One Hundred Case Series of Vocal Cord Dysfunction in a Military Treatment Facility

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The authors' evaluation of vocal cord dysfunction cases reveals that prevalence may be higher than previously reported in the literature.

Vocal cord dysfunction (VCD), also known as paradoxical vocal cord movement, is described as paroxysms of glottis obstruction due to true vocal cord adduction.[1] Since VCD presents as a constellation of symptoms associated with dyspnea, it often is misdiagnosed as asthma.[2] Vocal cord dysfunction often manifests as episodic dyspnea and wheezing, may occur with exercise, and may be minimally responsive to initial therapies. Flattened inspiratory curves may be noted on pulmonary function tests (PFTs), but direct laryngoscopy is the gold standard for diagnosis.[3] A cohort of proven patients with VCD with a plateau in the inspiratory curve of PFTs also had a plateau on expiratory phase in 81% of cases.[4]

The differential diagnosis of patients presenting with upper airway symptoms is broad. It must include VCD, asthma, angioedema, laryngomalacia, vocal cord polyps, vocal cord tumors, and neurologic conditions such as brain stem compression or movement disorders. Essentially, all movement disorders of vocal cords must be considered, and organic causes of this movement disorder can be evaluated by visualization of the vocal cords. Triggers for VCD include exercise, airborne irritants, gastroesophageal reflux disease (GERD), allergic rhinitis, medications, and psychological conditions.[5] Additionally, VCD can coexist with asthma, further complicating accurate diagnoses.[6]

Therapies are reported in case studies, but no large randomized controlled trials exist to evaluate current therapy options. Primary treatments of asthma therapy were largely ineffective, and ideal therapy includes a multidisciplinary approach, including speech therapy to optimize laryngeal control and treatment of all identified laryngeal irritants.[6]

The prevalence of VCD is unknown, with no prospective cohort studies completed to date and conflicting diagnostic criteria used in many case studies.[7] A prevalence of 2.8% was noted in one particular cohort of 1,028 patients admitted to a rehabilitation center in a calendar year with the primary pulmonary diagnosis on admission.[6] Females seemed to be affected at a higher ratio than were males, 2 to 3 females per 1 male diagnosis.[7]

In the military population, certain risk factors were noted in returning deployed members, including anxiety/high stress, exercise, and acute respiratory illnesses.[8] In that particular cohort, 72% positive predictive value was noted for VCD if flattened inspiratory flow loops with negative methacholine challenge were present.

Diagnostic criteria are challenging, as symptoms such as dyspnea may be present acutely, last < 2 minutes, be self-limiting, and completely resolve outside of acute events. Stridor may be noted, primarily above the vocal cords, and less audible on chest auscultation.[6] A goal of therapy, in addition to dedicated speech pathologist input, is optimizing comedical conditions, including GERD, allergic rhinitis, concomitant asthma, and any psychological diagnoses.[9]

Athletes are a particular subset of patients with VCD who are crucial to appropriately diagnose, including a detailed history and physical, PFTs, and proceeding to direct laryngoscopy to confirm diagnoses.[10] Behavioral management includes rescue breathing techniques, and speech therapy programs focus on

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relaxation of the larynx and diaphragmatic breathing techniques, with the goal of establishing sense of control during acute events.[10] Military service members are expected to operate at a high-intensity level similar to that of athletes, and treatments considered for athletes are applicable to military service members as well. Military strength and cardiovascular standards are measured by a combination of push-ups, sit-ups, and a run test, in addition to waist measurements. Some of the cohort were identified during physical fitness standard failures, usually in the run test, and ultimately received a pulmonology referral for wheezing or dyspnea with exertion. The objective of this retrospective cohort study was to evaluate 100 consecutively diagnosed cases of VCD in a military treatment facility.

METHODS

The authors conducted a retrospective chart review of DoD military medical records of outpatient diagnoses in 100 consecutive diagnoses of VCD from January 2011 to February 2014. Institutional review board approval was obtained under Project RSM20130001E by the Exempt Determination Official at Eglin Air Force Base (AFB), Florida.

All cases were identified at time of VCD visualization and were diagnosed with video stroboscopy by speech therapy or by visual laryngoscopy by the otolaryngology or pulmonology departments via direct visualization.

