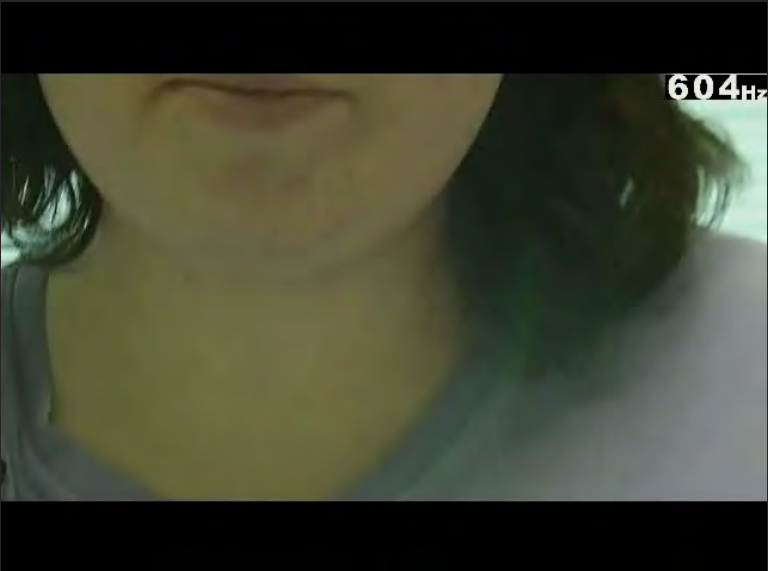

**Texas Children's
Hospital**

What's That Noise? Stridor in the Older Child/Teen


Julina Ongkasuwan, MD, FAAP, FACS
Associate Professor
Adult and Pediatric Laryngology

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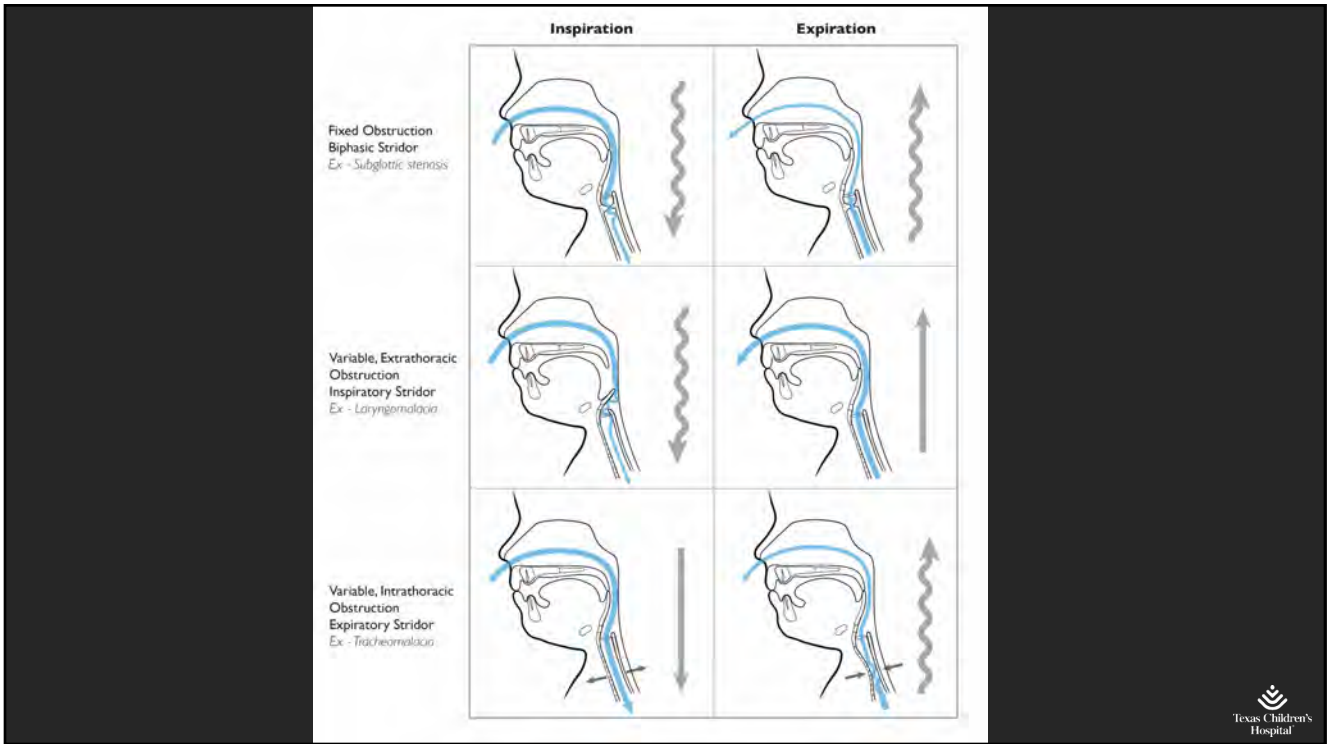
Case



