

## Vocal Fold Immobility in Infants and Children: Multidisciplinary Approach

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## Learner outcomes

- Recognize the roles of the multidisciplinary team members in the diagnosis and management of vocal fold immobility.
- Explain laryngeal anatomy and vocal fold function.
- Understand management techniques for swallowing function and vocal quality.

## Why are we concerned about VF function?

- Vocal fold immobility (VFI)
  - immobility is best term if cause unknown
  - 2<sup>nd</sup> most common laryngeal anomaly of infants
  - unilateral and bilateral VFI comprises 10% of all congenital laryngeal lesions
- Recurrent laryngeal nerve injury
  - common complication of neck and cardiothoracic surgery
  - results in serious post-op sequelae
- Airway and feeding difficulties necessitate a complete laryngeal exam

## Why a multidisciplinary team?

- Co-morbidities within each of these areas
  - airway compromise
  - feeding/swallowing impairments
  - voice issues/quality changes
- Expertise needed from multiple disciplines who specialize in each of these areas
- Coordinated care for patients/families

## Role of SLP

### To Assess:

- oral motor structures and function
- swallowing and overall feeding pattern
- respiratory pattern
- vocal quality

### Ultimate Goals:

- facilitate safe and efficient oral feeding
- establish positive patterns to help decrease length of stay
- promote functional communication

## Role of the Otolaryngologist

### To Assess:

- airway function/safety
- define anatomy
- identify vocal fold pathology

- Surgical intervention as necessary

## Other professionals

- Nursing
- Dietitian
- Lactation consultant
- Pulmonologist
- Gastroenterologist
- Cardiologist/intensivist
- Primary care physician
- Community SLP
- Teacher
- Occupational therapist
- Physical therapist

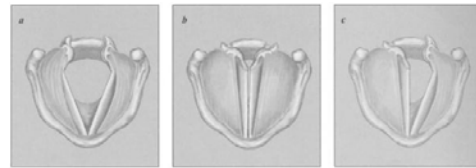
## Communication

- Multiple team members involved – consistent communication necessary between providers and family
  - during hospitalization
  - once discharged
    - early intervention
    - school

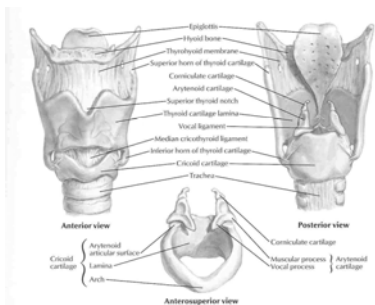
## Basics of Vocal Fold Anatomy and Physiology

## Laryngeal functions

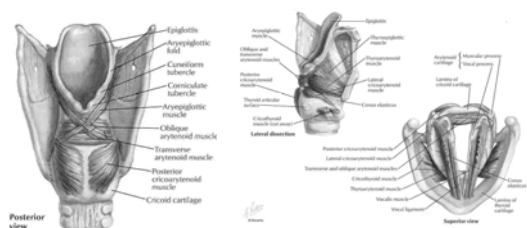
1. Airway
2. Airway protection during swallowing
  - vocal fold closure/ epiglottic inversion/ cough reflex
3. Phonation



## Anatomy of the larynx - cartilages



## Anatomy of the larynx – intrinsic muscles

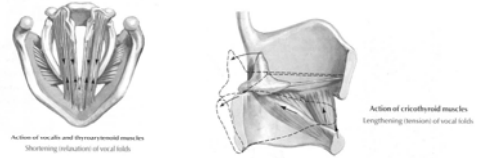


## Intrinsic laryngeal muscles



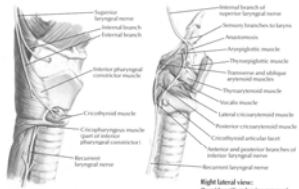
- Posterior cricoarytenoid muscles (PCA) – rotates the arytenoids and opens or abducts the glottis
- Lateral cricoarytenoid muscles (LCA) – rotates the arytenoids and closes or adducts the glottis
- Transverse arytenoid muscle (TA) – approximates the arytenoids and closes or adducts the posterior commissure

## Intrinsic laryngeal muscles



- Vocal fold tension
  - cricothyroid muscle – tilts cricoid back & tenses/lengthens folds
  - thyroarytenoid muscle – relaxes and shortens folds
  - vocalis muscle – fine tunes the tension
- Lowers/Raises the epiglottis
  - aryepiglottic muscle – lowers the epiglottis
  - thyroepiglottic muscle – raises the epiglottis

