Behavioral Management of Paradoxical Vocal Fold Motion

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Abstract

Paradoxical vocal fold motion (PVFM), or vocal cord dysfunction (VCD), is a non-organic, behavioral, upper airway disorder primarily characterized by adduction of the true vocal folds during respiration. Recognition of this condition is becoming more prevalent amongst physicians, resulting in an increased number of referrals to speech-language pathologists (SLPs) for assessment and treatment. Diagnosis of PVFM requires a multidisciplinary approach. Treatment for PVFM is also multi-factorial, but is primarily designed to train abduction of the vocal folds during the breathing cycle, allowing easy movement of breath to and from the lungs without laryngeal constriction. Behavioral management is the preferred and most common approach to treatment and may include relaxed throat breathing and laryngeal control exercises during trigger-specific training.

Paradoxical vocal fold motion (PVFM), or vocal cord dysfunction (VCD), is a non-organic, behavioral, upper airway disorder that is primarily characterized by malfunction of the true vocal folds during respiration (Blager, 2006). In some cases, the supraglottic structures, such as the false vocal folds or epiglottis, may be involved (Blager, 2006). The upper airway is then constricted during a portion of the respiratory cycle, typically inhalation, resulting in varying degrees of dyspnea with accompanying laryngeal symptoms. This may be quite frightening for the patient, sometimes causing associated high anxiety or panic with the dyspnea. Historically, PVFM has been considered to mimic asthma, with PVFM being recognized as the reason for treatment failure in one-third of patients diagnosed with refractory asthma (Newman, Mason, & Schmaling, 1995). In extreme cases, the patient seeking emergency care that is unresponsive to breathing treatments may be treated with emergency intubation or tracheostomy. Despite the complex nature of this disorder, there are several distinct features used to differentially diagnose PVFM from other disorders of breathing.

Though PVFM has been documented across the lifespan, there are certain demographic patterns identified in the literature, including increased prevalence in female patients with the majority of reported cases between the ages of 10 and 40 (Kuppersmith, Rosen, & Wiatrak, 1993). School-age children and adolescents with PVFM are often high-achieving, competitive athletes who work hard to excel in school. Depending on the nature of the sport, young athletes may describe more difficulty breathing during intensive practices consisting of exhausting fitness drills and/or during competition. The onset of the breathing difficulties may begin at a time when the patient's athletic demands are suddenly increased, such as when joining a more competitive team or when moving from grade school to high school. It is estimated that approximately 5% of American Olympic athletes experience dyspnea due to PVFM, with increased

difficulties occurring in those performing in cold air (Rundell & Spiering, 2003). Patterns among adult patients with PVFM are less obvious, making it more challenging to develop a "typical" adult profile.

Though there are no definitive pathophysiological causes of PVFM, it can be attributed to a number of underlying mechanisms, such as laryngopharyngeal irritation, laryngeal trauma secondary to frequent coughing and throat clearing, irritable larynx syndrome, and vocal fold paresis (Kenn & Hess, 2008). As the larynx is considered the most functionally sensitive part of the respiratory tract due to its complexity and primary function of protecting the airway, PVFM is the result of the upper respiratory tract being threatened.

SLPs are uniquely qualified to detect laryngeal-respiratory abnormalities, and considered the primary provider in the identification and treatment of PVFM. As the signs and symptoms of PVFM become increasingly recognized within the medical and athletic communities, SLPs are receiving an increased number of direct referrals from various medical specialists, including pulmonologists and pediatricians. Effective treatment requires an in-depth understanding of laryngeal-respiratory function, the ability to appropriately evaluate the glottic airway, and working knowledge of intervention techniques to aid the patient in maintaining a normal glottic airway during respiration. The following article aims to provide the reader with an understanding of the multidisciplinary assessment required for proper diagnosis of PVFM, including the SLP's specific role in evaluation, as well as to describe fundamental intervention techniques.

Diagnosis of Vocal Cord Dysfunction

There are a variety of assessment tools for the evaluation of PVFM. A team approach may involve input from pulmonologists, otolaryngologists, gastroenterologists, cardiologists, allergy/immunologists, psychologists, and SLPs (Altman, Mirza, Ruiz, & Sataloff, 2000; Mathers-Schmidt, 2001). Commonly, patients will have a pulmonary consult that may include chest radiography, pulmonary function testing, pulse oximetry, arterial-blood-gas analysis, and methacholine provocation. Less common assessments of diagnosis and cause may include laboratory tests, gastroenterology workup, and allergy testing. Diagnosis and cause of PVFM may in part be made by process of exclusion. Differential diagnoses may include asthma or other pulmonary disorder (i.e., pleural effusion, collapsed lung), laryngeal abnormality, cardiovascular disease, tracheal or glottic stenosis, cardiac pathology, laryngospasm, irritable larynx syndrome/chronic cough, or general inefficient breathing patterns.