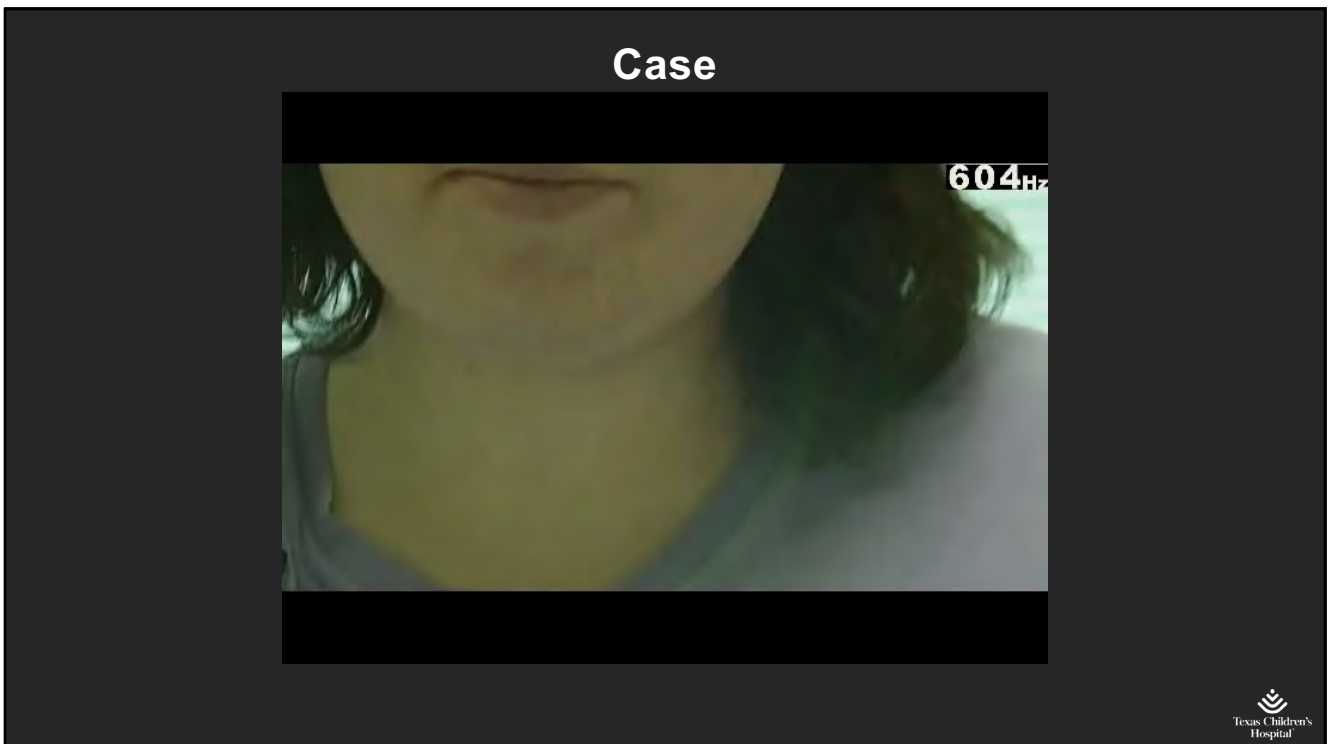
604Hz



125

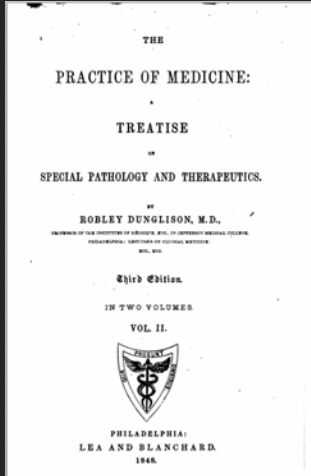


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Historical Perspectives



In hysterical females, a spasmodic affection of the laryngeal muscles is by no means unfrequent, giving rise to what has been termed "hysterical croup." The paroxysms consist of a long-protracted, loud and convulsive cough, followed, at times, by the crowing inspiration, and by dyspnoea so great as to threaten suffocation. This state may continue for two or three hours, until the patient faints, or a decided hysterical attack supervenes.