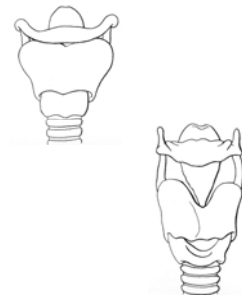
## Laryngeal innervation



- 10<sup>th</sup> cranial nerve provides motor and sensory input
- Superior laryngeal nerve (SLN)
  - external – motor supply to the cricothyroid muscle
  - internal – sensory supply to the larynx
- Recurrent laryngeal nerve (RLN) – motor supply to all other intrinsic muscles

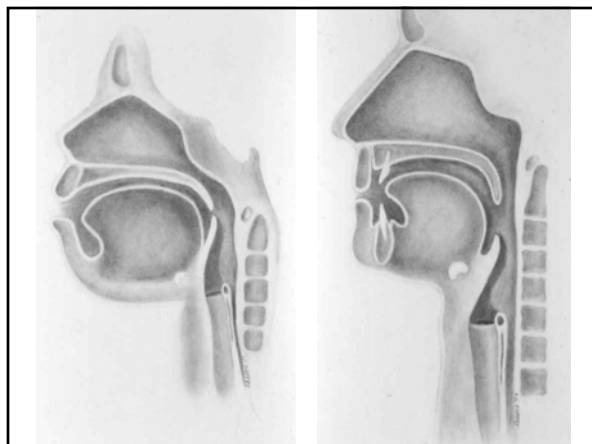
## Infantile laryngeal anatomy

- Different in form and position from adult
  - inferior cricoid margin is at C4
  - tip of epiglottis at C1
- Hyolaryngeal skeleton is vertically compact
- Dimensions:
  - AP – 7mm
  - lateral – 4 mm



## Neonatal larynx

- Neonatal glottis closes in response to a tactile, thermal or chemical stimulation of:
  - laryngeal inlet or trachea
  - irritation of distal esophageal afferents
  - stimulation of any major cranial nerve
- Larynx should open after stimulus disappears
- Neonatal larynx can be inefficient
  - neurologically immature
  - glottic closure may continue long after the stimulus disappears = laryngospasm



## Types of VFI

- Abductor VF immobility
  - muscles affected - PCA
  - vocal fold position – median or paramedian
- Adductor VF immobility
  - muscles affected – LCA
  - vocal fold position – lateral or paramedian

## Congenital VFI

- Usually diagnosed at birth or by 1-2 months of age
- 2<sup>nd</sup> most common laryngeal anomaly
  - accounts for ~ 15% of stridor in infants
- Caused by any lesion involving the RLN from skull base to chest
- Majority of the infants have multiple congenital defects

## Etiology of congenital VFI

- CNS
  - most common: Arnold-Chiari malformation
- Peripheral nervous system disorders
- Cardiovascular anomalies
- Other congenital anomalies
  - mediastinal tumors/cysts
  - malformation of tracheobronchial tree
  - esophageal malformations
  - diaphragmatic hernia
- Unknown

## Acquired VFI

- Trauma
  - birth injury
  - surgical interventions
    - cardiovascular
    - esophageal
    - brain tumor resection
  - infections
    - polyneuritis (polio, diphtheria, rabies, syphilis, tetanus, botulism, TB, Guillain-Barre)
- Intracranial cause
  - kernicterus – complication of elevated bilirubin

## Diagnostic work-up for VFI

- Congenital
  - chest X-ray – screen for intrathoracic lesions
  - MRI of brain – screen for CNS disorders
  - CT of skull base to mediastinum
- Acquired
  - perceptual voice assessment
  - clinical feeding evaluation
  - flexible laryngoscopy

## Unilateral VFI

### No treatment

- spontaneous recovery of voice and/or function occurs
- multiple studies across centers report up to 25% recovery rate
- recovery can take up to 18 months

## VFI and intubation

- Intubation does not cause immobility of the vocal folds
  - NOT caused by:
    - prolonged intubation
    - traumatic intubation
    - multiple intubation attempts
- Intubation can cause injury to vocal folds or the joint

## Presenting symptoms of VFI

- Bilateral
  - airway compromise
    - stridor
    - cyanosis
  - feeding difficulties
  - vocal quality variable dependent on position of vocal folds
- Symptoms may become worse during feeding, agitation, or when awake/active