Cases were collected chronologically, and all diagnosed cases at Eglin AFB hospital were included. Follow-up was scheduled with all patients diagnosed in Speech Therapy, and most patients were concurrently treated by Pulmonology or Allergy/Immunology. Pulmonary function tests were obtained in 98 of the 100 diagnosed cases. Patients eligible for care at Eglin AFB included active-duty and Reserve military members plus dependents and retirees.

The majority of patients diagnosed in this cohort were seen and diagnosed by Speech Therapy. Video stroboscopy is based on the principle that a movement of an object higher than a certain flicker rate appears to stand still to direct visualization, but with a rate of light exposure and imaging above the flicker rate by video, the true movement of the object can be identified.[11] Video stroboscopy is considered highly sensitive for organic disorders of vocal cords, but it is not specific for either organic or dysfunctional disorders.[11] It is still the gold standard above direct visualization, as it can detect abnormal movement of vocal cords above the critical rate that the human eye would perceive as not moving due to the frequency of movement (Figures 1 & 2).[11]

In an older study, laryngoscopy was able to diagnose 100% of patients with symptomatic paradoxical vocal cord movement and additional 60% asymptomatic patients with a constellation of symptoms consistent with paradoxical vocal cord movement.[12]

Speech Therapy; Ear, Nose, and Throat (ENT); and Pulmonology may not perform direct visualization in these patients at initial presentation due to other suspected diagnoses. A more common test is the PFT, especially if asthma or other airway tract diseases are suspected (Figure 3).

PATIENT DESCRIPTIONS

Study patients were referred for a variety of reasons, often from primary care clinics for concerns for asthma, episodic dyspnea, wheezing, or decreased exercise tolerance thought to be related to pulmonary or allergy causes. Pulmonology worked closely with Speech Therapy and referred VCD cases for speech evaluation, including video stroboscopy. Notably, of the patients in this cohort, although some were suspected to have asthma, those patients were ruled out during part of the pulmonology evaluation, both with PFT testing and methacholine challenges. An asthma diagnosis is important in a military treatment facility, as asthma is often grounds for discharge.

Patients ranged in age from 13 to 68 years, with a median age at 31 years diagnosis. Thirty-nine females and 61 males comprised the total case series. Speech Therapy diagnosed 97 patients, 96 were diagnosed at Eglin AFB hospital via stroboscopy. One patient was diagnosed off-base by Speech Therapy via direct visualization,

Table. Pulmonary Function Testing Data

Data	Median	Range
FEV_1	3.66	1.23-6.04
FVC	4.46	1.67-7.14
FEV_1/FVC	0.82	0.54-1.20
PIF	5.06	0.91-9.29
PEF	8.21	2.96-15.05
PIF/PEF	0.61	0-1.04
MVV	118.50	34-203.00
MVV/FEV_1	32.00	14.4-48.70
FEF 25%-75%	3.31	0.73-6.38

Abbreviations: FEF 25%-75%, forced expiratory flow from 25%-75% of FVC; FEV_1, forced expiratory volume at 1 second; FVC, forced vital capacity; PIF, peak inspiratory flow; PEF, peak expiratory flow; MVV, maximum voluntary ventilation.

Figure 1. Normal Vocal Cord Function During Inspiration

Figure 2. Paradoxical Adduction of Vocal Cords During Inspiration

Vocal cords showing the loss of available airflow capability; this motion can vary in severity.

1 patient was diagnosed by Pulmonology on-base via direct visualization, and 2 patients were diagnosed by ENT on-base via direct visualization. These patients had direct laryngoscopy completed, often to rule out other organic causes for upper airway disease processes, and were found to have visual paradoxical vocal cord movement. Ninety-eight patients completed PFTs. Several patients were lost to follow-up, as can be common in a military population with frequent moves or members leaving service.

On record review, patient symptoms were present in the range of 2 months to 20 years, with a median duration of symptomatic reports lasting 2 years prior to diagnosis. Common diagnoses prior to visual VCD diagnosis included asthma, exercise-induced asthma, anxiety, and episodic wheezing. Risk factors that were evaluated in this case series included age, sex, body mass index (BMI), GERD, allergic rhinitis, postnasal drip, active smoker, previous smoker, and mental health diagnoses (Figure 4).