Because pulmonary workup is common in the assessment and diagnosis, it is important to briefly discuss commonly used pulmonary indicators of PVFM. One of the most common indicators is the flow-volume loop obtained during spirometry, which demonstrates a flattened inspiratory flow loop when the patient is symptomatic (Brugman & Newman, 1993; Christopher et al., 1983; Selner et al., 1987). Additionally, patients with PVFM will demonstrate much variability and poor reproducibility in spirometric testing (Goldman & Muers, 1991). A patient with PVFM will demonstrate unchanged pulmonary function only after bronchial provocation (i.e., negative methacholine challenge) and have normal or near-normal pulse oximetry. Coexistence of breathing disorders mediated by the pulmonary system also occurs and should not be overlooked. In a study by Hanks et al. (2012), PVFM occurred with exercise-induced bronchospasm in 31% of cases and with asthma in 8% of cases. Another study by Traister, Fajt, Whitman-Purves, Anderson, & Petrov (2013) reported coexistent asthma and PVFM in 36% of cases.

SLPs play perhaps the most important role in the diagnosis of PVFM. They must obtain a detailed case history of the problem, broadly assess the patient's breathing patterns, conduct skilled fiberoptic laryngoscopy, and synthesize information obtained during the assessment with all previous testing the patient may have undergone. Although it is helpful to have results

of previous testing and attempted treatments, evaluation by the SLP can be done prior to workup by related professionals.

During the case history, relevant information may include questioning the patient about onset of the dyspnea with any co-occurring events or illnesses, duration of episodes, triggers, presence, and location of tightness/pain, concurrent cough, lightheadedness, hoarseness or aphonia, sense of effort with inhalation versus exhalation, presence of stridor or wheezing, psychosocial stress, and attempted treatments and response. The following reported symptoms would be suggestive of PVFM: fairly sudden onset of dyspnea induced by a specific trigger (i.e., exercise, psychosocial stress, gastroesophageal reflux, or inhaled irritant), tightness in the throat, difficult inhalation, stridor upon inhalation, concurrent dry cough and hoarseness during an attack, and lightheadedness that resolves fairly quickly when the trigger is removed. Throughout the case history, the clinician should be acutely aware of the patient's resting breathing pattern and use of breath support for voicing. For example, clavicular breathing, frequent shallow or short breaths, and lack of diaphragmatic movement may predispose the patient to an attack or exacerbate the PVFM once it begins.

Perhaps the most important part of the SLP's evaluation and the current gold standard for diagnosis of PVFM is the use of fiberoptic laryngoscopy (Bahrainwala & Simon, 2001; Balkisoon & Kenn, 2012; Chiang, Goh, Ho, Tang, & Chay, 2008; Newman, Mason, & Schmaling, 1995). Flexible nasoendoscopy is preferential to rigid assessment because of its ability to assess laryngeal dynamics including sustained phonation, running speech, laughing, panting, sniffing, and deep breathing. Endoscopy is also key in ruling out structural abnormalities such as subglottic and glottis stenosis or obstructive laryngeal lesion. Breathing patterns are assessed during resting breathing and after inducing dyspnea when there is a known trigger. If the patient presents with a known diagnosis of asthma, it is imperative he or she brings his or her rescue inhaler to be used in the event an asthma attack occurs during the evaluation. Using flexible nasoendoscopy, the SLP assesses the airway for paradoxical adduction of the true vocal folds with or without involvement of the supraglottic structures, which may be present during inhalation or exhalation. The classic presentation of PVFM includes presence of a posterior glottic chink, usually during inhalation, in which the anterior two-thirds portion of the bilateral true vocal folds are adducted and the posterior one-third portion creates a diamond-shaped glottic gap (Morris, Allan, & Perkins, 2006; Perkner et al., 1998). Once PVFM has been identified, the clinician instructs the patient on laryngeal control exercises/relaxed throat breathing to eliminate the acute episode of PVFM and to begin use of visual biofeedback as part of patient education and intervention.