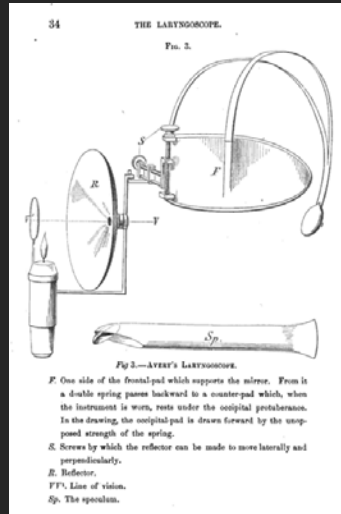
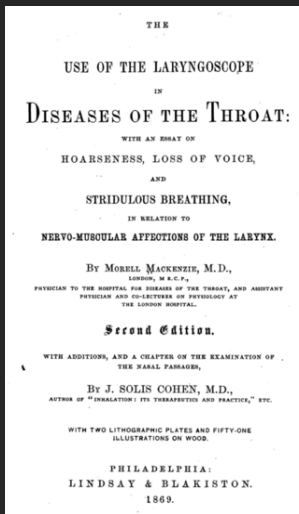
The Treatment is that recommended for hysteria. During the paroxysm, new impressions must be excited by cold water thrown over the face and neck; or by the *douche* from the spout of an ordinary teapot. In such a case, the inhalation of ether is clearly indicated; or the aromatic spirit, or the carbonate of ammonia, may be held to the nostrils; and when the patient is able to swallow, the various remedies advised for hysteria may be administered. In one case, creasote* was used with much benefit as an inhalation by Dr. Herndon, of Virginia.

* R.—Creasot. gtt. xxx.
Aq. fervent. Oij.—M.

Dunglison RD. The practice of medicine. Philadelphia: Lea and Blanchard, 1842:267-8.
Ibrahimi WH, Gheriani HA, Almohamed AA, Raza T. Paradoxical vocal cord motion disorder: past, present and future. *Postgraduate Medical Journal*. 2007;83:164-72.



Historical Perspectives



ally to a considerable extent. With the laryngoscope the vocal cords can be seen on inspiration to be spasmodically approximated. They may separate widely; but instead of remaining apart for a few seconds, they are instantly and spasmodically adducted to the median line, or even beyond it, that is, against one another. Often, in these cases, there is also excessive tension of the vocal cords. Sometimes the closure of the glottis is immediately followed by the spasmodic approximation of the ventricular bands (false vocal cords). In this case the view of the vocal cords is at once occluded. The surface of the larynx may appear perfectly

Mackenzie M. Use of laryngoscopy in diseases of the throat. Philadelphia:Lindsey and Blackeston, 1869:246-50.



Historical Perspectives

1566

THE NEW ENGLAND JOURNAL OF MEDICINE

June 30, 1983

VOCAL-CORD DYSFUNCTION PRESENTING AS ASTHMA

KENT L. CHRISTOPHER, M.D., RAYMOND P. WOOD II, M.D., R. CHRISTA ECKERT, M.D.,
FLORENCE B. BLAGER, PH.D., ROY A. RANEY, AND JOSEPH F. SOUHRADA, M.D., PH.D.

Osler W. Hysteria. The principles and practice of medicine. 4th edn. New York: Appleton, 1901:1111-22.
Patterson R, Schatz M, Horton M. Munchausen's stridor: non-organic laryngeal obstruction. Clin Allergy 1994;4:307-10.
Christopher KL, Wood RP, Eckert C, et al. Vocal cord dysfunction presenting as asthma. N Engl J Med 1983;308:1566-70.



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A Rose By Any Other Name?

Kent L. Christopher, MD^{a,*},
Michael J. Morris, MD^b

Periodic occurrence of laryngeal obstruction (POLO)
Paradoxical upper airway obstruction
Functional upper airway obstruction

Episodic Laryngeal Breathing Disorders: Literature Review and Proposal of Preliminary Theoretical Framework

ERS/ELS/ACCP 2013 international consensus conference nomenclature on inducible laryngeal obstructions

Pernille M. Christensen¹, John-Helge Heimdal², Kent L. Christopher³,
Caterina Bucca⁴, Giovanna Cantarella⁵, Gerhard Friedrich⁶, Thomas Halvorsen⁷,
Felix Herth⁸, Harald Jung⁹, Michael J. Morris¹⁰, Marc Remacle¹¹,
Niels Rasmussen^{12,13} and Janet A. Wilson¹⁴ on behalf of the ERS/ELS/ACCP
Task Force on Inducible Laryngeal Obstructions

Year
1974
1976
1989
1990
1991
1993
1993
1996
1999
2004

and "Katherine Verdolini Abbott, ^aPittsburgh, Pennsylvania, and ^b Auburn, Alabama

Christopher KL, Morris MJ. Vocal cord dysfunction, paradoxical vocal fold motion, or laryngomalacia? Our understanding requires an interdisciplinary approach. Otolaryngol Clin North Am. 2010 Feb;43(1):43-66, viii.
Shembel AC, Sandage MJ, Verdolini Abbott K. Episodic Laryngeal Breathing Disorders: Literature Review and Proposal of Preliminary Theoretical Framework. J Voice. 2016 Feb 24.
Christensen PM, Heimdal JH, Christopher KL, Bucca C, Cantarella G, Friedrich G, Halvorsen T, Herth F, Jung H, Morris MJ, Remacle M, Rasmussen N, Wilson JA. ERS/ELS/ACCP Task Force on Inducible Laryngeal Obstructions. ERS/ELS/ACCP 2013 international consensus conference nomenclature on inducible laryngeal obstructions. Eur Respir Rev. 2015 Sep;24(137):445-50.



