

Letter to the Editor

Masqueraders of exercise-induced vocal cord dysfunction

To the Editor:

Vocal cord dysfunction (VCD) is well known to asthma specialists as a masquerader of asthma that should be considered in patients who fail to respond to asthma treatment.¹ Because asthma and VCD have overlapping symptoms (dyspnea, wheezing, chest tightness) and triggering factors (exercise, irritant exposures), using the clinical history to distinguish VCD from asthma may be difficult. However, VCD is more likely when a patient previously thought to have asthma localizes the sensation of airflow obstruction to the throat with choking or stridor.² Exercise-induced VCD is a particularly common cause of dyspnea and upper chest or throat symptoms that have failed to improve with aggressive treatment for exercise-induced asthma. The confirmation of VCD requires direct or indirect visualization of paradoxical laryngeal motion during symptoms.^{1,3,4} Because VCD symptoms are episodic, performing a laryngoscopy in an asymptomatic patient is usually not sufficient to document paradoxical motion. Consequently, many clinicians diagnose VCD provisionally without visualizing the larynx, choosing instead to proceed with empiric treatment that typically involves a consultation with a speech pathologist for laryngeal relaxation training.

This report describes 5 cases involving recurrent respiratory symptoms caused by physiologically significant anatomical abnormalities resulting in symptoms during exercise. In each case, an asthma specialist suspected exercise-induced VCD and referred the patient to our VCD clinic for symptom provocation and laryngoscopy. Table I and this article's Table E1 in the Online Repository at www.jacionline.org summarize the clinical presentation and findings of each of the cases. The VCD clinic evaluation included a detailed history, physical examination, and baseline laryngoscopy. Each of these patients was generally very healthy without a history

of severe respiratory illness, intubation, laryngeal trauma, or autoimmune disease. Patients 1, 2, and 3 underwent exercise challenge with repeat laryngoscopy during symptoms.

During his evaluation in the VCD clinic, patient 1 had apparent fixed adduction of both arytenoid cartilages that partially occluded the airway, resulting in obstruction of airflow during inspiration. Additional findings during symptoms provoked by exercise challenge included inspiratory prolapse of the arytenoids into the glottic space (laryngomalacia) and inspiratory adduction of the vocal cords. Subsequent consultation at the Seattle Children's Hospital Laryngology Clinic revealed that the primary pathology was unilateral right arytenoid fixation. Patient 2 also had a fixed right arytenoid (see this article's Fig E1 in the Online Repository at www.jacionline.org) with postexercise inspiratory prolapse of both arytenoids into the glottic space. Patients 1 and 2 both underwent surgical removal of the abnormally positioned arytenoid tissue, resulting in improvement in their exercise-induced symptoms.

Laryngomalacia is a term used to describe reduced laryngeal tone and a predilection toward prolapse of supraglottic structures, causing obstruction of airflow. Most cases are congenital, present in infancy, and resolve within a year or 2 without long-term sequelae. However, laryngomalacia also may present after infancy in conjunction with acid reflux, sleep apnea, or intense exercise.⁵⁻⁷ Patients 1 and 2 are examples of adolescent athletes with exercise-induced symptoms caused by fixed positioning of arytenoid cartilage with laryngomalacia. Exercise-induced laryngomalacia in adolescents is well described^{5,7} and is not rare. However, it is usually not associated with other laryngeal anatomic abnormalities,⁶ and it may be closely related to vocal cord dysfunction. Patients 1 and 2 in our series were distinct from patients with previously reported forms of exercise-induced laryngomalacia because the primary reason for symptoms was unilateral immobility of an arytenoid cartilage.

TABLE I. Masqueraders of exercise-induced VCD: presentation and findings in 5 patients

Patient no.	Age (y)	M/F	Activity resulting in symptoms	Presenting symptoms during exercise	Laryngoscopy findings in VCD clinic	Additional workup/treatment
1	11	M	Running (youth football)	Dyspnea, stridor	Apparent fixed adduction of both arytenoid cartilages; postexercise there was also laryngomalacia and partial inspiratory adduction of the vocal cords	Manual palpation of arytenoids revealed unilateral fixation of the right arytenoid ; right arytenoidectomy performed
2	16	M	Wind sprints (high school varsity football)	Dyspnea, throat tightness	Unilateral right arytenoid fixation ; postexercise there was also laryngomalacia without paradoxical vocal cord motion	Right arytenoidectomy
3	15	M	Tennis (high school varsity)	Dyspnea, chest tightness, inspiratory and expiratory hissing	Normal	Bronchoscopy: anomalous bronchi with stenotic left mainstem bronchus
4	37	F	Stationary bicycle	Dyspnea, wheezing, throat tightness	Subglottic stenosis	Rigid bronchoscopy with dilation
5	39	F	Treadmill	Dyspnea, throat tightness	Subglottic stenosis	Dilation using microdirect laryngoscopy/bronchoscopy

F, Female; M, male. Boldface indicates final diagnosis.