Treatment of Vocal Cord Dysfunction

Treating patients with PVFM can be like chasing one's shadow unless they've been appropriately and accurately diagnosed. To reiterate, ruling out other diagnoses is just as important as the inclusion of other diagnoses that may co-occur with PVFM in order to effectively treat patients with PVFM. There are principles of treatment that can be used across the board with nearly all patients with PVFM, just as there are individualized areas of treatment based on specific PVFM triggers. In any scenario, the goals of treatment are centered on establishing and maintaining a wide open glottic airway by re-establishing the appropriate muscle patterning for vocal fold abduction during the breathing cycle. For some, this may be all that is required, but for many more, this repatterning will also involve the muscles of inhalation and exhalation and synchronizing these muscle groups into a more efficient breathing pattern that is not mediated by the vocal folds. In treating PVFM, the SLP most often takes the lead role (Brugman & Simons, 1998).

Establishing the Glottic Airway

Probably the most disconcerting sensation in PVFM is the feeling of not being able to breathe. Establishing an open airway is often the first step in reducing high levels of anxiety and/or

outright panic that often accompanies this feeling. It is important to help patients realize that breathing is not only possible during the trigger event, but a consistently achievable goal that will eventually become automatic once again.

Relaxed Throat Breathing

The basis for treating PVFM lies in training the vocal folds to abduct and stay abducted during the breathing cycle whether engaged in quiet breathing or during a trigger event, such as exercise. Inhaling through the nose with the tongue in a relaxed position on the floor of the mouth and lips gently touching, then exhaling through pursed lips is the basic training exercise (Mathers-Schmidt, 2001). Variations on this include exhaling on the /s/ or "sh" phonemes, creating a restriction in the most forward part of the oral cavity. The nasal inhalation induces abduction of the vocal folds (brain stem reflex) while the partially obturated exhalation creates posterior vocal tract air pressure which helps maintain the abducted position of the vocal folds. Great emphasis is placed on exercise frequency since the goal is to retrain a muscle group, so each patient is instructed to do 20 sets of 5 repetitions of this sequence each day during quiet breathing activities (e.g., reading, watching television, walking from classroom to classroom). Since a majority of our patients with PVFM are athletes of one kind or another, this breathing method is also taught during exercise, mainly running. Care is taken to start slowly and then to gradually "push the envelope" of the trigger. With trained athletes, taking them to a level of exercise intensity that mimics what they do in their sport is often times difficult, if not impossible in the clinic, even if you have a reliable, calibrated treadmill or exercise bike. Therefore, it is a requirement that the patient takes their therapeutic experience to their sport in order to complete the carryover of their skills.

Diaphragmatic Breathing

It is not unusual for a PVFM patient to develop a breathing pattern where the abdomen contracts on the inhale and expands on the exhale, complicating the breathing disorder and decreasing the efficiency of the breathing cycle. Part of the training for PVFM patients then is instruction in engaging the diaphragm more efficiently for inhalation and engaging the abdominal muscles more efficiently for exhalation. This usually starts with the patient lying supine on a massage table with a weight (i.e., heavy book, 5–10 lb. hand weight if available) positioned on the abdomen. They are instructed to, "push the weight towards the ceiling with your belly on inhalation, let it depress towards your belly on exhalation." Instructions include taking a maximum inhale to achieve full distension of the belly and then a maximum exhale to achieve sustained contraction of the abdominal muscles. In the supine position, most patients are able to master this breathing pattern within a few trials. Once mastery in the supine position is achieved, the patient stands with one hand on his/her belly with slight pressure for tactile feedback. The instructions are to, "make your hand move away from your body while inhaling, move it back towards your core while exhaling." Once the appropriate pattern is established, then it is adapted to what Blager (2006) described as "activity-based breathing" with the focus on the ribcage for more rapid inhalation/exhalation, gently pursed lips, and focus on breathing from the front of the mouth to avoid pulling from the larynx. This is then paired with activity: first walking, then easy jogging, then running, then exercise running, and so forth. The goal, again, is to push the envelope of the trigger.