## Presenting symptoms of VFI

- Unilateral
  - adequate airway (absence of stridor)
    - if stridor is present → usually from co-existing laryngomalacia, subglottic stenosis, or partially immobile contralateral vocal fold
  - feeding difficulties more likely
  - altered vocal quality
- Symptoms may become worse during feeding, agitation, or when awake/active

## Presenting symptoms during feeding

- Increased stridor
- Increased work of breathing
- Change in vocal quality during or after swallowing
- Clinical signs of possible aspiration
  - coughing/sputtering with swallowing
  - wet/coarse upper airway sounds
  - desaturation episodes

## If an infant/child has...

- airway problems
- feeding difficulties
- changes in vocal quality
- known anomaly of esophagus, heart or CNS

...they should undergo a laryngeal exam and a clinical feeding assessment

## Methods of laryngeal examination

- Listen to child during phonation
- Neck auscultation
- Flexible fiberoptic laryngoscopy
  - any age in office/bedside/OR
- Fiberoptic endoscopic evaluation of swallowing (FEES)
  - assess for aspiration/dysphagia
- Micro direct laryngoscopy
  - passive movement of arytenoid (VFI vs fixation)
- Electromyography (EMG)
  - defines the nature of the immobility and long term prognosis

## Airway management

- Plan individualized for patient
  - critical illness
  - If aspiration is chronic and severe – earlier management may be warranted
- Timeframe
  - largely unstudied
    - recovery
    - treatment

## Treatment of bilateral VFI

- Close observation
- Tracheostomy
  - restricts laryngeal elevation
- Arytenoidectomy/cordotomy
- Posterior laryngotracheoplasty with graft

## If an infant/child has...

- airway problems
- feeding difficulties
- changes in vocal quality
- known anomaly of esophagus, heart or CNS

...they should undergo a laryngeal exam and a clinical feeding assessment

## SLP assessment

### To Assess:

- oral motor structures and function
- swallowing and overall feeding pattern
- respiratory pattern
- vocal quality

## Oral feeding: infant's perspective

A successful feeding experience is...

- safe, no aspiration
- non-stressful
- developmentally appropriate
- nurturing

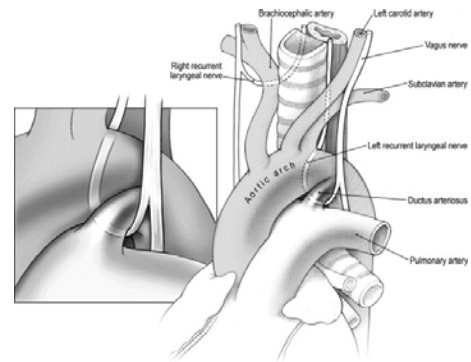
Success does not mean volume is finished!

## Why increased aspiration risk?

- Incomplete glottic closure
  - decreased risk if vocal fold(s) at midline
- Decreased laryngeal sensation if SLN affected
- Altered respiratory pattern if incomplete glottic closure
- Coexisting conditions
  - laryngomalacia

## Conditions that may pre-dispose an infant for VFI

- Some cardiac surgical procedures
  - PDA ligation
    - increased risk – premature infants less than 1 kg
    - current practice at CHW NICU – laryngeal examination following PDA ligation
  - repair involving the aortic arch
    - HLHS, coarctation of the aorta
- Repair of tracheoesophageal fistula/esophageal atresia



Pediatric vocal fold paralysis after cardiac surgery: rate of recovery and sequelae. Truong, M.T., et al. (2007)

## Clinical feeding evaluation

- Airway & nutrition/hydration highest priorities
- Indications of unsafe feeding:
  - coughing/sputtering
  - desaturations
  - bradycardia
  - color changes
  - vocal quality changes

## Respiration

- Respiration, Respiration, Respiration
- Respiratory rate: at rest and during feeding
- Changes from baseline?
  - work of breathing
  - retractions
  - stridor
  - congestion
  - vocal quality changes - wet/coarse

## Feeding management

- Flow rate
- Positioning
- Diet modifications
- Further assessment

## Nipple Selection

Nipple selected to fit mouth, match pacifier, and for optimal liquid flow and control

### Various nipples available

- standard (medium flow rate)
- slow-flow (best to start with in premature infants/newborns)
- NUK (fast flowing, made of latex!)
- Special Needs Feeder (Haberman)
  - (variable flow can be beneficial, expensive)
- name brands (ok for parents to bring in, but need to assess as flow rate can be very different)