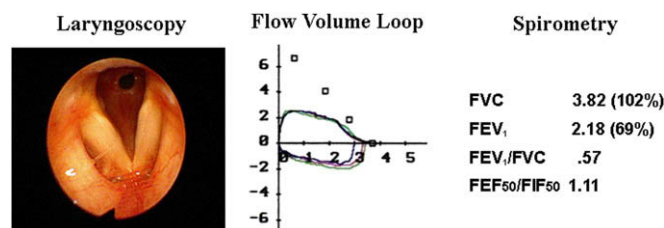


FIG 1. Left, Laryngoscopy photograph from patient 4 shows membranous stenosis just below the glottis with a small round posterior airway. Middle, Flow volume loop from patient 4 with significantly decreased expiratory and inspiratory flows, suggesting fixed obstruction. This illustrates the importance of examining both the flow volume loop and numeric data before interpreting abnormal findings. FEF₅₀/FIF₅₀, Ratio of forced expiratory flow to forced inspiratory flow at 50% FVC. Right, Spirometry from patient 4 reveals low FEV₁, normal forced vital capacity, and low FEV₁/forced vital capacity.

Patient 3 had a normal laryngoscopy and spirometry in our VCD clinic, both at baseline and during symptoms provoked by exercise challenge. Because the observed symptoms included a loud hissing sound without bronchospasm, he was also referred to the Seattle Children's Hospital Laryngology Clinic, where laryngoscopy and bronchoscopy were performed together under general anesthesia. The markedly abnormal findings included a tracheal origin of the right upper lobe bronchus (see this article's Fig E2) followed by a stenotic trachea with complete tracheal rings before to the origins of the left main bronchus and bronchus intermedius. In addition, further workup revealed that his left main pulmonary artery arose on the right side, arching behind the distal trachea to perfuse the left lung. Despite these findings, patient 3 continues to compete on his high school varsity tennis team. The consulting cardiothoracic surgeons feel that he will likely require surgical correction electively in several years because of the risk of progressive respiratory failure.

In patients 4 and 5, laryngoscopy identified subglottic stenoses (Fig 1), and both were referred to the University of Washington Laryngology Clinic, where they underwent dilation procedures that enabled resumption of exercise without symptoms. Both cases were labeled *idiopathic subglottic stenosis* after having a negative laboratory workup for autoimmune disease. Two years after treatment, patient 4 experienced a gradual relapse of symptoms, and she recently had a second dilation procedure.

In each of these patients, the referring asthma specialist suspected VCD on the basis of a history of exercise-induced symptoms that were refractory to asthma medications and/or involved discomfort localized to the throat. Alternative diagnoses became evident only after laryngoscopy, either at rest or during symptoms provoked by exercise challenge. Previous published reports have identified a range of diagnoses encountered in children with exercise-induced dyspnea⁷ and in patients referred to a laryngology clinic for VCD,⁸ and these diagnoses include laryngomalacia, sulcus vocalis, vocal cord nodules, vocal cord paralysis, subglottic stenosis, hyperventilation syndrome, and supraventricular tachycardia. Along with this previous literature, our study underscores the fact that diagnoses other than VCD sometimes present to asthma specialists masquerading as exercise-induced asthma, and that confirming the diagnosis of VCD requires visualization of the larynx during symptoms.