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Differential Diagnoses

- Asthma
- Vocal fold movement impairment (paralysis/paresis)
- GERD/LPR
- Laryngotracheal Stenosis (glottic, subglottic, tracheal)
- Tracheal/Bronchomalacia
- Exercise induced laryngomalacia aka Intermittent arytenoid region prolapse
- Neurologic Disorders (Dystonia, Multiple System Atrophy, etc.)



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The Classic

Primary Complaints:

- Noisy breathing, “stridor” or “wheeze”
- Dyspnea
- Refractory to asthma medications

Secondary Complaints:

- Cough
- Chest tightness
- Throat tightness
- Changes in voice

- Exercise
- Stress or anxiety
- GERD/LPR
- Mucosal irritants
 - Inhaled odors/chemicals
 - Tobacco
 - Allergy
 - URI
 - Voice use
 - Cold air

O'Connell MA, Sklarew PR, Goodman DL. Spectrum of presentation of paradoxical vocal cord motion in ambulatory patients. *Ann All Asthma Imm* 1995;74:341-4.
 Powell DM, Karanfilov BI, Beechler KB, et al. Paradoxical vocal cord dysfunction in juveniles. *Arch Otolaryngol Head Neck Surg* 2000;126:23-34
<https://www.google.com/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=katie%20edecky>.



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The Classic

- Average age at onset
 - Children: 14.5 years
 - Adults: 33 years
- 2:1 to 3:1 female predominance
- Teen-age female
- High achiever
 - 46.2% straight-A students
 - 41% A's and B's
- Competitive athlete
 - Track (30%), Swimming (17%)



O'Connell MA, Sklarew PR, Goodman DL. Spectrum of presentation of paradoxical vocal cord motion in ambulatory patients. *Ann All Asthma Imm* 1995;74:341-4.
 Powell DM, Karanfilov BI, Beechler KB, et al. Paradoxical vocal cord dysfunction in juveniles. *Arch Otolaryngol Head Neck Surg* 2000;126:29-34
 Liao KS, Kwak PE, Hewitt H, Hollas S, Ongkasuwan J. Measuring Quality of Life in Pediatric Paradoxical Vocal Fold Motion Using the SF-36v2.Voice. 2017 Jul;31(4):518.e1-518.e5.



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Background



Primary PVFM (psychological): 75% of cases

- Conversion disorder with comorbid conditions: 50%
- Conversion disorder only: 20%
- Malingering: 5%

Secondary PVFM: 25% of cases

- Laryngeal hypersensitivity (aka irritable larynx)
- Neurologic
 - Focal respiratory dystonia
 - Multiple Sclerosis
 - Autonomic dysfunction

Forrest LA, Husein T, Husein O. *Laryngoscope*, 122:844-853, 2012



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Is it PVFM or Asthma?

Symptom	PVFM (%)	Asthma (%)
Wheezing	80	100
Cough	77	87
Dyspnea	83	97
Choking sensation	6	28
Chest pain	12	45
Stridor	18	6
Improvement with bronchodilators	10	90
Reflux	33	47
Voice changes	29	39
Difficulty with speech	6	26
Sputum production	3	80

Newman KB, Mason UG, Schmalig KB. Clinical features of vocal cord dysfunction. Am J Respir Crit Care Med 1995;152:1382-6.



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PVFM Screening Questionnaire

TABLE 6.
The PVFMD Screening Questionnaire

Instructions: Each Question Has Four Options That Relate to How Frequently You May Experience the Condition Asked on Each Question. Please Choose the Option That Most Closely Matches What You Feel.