## Positioning/Environment

- Infant should be held for feeding
- Feeder must be comfortable
- Semi-upright position with head supported & neck in neutral position
- Check feeding plan for guidelines
  - modifications often made due to respiratory pattern
- Decrease direct light – often overwhelms infant
- Decrease distractions for infant and feeder

## Positioning in bilateral VFI

- Use principles of infant feeding to start
- Depends on position of VF
  - if vocal folds are persistently abducted
    - greater risk for aspiration
    - G-tube likely
  - if vocal folds are persistently adducted
    - safe feeding more likely
    - more likely to have a tracheostomy
    - G-tube may still be required

## Tracheostomy and feeding

- Complex clinical feeding evaluation
  - change dynamics of the airway
  - other pulmonary issues
    - in premature population → co-morbidities
- Further evaluation often warranted
  - risk of silent aspiration

## Positioning in unilateral VFI

For infants:

- held in side-lying with the unaffected side down for feeding
  - why this seems to work?
    - allows functioning vocal fold normal range of motion (to midline) during swallowing and gravity may facilitate better closure of the immobile vocal fold
  - e.g., left vocal fold immobility → position the infant in right side-lying

## Positioning in unilateral VFI

For older children:

- head turned to the weaker side for better glottic closure
  - e.g., left vocal fold immobility → head turn to the left
- chin tuck
- liquids vs. solids

## Further assessment ?

- If continued signs of stress or clinical indicators of a swallowing problem despite other management techniques...
- Further assessment may be needed
  - ENT
  - videofluoroscopic swallow study (VFSS)
  - FEES

## VFSS

- Completed in conjunction with radiologist
- Defines oral and pharyngeal phases of swallowing
  - anatomy
  - physiology
- Defines basic motility throughout swallowing mechanism

## FEES

- Completed in conjunction with ENT
- Dynamic instrumental assessment of swallowing.
  - allows observation of
    - structure and function of pharynx and larynx
    - movement and sensation of critical structures within the hypopharynx
    - management of secretions
    - pharyngeal physiology during swallowing

## VFSS vs. FEES

- With VFI
  - Both useful procedures
  - FEES allows dynamic airway assessment but may not fully define pharyngeal swallow
  - FEES used more often with unilateral VFI and may be done as part of ENT's initial assessment
  - VFSS allows better visualization of aspiration events

## Management of aspiration

- Airway safety is priority
- Preserve oral motor function – despite aspiration, small volume trials for practice experience
  - literature supports
- Diet modifications
- Surgical
  - GI
  - ENT

## G-tubes

- G-tube could be needed due to multiple factors
  - endurance
  - aspiration
  - inefficient pattern
    - oral-motor
    - respiratory

## Surgical management for aspiration

### Vocal fold medialization

- injection technique
- laryngeal framework surgery
- arytenoid adduction

### Re-innervation procedures

## Injection techniques for medialization

- Teflon (no longer used)
- Fat (minimal usage)
- Collagen
  - Autologous Collagen
  - Homologous Micronized Alloderm
  - Heterologous Bovine Collagen
- Hyaluronic Acid
- Calcium Hydroxyapatite gel

## When medialization is contraindicated

- Airway is the priority
- Surgical options are not always appropriate
  - need to look at the whole picture
    - overall medical stability
    - need for future surgeries/intubation

## Voice assessment

- Assess for vocal quality changes
  - aphonia
  - weakness
  - hoarseness
  - strain
- Vocal quality is not always accurate predictor of VF function
- Flexible laryngoscopy/stroboscopy is required for diagnosis

## SLP role in management for dysphonia

- Comprehensive evaluation in voice clinic
  - family understanding of speech/language vs. voice
- Voice therapy
  - goal → maximize vocal potential
    - breath support
    - decrease tension or negative behaviors
- Recommend assessment for possible surgical management

## Surgical management for dysphonia

- Vocal fold medialization
  - injection technique
  - laryngeal framework surgery
  - arytenoid adduction
  - reports appearing in the last 15 years
  - no true standard yet
  - temporary or permanent measures
- Re-innervation procedures

## Conclusions

- Multiple systems are impacted by VFI
  - airway
  - swallowing function
  - voice
- Complex nature of these patients requires both coordinated care and ongoing communication between providers for continuity of care
- Periodic follow-up necessary
  - Perceptual assessment does not always equate function

Questions?

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