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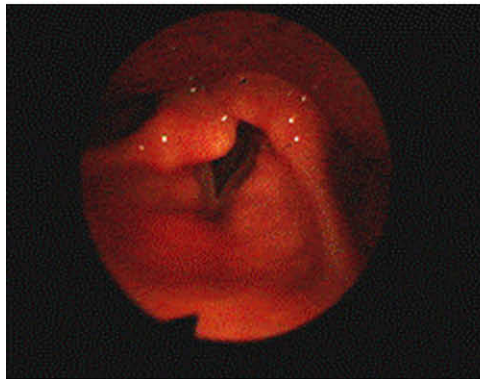
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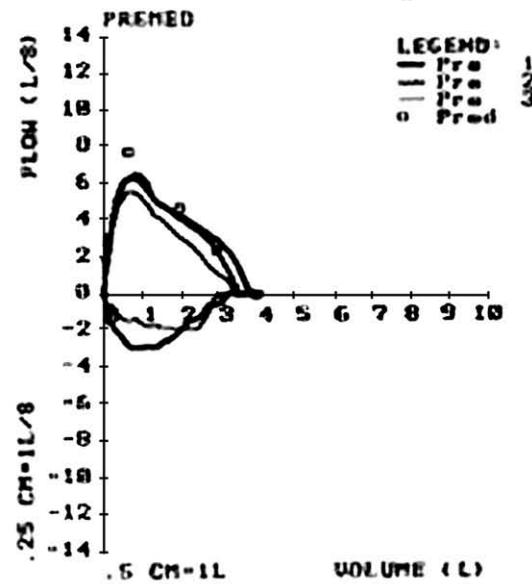
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Laryngoscopy



Flow Volume Loop



Spirometry

FVC	3.85 (96%)
FEV ₁	3.65 (98%)
FEV ₁ /FVC	.95 (103%)
FEF ₅₀ /FIF ₅₀	1.66

FIG E1. *Left* Laryngoscopy photograph for patient 2 shows obstruction of the glottic opening by abnormal positioning of the right arytenoid. *Middle*, Truncation of the inspiratory portion of the flow volume loop in patient 2, suggesting extrathoracic obstruction. *Right*, Patient 2 spirometry findings include an abnormally elevated ratio of forced expiratory to forced inspiratory flow at 50% of forced vital capacity (FEF_{50}/FIF_{50}), suggesting extrathoracic obstruction.

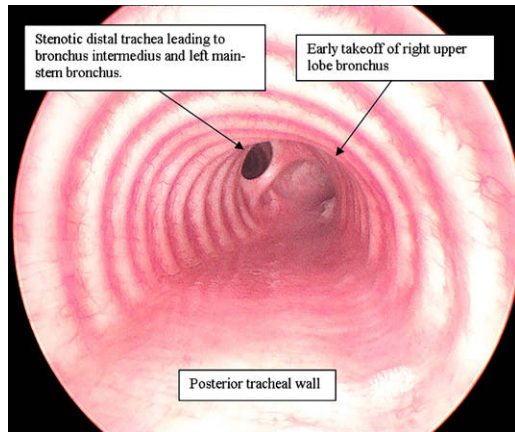


FIG E2. Patient 3: bronchoscopy photograph taken from the proximal trachea showing tracheal origin of the right upper lobe bronchus and stenosis of the distal trachea.

TABLE E1. Masqueraders of exercise-induced VCD: additional patient details

Patient no.	Referral source	Symptom duration at time of referral to VCD clinic	M/F	FEV ₁ (%)	FVC (%)	FEF ₅₀ /FIF ₅₀	Previous workup	Unsuccessful treatment
1	Pulm	9 y	M	129	131	1.28	CXR, ETT, laryngoscopy, methacholine challenge	L, FI, S, Sp
2	Aller	6 mo	M	98	96	1.66	ETT, barium swallow	La
3	Aller	11 y	M	92	118	0.88	Echocardiogram	FI, S, A, L, Sp
4	Aller	2.5 y	F	69	102	1.11	Chest CT, CXR	A, B, FI, S, M
5	Aller	1 y	F	100	109	3.00	Methacholine challenge	A

Abbreviations: *A*, Albuterol; *Aller*, board-certified allergist; *B*, budesonide; *CXR*, chest radiograph; *ETT*, cardiac treadmill exercise challenge with continuous electrocardiogram; *F*, female; *FI*, fluticasone propionate; *FEF₅₀/FIF₅₀*, ratio of forced expiratory flow to forced inspiratory flow at 50% of forced vital capacity; *FVC* (%), percent predicted of forced vital capacity (liters); *L*, levalbuterol; *La*, lansoprazole; *M*, male; *M*, montelukast; *methacholine*, methacholine challenge; *Pulm*, board-certified pulmonologist; *S*, salmeterol; *Sp*, speech therapy.