Exercise Specific Training

Most athletes engage in a variety of different fitness activities in order to train for their sport. Many sports require core training, which helps strengthen the abdominal muscles, as well as other muscle groups. Many core strengthening exercises involve weight bearing, such as sit ups, planking exercises, and push-ups. Weight-bearing activities tend to encourage a pattern of breath holding to bear the weight, which, in turn, encourages the vocal folds to adduct during the breathing cycle when they should be abducted. This leads to periods of several seconds when there is no air exchange, further habituating the maladaptive pattern of breathing. Training

athletes to breathe properly during any core strengthening or weight-bearing activities is important in reversing the pattern of vocal fold adduction to an abducted pattern. Relaxed throat breathing is taught to our patients while doing these types of exercises, inhaling through the nose while releasing the weight, exhaling through pursed/obstructed lips while bearing the weight.

Swimmers

A challenging subset of athletes who present with PVFM are swimmers. Swimmers are trained to function in an anaerobic state much of the time with the breathing cycle altered. In three of the four strokes in swimming (freestyle, butterfly, breast stroke), the swimmer's face is in the water at least 50% of the time. In the fourth stroke (backstroke), the swimmer is bombarded with water splashing in his/her face due to the rapid rotation of the arms/shoulders, making it more difficult to inhale through the nose efficiently. Certain workouts may require the swimmer to hold the breath for long periods of time, such as one pool length, in order to build the anaerobic capacity of the cardiovascular system. This, however, aids in training the vocal folds to adduct during the breathing cycle and potentially an exacerbation of PVFM symptoms. The training in relaxed throat breathing is altered due to the challenge of inhaling through the nose while swimming (and risking inhaling a large amount of water).

The alteration in training these athletes centers on how to get the breath without adducting the vocal folds. Because of the decreased amount of time a swimmer has to get a breath because the face is out of the water only briefly, nasal inhalation may not be the most efficient method due to the possibility of inhaling water. In this case, the swimmer is instructed to "sip" breath through slightly parted lips and to forcefully exhale, trying to empty the lungs of breath. This creates a negative pressure in the lungs, which needs to be equalized. The physiologic response is: vocal fold abduction to allow maximum airway size to allow the air pressure to equalize and inflate the lungs for the next breath cycle. As always, starting slowly in each stroke, feeling comfortable as the intensity level gets higher, and pushing the envelope of the trigger is all important. In training for the backstroke, the same principles apply with regard to taking "sips" of breath through slightly parted lips and exhaling forcefully. Practicing both in and out of water is essential. Out of water practice with the swimmer lying on an exercise ball while mimicking their strokes coupled with relaxed throat breathing techniques gives them an opportunity to train the vocal folds in a more controlled condition and helps in the transition to in water training. In training the anaerobic capacity of the cardiovascular system, the extended breath holding pattern can be altered to a long, slow exhalation for the duration of the underwater lap.

Odors and Other Factors

While many PVFM patients we see are of the athletic variety and fit the typical demographic, there are still some who experience PVFM in the absence of aerobic/anaerobic activity and whose symptoms are triggered by strong odors and sensitivity to such. In these patients, the treatment of PVFM follows the same principals outlined above; however, what changes here is a hierarchy of odiferous triggers is developed and presented, starting with those not noxious to the patient. Then, progressively noxious odors are presented while the patient practices relaxed throat breathing in the presence of these odors. The most noxious odors are introduced last with the patient gaining greater facility and confidence as each level on the hierarchy of noxious odors is achieved. Many times with odor-specific triggers, there is an added layer of laryngeal sensitivity, such as acid reflux irritation (Perkner et al., 1998; Powell et al., 2000), or perhaps an allergic condition that also needs to be successfully addressed in order to successfully treat PVFM.

Some patients also will have positively diagnosed asthma in addition to PVFM, which can make PVFM treatment somewhat challenging. In order to deliver asthma medication efficiently and effectively, the glottic airway needs to be sufficiently abducted to allow delivery of inhaled

asthma medication to the lower airways. In addition to teaching relaxed throat breathing as previously outlined, patients are instructed to use their inhaled medication prior to a workout or competition in order to minimize the effects of asthma on breathing, as well as to use a spacer with their inhaler if appropriate to aid in efficient delivery of the medicine. If instruction is needed in the use of the spacer, then any instruction they have received from the pulmonologist is practiced and reinforced.

Final Thoughts

Even with years of experience, PVFM can be a perplexing disorder to treat due to its complexity physiologically/biologically in addition to the confounding factors, such as acid reflux and asthma that can challenge both the patient and SLP. With proper training, guidance, and patience, the patient can successfully navigate the minefield of PVFM to a successful and rewarding conclusion.

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