Patients should be encouraged to practice these exercises, allowing for muscle memory and a more automatic response during an episode.²⁹ The techniques can be practiced in the presence of an identified trigger, providing the patient with additional practice.³⁰ Having family members or coaches available during session creates a knowledgeable support system for the patient to utilize during episodes.

Adjuncts to speech therapy and for severe cases include utilizing a mixture of helium and oxygen (termed heliox) or noninvasive, positive-pressure ventilation.³¹ Heliox allows for less turbulent airflow decreasing the sensation of dyspnea, but it does not lead to vocal fold relaxation.³² When anxiety or other psychiatric condi-

tions are a component of the presentation, benzodiazepines or ketamine have been shown to be effective, but long-term use of these medication should be avoided through identification and treatment of the underlying cause.³³ In respiratory dystonia, botulinum toxin injection into the vocal folds can be employed to decrease adduction of the vocal folds.³⁴ For singers, using frequent low doses may help control the symptoms and minimize the adverse effects, such as breathy voice or voice instability during loud singing due to lack of lateral resistance from Botox-induced vocalis muscle weakness. Accurate diagnosis is needed to avoid unnecessary management options such as tracheotomy tube placement.

With appropriate treatment, PVFM is a manageable disease. The crucial aspect of the disorder is appropriate diagnosis. This will improve with continued education of patients and health care providers, and singing teachers. Singing teachers should be familiar with PVFM as many teachers commonly are the first person to recognize symptoms of this treatable condition. Teachers should not hesitate to refer student for evaluation and to participant in their care.

NOTES

1. Nizhoni Denipah, Christopher M. Dominguez, Erik P. Kraai, Tania L. Kraai, Paul Leos, and Darren Braude, "Acute Management of Paradoxical Vocal Fold Motion (Vocal Cord Dysfunction)," *Annals of Emergency Medicine* 69, no. 1 (January 2017): 18–23.
2. Laura Matrka, "Paradoxical Vocal Fold Movement Disorder," *Otolaryngologic Clinics of North American* 47, no. 1 (February 2014): 135–146; doi:10.1016/j.otc.2013.08.014. Robley Dunglison, "The Practice of Medicine; Or, a Treatise on Special Pathology and Therapeutics," *The American Journal of the Medical Sciences* 6 (1842): 257–258; doi:10.1097/00000441-184204000-0009.
3. Denipah et al. Matrka. Marcy Hicks, Susan M. Brugman, and Rohit Katial, "Vocal Cord Dysfunction/Paradoxical Vocal Fold Motion," *Clinics in Office Practice* 35, no. 1 (March 2008): 81–103; doi:10/1016/j.pop.2007.09.005. Anna M. Marcinow, Jennifer Thompson, L. Arick Forrest, and Brad W. Desilva, "Irritant-Induced Paradoxical Vocal Fold Motion Disorder," *Otolaryngology—Head and Neck Surgery* 153, no. 6 (August 2015): 996–1000; doi:10.1177/0194599815600144.
4. Hicks et al.
5. Matrka.