Pulmonary function test results were analyzed on 98 patients, including forced expiratory volume in 1 second (FEV_1); forced vital capacity (FVC), FEV_1/FVC ratio; peak inspiratory flow (PIF) and peak expiratory flow (PEF)—available in 97 studies; forced expiratory flow (FEF) at 25% to 75% of FVC (FEF 25%-75%)—available in 96 studies; and maximum voluntary ventilation (MVV) and MVV/FEV_1 ratio—available in 60 of 98 PFTs.

INTERVENTIONS

All patients diagnosed by Speech Therapy on-base were provided with laryngeal relaxation techniques, diaphragmatic breathing techniques, and controlled inhale/exhale techniques at time of diagnosis, with frequent follow-up scheduled with Speech Therapy and Pulmonology. All diagnoses potentially contributing to laryngeal irritation were treated, including GERD, allergic rhinitis, smoking cessation, weight loss, and exercise recommendations as needed

Patients reported improvement on follow-up appointments with Speech Therapy in overall control of symptoms, subjectively categorized as poor improvement, partial improvement, and complete improvement. This was a subjective measurement of improvement and fully dependent on follow-up care and patient reporting for improvement. No predefined number of follow-ups was determined; patients were followed monthly until they declined further care, fully improved, moved out of the military treatment system, or were lost to follow-up.

Treatment included structured Speech Therapy sessions. Response to treatment was subjectively qualified by patient report. Fifteen patients reported complete resolution of symptoms, 57 reported partial improvement, 24 reported poor improvement, and 4 patients were lost to follow-up.

RESULTS

Risk factors for the diagnosis of VCD included possible associations with GERD, allergic rhinitis, smoking, prior smoking, BMI, and mental health diagnoses. Body mass index ranged from 17 to 36 in the case series, with median BMI of 27. Mental health diagnoses were present in 35 patients and included diagnoses of anxiety, depression, and adjustment disorders. Gastroesophageal reflux disease diagnosis was present in 59 of the case series patients, 80 had the diagnosis of allergic rhinitis, 63 were diagnosed with postnasal drip. Sixteen case series patients were current smokers. An additional 26 were previous smokers (at least 100 cigarettes in lifetime) for a total of 42 patients that were current or prior smokers.

The chart review was completed to evaluate for the presence of these diagnoses, which included previous treatments; for example, proton pump inhibitors for GERD, antidepressants for depression, or intranasal steroids for allergic rhinitis. The diagnosis was counted as present if the patient was currently being treated for the particular diagnosis in question.