	1	2	3	4	Score
1. I get hoarse when I cough.	1	2	3	4	Response * -0.29 = ___
2. I have tightness in my throat when I cough.	1	2	3	4	Response * -0.22 = ___
3. My cough is worse when I yell or laugh.	1	2	3	4	Response * 0.15 = ___
4. Strong smells (perfumes, cleaning supplies, others) make me cough.	1	2	3	4	Response * -0.02 = ___
5. Second hand smoke makes me cough.	1	2	3	4	Response * -0.2 = ___
6. If I relax, my cough goes away.	1	2	3	4	Response * -0.03 = ___
7. When I am having breathing problems, I feel like I am breathing through a straw.	1	2	3	4	Response * -0.12 = ___
8. When I am having breathing problems, I have trouble getting the air in.	1	2	3	4	Response * -0.25 = ___
9. When I am having breathing problems, albuterol spray makes me feel better.	1	2	3	4	Response * 0.45 = ___
10. When I am having breathing problems, albuterol nebulizations make me feel better.	1	2	3	4	Response * 0.32 = ___
11. When I am having breathing problems, stress makes my breathing worse.	1	2	3	4	Response * -0.05 = ___
12. If I relax, my shortness of breath goes away.	1	2	3	4	Response * -0.18 = ___
13. Strong smells (perfumes, cleaning supplies, others) cause my throat to close or tighten.	1	2	3	4	Response * 0.08 = ___
14. Strong smells (perfumes, cleaning supplies, others) make me feel out of breath.	1	2	3	4	Response * 0.2 = ___
15. Cold air makes me feel out of breath.	1	2	3	4	Response * -0.04 = ___

Total Score:
Scores < -1.17 favors PVFMD
Scores ≥ -1.17 favors asthma

Diagnosis of Asthma:

- Sensitivity = 89%
- Specificity = 73%

Ye J, Nouraei M, Holguin F, Gillespie AI. The Ability of Patient-Symptom Questionnaires to Differentiate PVFMD From Asthma. J Voice. 2017 May;31(3):382.e1-382.e8.



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Pittsburgh VCD Index

Original Article

A Novel Scoring System to Distinguish Vocal Cord Dysfunction From Asthma

Russell S. Traister, MD, PhD¹, Merritt L. Fajt, MD², Douglass Landsittel, PhD³, and Andrej A. Petrov, MD⁴ Pittsburgh, Pa

Throat tightness	4 points
Odors as a symptom trigger	3 points
Absence of wheezing	2 points
Dysphonia	2 points

≥ 4

Sensitivity of 83%

Specificity of 95%

Positive predictive value of 96%

Negative predictive value of 77%

- 42% patients misdiagnosed as asthma for 9 years
- 50% patients with asthma had PVFM

asthma. This suggests in turn that abnormal vocal cord movement may represent a **coexisting condition**—rather than an alternative diagnosis—in this group. It tallies with the impression of many clinicians that patients with difficult-to-treat asthma have coexistent laryngeal dysfunction. Mechanistically, it raises the possibility that **asthma and laryngeal dysfunction** are interrelated conditions with **“laryngeal hyperresponsiveness”** as an intrinsic and unsuspected characteristic of asthma itself. Conceivably, intermittent

Traister RS, Fajt ML, Landsittel D, Petrov AA. A novel scoring system to distinguish vocal cord dysfunction from asthma. J Allergy Clin Immunol Pract. 2014 Jan-Feb;2(1):65-9.
Traister RS, Fajt ML, Whitman-Purves E, Anderson WC, Petrov AA. A retrospective analysis comparing subjects with isolated and co-existent vocal cord dysfunction and asthma. Allergy Asthma Proc 2013;34:349-55.
Low K, Lau KK, Holmes P, et al Abnormal vocal cord function in difficult-to-treat asthma. Am J Respir Crit Care Med. 2011 Jul 1;184(1):50-6



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Work Up – What Would You Do?

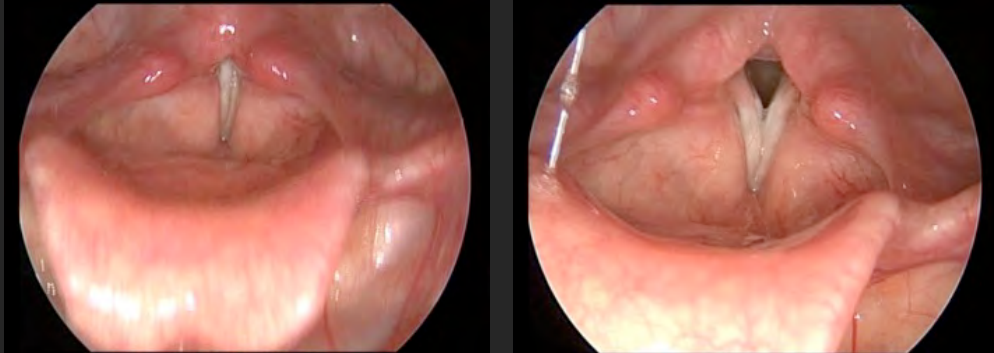
- Laryngoscopy
- Exercise Laryngoscopy
- Pulmonary Function Testing
- Methacholine Challenge Testing



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Laryngoscopy

- Gold standard
- Exclude fixed obstructive airway lesion
- >50% closure on inspiration?