6. Denipah et al. N. Patel, "Concurrent Laryngeal Anomalies in Patients with Paradoxical Vocal Fold Motion," *Otolaryngology—Head and Neck Surgery* 129, no. 2 (August 2003); doi:10.1016/s0194-5998(03)00804-0.
7. Denipah et al. Matrka. Patel. K. Kenn and R. Balkissoon, "Vocal Cord Dysfunction: What Do We Know?," *European Respiratory Journal* 37, no. 1 (January 2011): 194–200; doi:10.1183/09031936.00192809. M. Seear, "How Accurate is the Diagnosis of Exercise Induced Asthma among Vancouver Schoolchildren?," *Archives of Disease in Childhood* 90, no. 9 (September 2005): 898–902; doi:10.1136/adc.2004.063974.
8. Kershena S. Liao, Paul E. Kwak, Hazel Hewitt, Sarah Hollas, and Julina Ongkasuwan, "Measuring Quality of Life in Pediatric Paradoxical Vocal Fold Motion Using the SF-36v2," *Journal of Voice* 31, no. 4 (July 2017); doi:10.1016/j.rmed.2011.08.023.
9. Hicks et al.
10. Matrka. Maria Claudia Franca, "Differential Diagnosis in Paradoxical Vocal Fold Movement (PVFM): An Interdisciplinary Task," *International Journal of Pediatric Otorhinolaryngology* 78, no. 12 (2014): 2169–2173; doi:10.106/j.ijporl.2014.10.003.
11. Aaron J. Jaworek, Daniel A. Deems, and Robert T. Sataloff, "Spasmodic Dysphonia," in Robert T. Sataloff, ed., *Professional Voice: The Science and Art of Clinical Care*, 4th ed. (San Diego: Plural Publishing, 2017), 1077–1099.
12. Venu Divid, Mary J. Hawkshaw, and Robert T. Sataloff, "Paradoxical Vocal Fold Motion in Pediatric Voice Disorder," in Christopher J. Hartnick and Mark E. Boseley, eds., *Pediatric Voice Disorders: Diagnosis and Treatment* (San Diego: Plural Publishing, 2008), 253–264.
13. Jaworek et al.
14. Hicks et al. Franca.
15. Denipah et al. Matrka.
16. Hicks et al. Matrka.
17. Franca. Kursat Yelken, Erdogklan Gultekin, Mehmet Guven, Ahmet Eyibilen, and Ibrahim Aladag, "Impairment of Voice Quality in Paradoxical Vocal Fold Motion Dysfunction," *Journal of Voice* 24, No. 6 (November 2010): 724–727; doi:10.1016/j.jvoice.2009.05.004.
18. Denipah et al. Hicks et al.
19. Seear. Kenneth W. Rundell and Barry A. Spiering, "Inspiratory Stridor in Elite Athletes," *Chest* 123, no. 2 (February 2003): 468–474; doi:10.1378/chest.123.2.468.
20. Denipah et al. Hicks et al. Matrka. Thomas Murry, Sabrina Cukier-Blaj, Alison Kelleher, and Khalid H. Malki, "Laryngeal and Respiratory Patterns in Patients with Paradoxical Vocal Fold Motion," *Respiratory Medicine* 105, no. 12 (December 2011): 1891–1895; doi:10.1016/j.rmed.2011.08.023.
21. Hicks et al.
22. Denipah et al.
23. Hicks et al. Matrka. Marcinow et al. Liao et al.
24. R. T. Sataloff, personal communication (May 28, 2019).
25. Hicks et al.
26. Denipah et al. Hicks et al. Marcinow et al.
27. Denipah et al. Hicks et al. Matrka. Marcinow et al. Franca. Thomas Murry and Christine Sapienza, "The Role of Voice Therapy in the Management of Paradoxical Vocal Fold Motion, Chronic Cough, and Laryngospasm," *Otolaryngologic Clinics of North America* 43, no. 1 (February 2010): 73–83; doi:10.1016/j.otc.2009.11.004.
28. Franca. Murry and Sapienza.
29. Hicks et al. Matrka. Franca.
30. Marcinow et al.
31. Denipah et al. Hicks et al. Matrka. Liao et al.
32. Hicks et al.
33. Denipah et al. Hicks et al. Matrka.
34. Hicks et al. Matrka. Liao et al.

Dr. Howell was born and raised in Savannah, GA. She attended the University of Virginia, where she graduated with distinction. She then attended the Medical College of Georgia, where she received multiple scholarships and was inducted into the Alpha Omega Alpha Honors Society. She then returned to Virginia for her Otolaryngology/Head and Neck Surgery residency, which she completed at Virginia Commonwealth University in Richmond in 2020. During her residency, Dr. Howell served as chief resident, authored numerous publications, and presented at multiple national ENT conferences. She has joined Otolaryngology Associates of Tennessee, and she is currently practicing in Nashville, TN.

Jaime Eaglin Moore, M.D., M.S. is an otolaryngologist and laryngologist. Dr. Moore is board certified by the American Board of Otolaryngology. Dr. Moore received her Doctor of Medicine degree from Eastern Virginia Medical School, and she completed a residency in Otolaryngology—Head and Neck Surgery at Virginia Commonwealth University in Richmond, Virginia. She was a fellow in laryngology and care of the professional voice at the American Institute for Voice and Ear Research, and complete a master's degree in Clinical Research and Biostatistics at Virginia Commonwealth University. She has authored numerous publications and is an editor for the *Journal of Voice* and *ENT Journal*. She is an associate professor in the Department of Otolaryngology, affiliate professor in the Department of Music and medical director of speech language pathology at Virginia Commonwealth University.