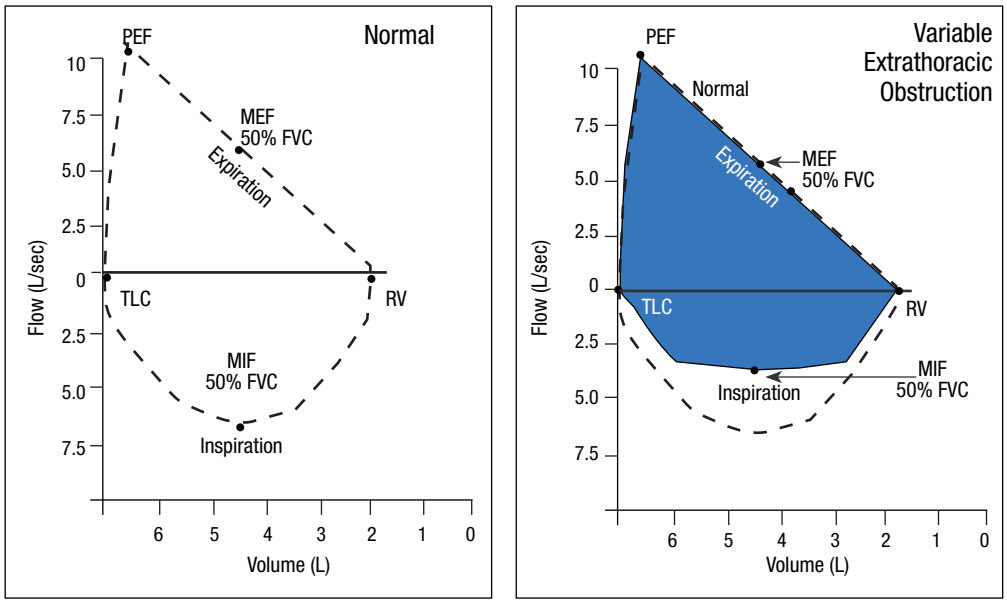
PFT Data

Data from PFTs were available for 98 of 100 cases diagnosed. Review of data across all 98 patients is noted for median FEV_1 of 3.6, a median FVC of 4.5, with ratio of 0.80. The median PIF was 5.1, and median PEF was 8.2, with a PIF/PEF ratio of 0.62. Mid-flow volumes also were analyzed, and FEF 25% to 75% median was 3.3. For the 60 patients that had minute ventilator volumes calculated, the median MVV was 118.5 L/min and median MVV/FEV_1 was 32.0 (Table).

Since PFT values vary according to age, sex, and ethnicity, PFTs were analyzed for percent predicted values based on age, gender, and race. Notably, median values for FEV_1, FVC, and PEF were all close to 100% of the predicted value. The MVV percent predicted was available in 60 cases and was 93% of predicted values. The most significant difference from expected values was FEF 25% to 75%, at 84% of expected results.

Flow-volume loop evaluations on the 97 PFTs available were completed, and 58 of the 97 were noted for variable extrathoracic airway obstruction consistent with inspiratory inhibition in the patient population. This is 60% of the available PFTs in this cohort study.

Figure 3. Flow-Volume Loops



A normal flow-volume loop compared with a variable extrathoracic obstruction as seen with VCD. Expiration essentially remains normal, while a flattened inspiratory peak often can be seen in the VCD patient.
Abbreviations: FVC, forced vital capacity; MEF, mid-expiratory flow; MIF, maximum inspiratory flow; PEF, peak expiratory flow; RV, residual volume; TLC, total lung capacity; VCD, vocal cord dysfunction.
Source: Parker R, ed. *MSD Manual Professional Version* (Known as the *Merck Manual* in the U.S. and Canada). http://www.msdmanuals.com/professional. Updated 2016. Accessed February 6, 2017.

DISCUSSION

This retrospective chart review of 100 consecutive VCD diagnoses in a military treatment facility reinforces many of the findings currently available in the literature. As illustrated in a *Chest* review article, the diagnosis of VCD on history, physical examination, or PFTs remains ellusive.[1] The PFT evaluation contains some subjectivity regarding the flattening of inspiratory flow-volume loops and is not routinely reported in PFT results. In patients diagnosed with VCD, a clear consensus of treatment modalities remains lacking. Modification of risk factors (allergic rhinitis, GERD, smoking cessation, weight loss) assisted in self-reported patient improvement, as did focused speech therapy.

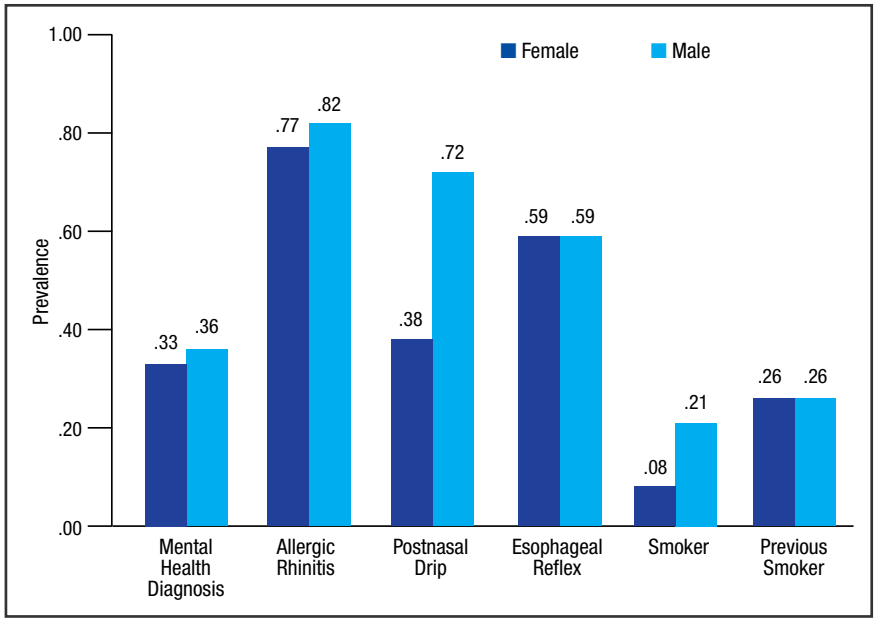
The median age of 31 years, likely reflected the younger military population served at Eglin AFB. Seventy-five of these patients were currently on active duty, 6 were retired from active duty (veterans), and 19 were dependents. The median time of symptoms to diagnosis was 2 years. Prior misdiagnosis with other diseases such as asthma was common. Also, referral to Pulmonology and Speech Therapy was usually completed after failed outpatient primary care management for the alternative diagnoses.