Morris MJ, Christopher KL. Diagnostic criteria for the classification of vocal cord dysfunction. *Chest* 2010;138:1213-1223.
 Olin JT, Clary MS, Connors D, Abbott J, Brugman S, Deng Y, Chen X, Courey M. Glottic configuration in patients with exercise-induced stridor: a new paradigm. *Laryngoscope*. 2014 Nov;124(11):2568-73



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Confirming the Diagnosis

- Intra-rater reliability for LUS $\kappa=0.94$
- Inter-rater reliability LUS $\kappa=0.78$
- LUS vs. FNL $\kappa=0.78$

		95% Confidence Interval	
Sensitivity	0.83	0.60	0.94
Specificity	0.95	0.75	1
Positive Predictive Value	0.95	0.73	1
Negative Predictive Value	0.84	0.63	0.95

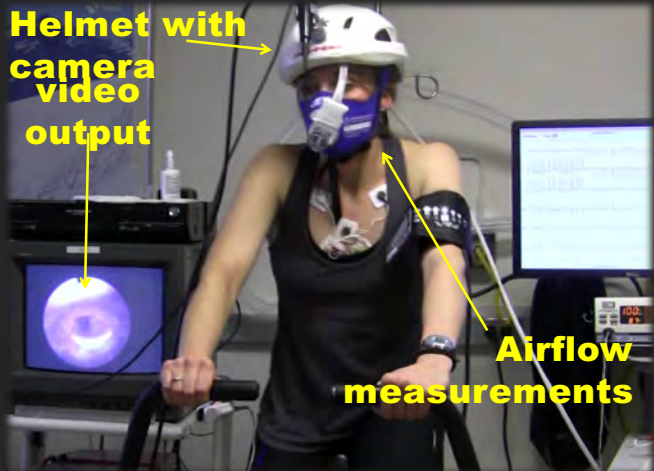


Finnoff JT, Orbelo DM, Ekbohm DC Identification of Paradoxical Vocal Fold Movement with Diagnostic Ultrasound: Confirmation with Video Laryngoscopy *PM R*. 2019 Aug 14.
 Ongkasuwan J, Ocampo E, Tran B. Laryngeal ultrasound and vocal fold movement in the pediatric cardiovascular intensive care unit. *Laryngoscope*. 2017 Jan;127(1):167-172



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Continuous Laryngoscopy During Exercise

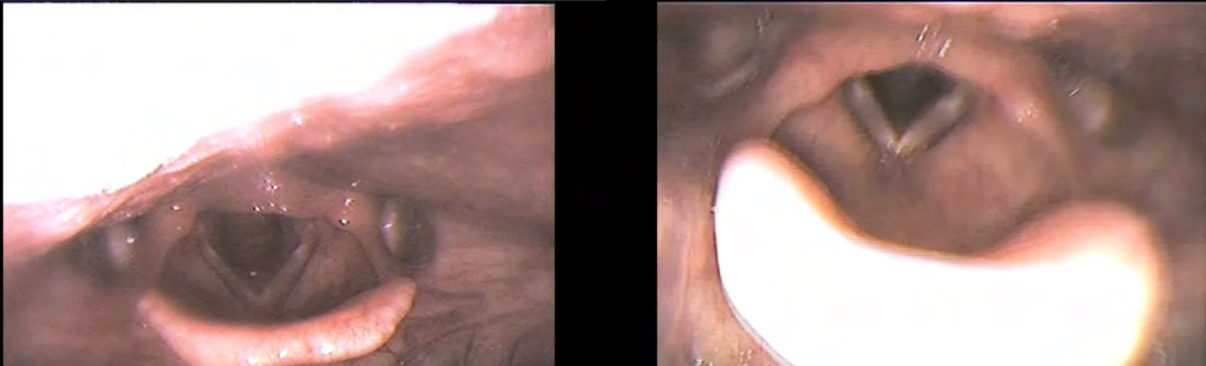


Credit: Tod Olin, MD, MSCS (exercise@njhealth.org)

Credit: Tod Olin, MD, MSCS (exercise@njhealth.org)