Improvement with therapy was mixed, and during the time of documented follow-up, 72 patients reported complete or partial improvement. Most active-duty patients in the partial improvement category based this subjective reporting on their ability to meet military physical fitness standards.

Previous data suggested a female predominance, but this study population was 61% male. Military populations are about 80% to 85% male, so an increase in male diagnosis is expected.

Many patients in the patient cohort arrived as a result of

Figure 4. Associated Comorbidities by Gender



Pulmonology referrals with a presumptive diagnoses of asthma but were determined not to have asthma through PFT results inconsistent with asthma, no improvement with β-agonist therapies, and negative methacholine challenges (if performed). These results prompted evaluations for other conditions and eventually a VCD diagnosis. As noted, exclusion of asthma is of particular importance in a military population, as medical discharges often are pursued in service members with asthma whether controlled or uncontrolled. Lag time to referral also is possible in failures of military physical, which prompted medical evaluation once several failures had occurred over a 1- to 2-year time frame.

The PFT data evaluation was inconclusive for statistically significant changes when compared with age-matched normal PFT values. This also was noted in previous studies of VCD cases. Most notable was percent predicted values of FEF 25% to 75%, with 84% of expected values. The FEV_1, FVC, and PEF all fell within predicted values of normal, despite wide ranges in age, sex, and ethnicity among the subjects. Inspiratory flattening consistent with extrathoracic obstruction was present in 58 of the 97 PFTs available for review at Eglin AFB.

Limitations

Limitations to this retrospective case series are illustrated here. Cases were found only when VCD was diagnosed and coded; and it is the authors' suspicion that many have been misdiagnosed or improperly treated for asthma or other pulmonary/oropharynx conditions. If providers are not familiar with VCD or if PFT readings do not comment on inspiratory findings, diagnosis is less likely. Some of the authors' colleagues already have determined that postdeployment prevalence of VCD seems to be elevated.[8]

This cohort was completed on all patients in a military treatment facility, with 75 active-duty personnel, 6 veterans, and 19 dependents of varying ages. This case series is retrospective and tabulates suspected risk factors; stronger and more informative studies could certainly be completed in prospective studies (although likely difficult with low prevalence) or in treatment comparison studies at the time of diagnosis.

Since the cohort had varied and lengthy time to diagnosis from onset of related symptoms, the treatment patients received prior to diagnosis differed extensively. Diagnosis was completed by numerous primary care managers or other subspecialties prior to arrival to Pulmonology and Speech Therapy at Eglin AFB. Once diagnosed in Speech Therapy, consistent treatment options were provided to patients in accordance with standard of care.

It is the authors' suspicion that VCD may have a higher prevalence than previously reported in the literature. Military service members are tested annually or biannually on physical fitness standards and are evaluated for medical reasons for recurrent fitness standard failures. This selection of patients is more likely to have a VCD evaluation as part of a comprehensive evaluation than is a healthy adult in a civilian population. A prospective study in military service members would be more fruitful and possibly yield a higher prevalence postdeployment.

CONCLUSION

Vocal cord dysfunction remains a difficult diagnosis to treat, because multiple comorbidities likely contribute to the diagnosis. This retrospective case series attempted to compile common themes and noted that most of the patients had 2 or more risk factors of smoking, allergic rhinitis, GERD, or mental health diagnoses. A prospective trial

would be ideal to evaluate VCD further. A focused trial in the particular communities of athletes or of military service members may be of increased benefit to better define VCD. It is notable that 100 cases were found in a relatively short period for a community hospital, and prevalence may be higher than previously reported. ●

Author disclosures

The authors report no actual or potential conflicts of interest with regard to this article.

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