Continuous Laryngoscopy During Exercise



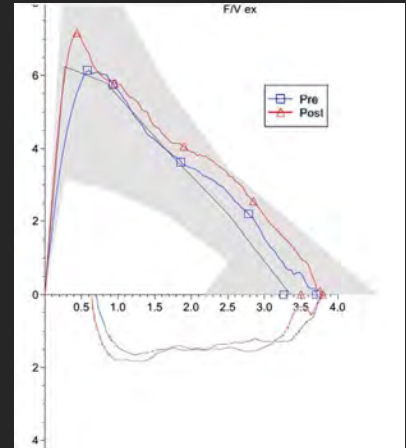
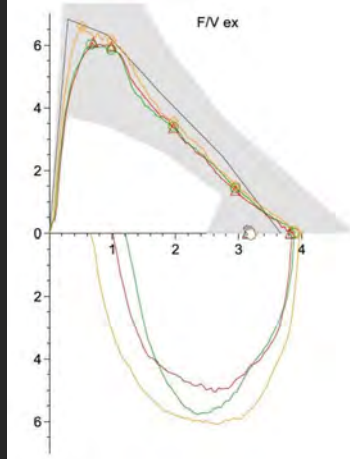
Credit: Tod Olin, MD, MSCS (exercise@njhealth.org)



Pulmonary Function Testing

Methacholine Challenge

- Decrease in FEV₁ by 20% → asthma
- Excellent negative predictive value of asthma
- False-positive result
 - Can induce PVFM symptoms



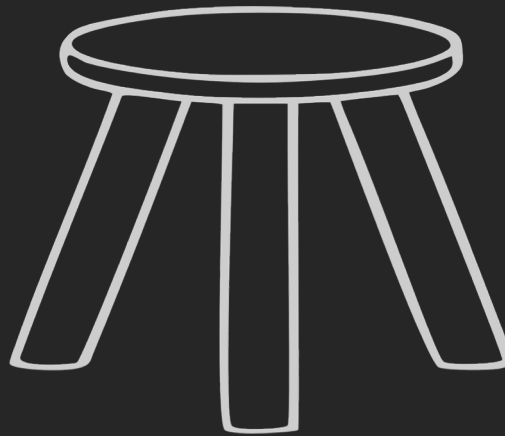
Guss J1, Mirza N. Methacholine challenge testing in the diagnosis of paradoxical vocal fold motion. Laryngoscope. 2006 Sep;116(9):1558-61.



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Treatment

Irritant
Allergy
Reflux
Anxiety
Stress



Laryngeal Sensitivity

Body Response
PVFM/ILO
Cough
Throat Clearing



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Respiratory Retraining

Exercise regimen

- Metered Breathing
- Resistance external to larynx
 - Nasal inhale
 - Pursed lip inhale

Success rates:

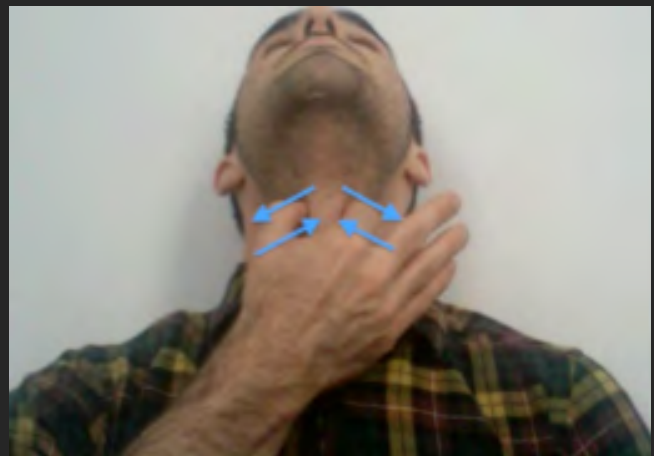
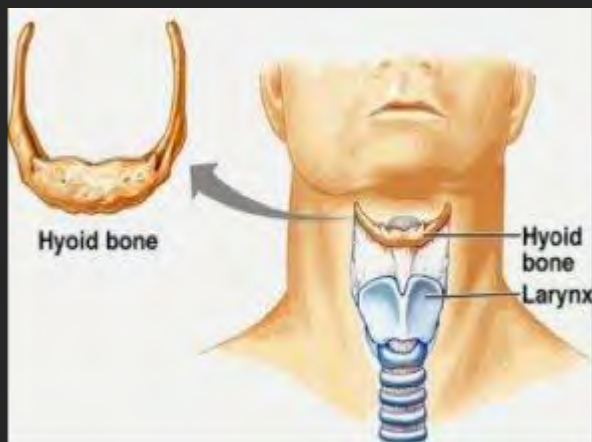
- Sullivan et al. 95%
- Hartnick et al. 56%

- Identifying areas of tension and treating
- Straw breathing or blowing bubbles
- Positional change/refocus tension
- Laryngeal valving awareness
- Laryngoscopy for Biofeedback
- Trigger symptoms



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Laryngeal Massage

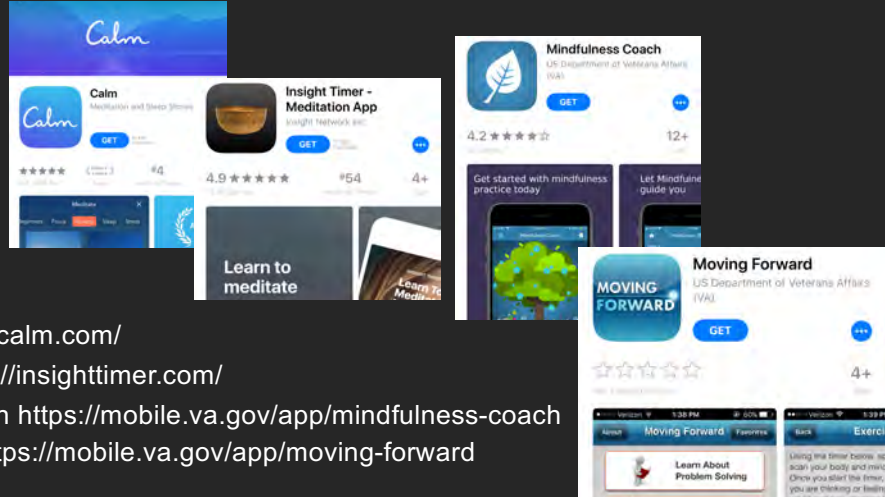


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Therapy Therapy Therapy

- Psychotherapy
- Sports psychology
- Hypnosis
- Biofeedback
- Mindfulness

- Calm <https://www.calm.com/>
- Insight timer <https://insighttimer.com/>
- Mindfulness Coach <https://mobile.va.gov/app/mindfulness-coach>
- Moving forward <https://mobile.va.gov/app/moving-forward>



Anbar RD, Hehir DA. Hypnosis as a diagnostic modality for vocal cord dysfunction. *Pediatrics*. 2000 Dec;106(6):E81.
 McBride JJ, Vlieger AM, Anbar RD. Hypnosis in paediatric respiratory medicine. *Paediatr Respir Rev*. 2014 Mar;15(1):82-5. doi: 10.1016/j.prrv.2013.09.002.
 Earles J, Kerr B, Kellar M. Psychophysiological treatment of vocal cord dysfunction. *Ann Allergy Asthma Immunol*. 2003 Jun;90(6):669-71.



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Medications etc.

- Benzodiazepines
- Heliox
- Inhaled lidocaine
- Anticholinergics
 - Ipratropium bromide
- CPAP



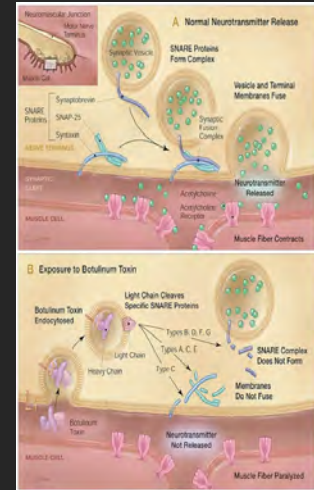
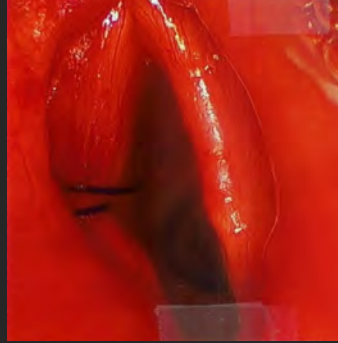
Morris MJ, Allan PF, Perkins PJ. Vocal cord dysfunction, aetiologies and treatment. *Clin Pulm Med* 2006;13:73-86.
 Brugman SM, Simon SM. Vocal cord dysfunction: don't mistake it for asthma. *Physician Sports Med* 1998;26:63-74.
 Diamond ED, Kane C, Dugan G. Presentation and evaluation of vocal cord dysfunction. *Chest* 2000;118:199S.
 Doshi DR, Weinberger MM. Long term outcome of vocal cord dysfunction. *Ann All Asthma Imm* 2006;96:794-9.



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Surgical Approaches

- Botulinum toxin
 - Starting 2.5 units
- Suture lateralization
- Tracheotomy



Maillard J, Schweizer V, Broccard A, Duscher A, Liaudet L, Schaller MD. Use of botulinum toxin type A to avoid tracheal intubation or tracheostomy in severe paradoxical vocal cord movement. *Chest*. 2000 Sep;118(3):874-7.
 van Griethuysen J, Al Yaghi C, Sandhu G. Use of bilateral suture lateralisation technique in severe paradoxical vocal fold movement, allowing removal of long-term tracheostomy: case report. *J Laryngol Otol*. 2012 Mar;126(3):328-30.
http://www.studentpulse.com/article-images/uploaded/324_1.jpg

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Conclusions

- Inducible Laryngeal Obstruction (PVFM, $\forall \text{CD}$)
- Differentiate from Asthma
 - History and PFT's
- Laryngoscopy
- Speech Therapy
- Adjuvant Medications

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