Diagnosis and Management of Bilateral Vocal Fold Paralysis

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Introduction

- Definition of Paralysis
  - Akinesia, palsy; loss of power of voluntary movement in a muscle through injury or disease of its nerve supply
  - (Stedman's medical dictionary, 22nd ed.)

- Bilateral Vocal Fold Paralysis
  - injury to nerve supply to vocal folds
    - Motor cortex, brain stem, vagus nerves or recurrent laryngeal nerves
Differential Diagnosis

- Bilateral Vocal Fold Paralysis
- Posterior Glottic Stenosis
- Bilateral Crico-arytenoid Joint Fixation or Dislocation
- Infiltrative Lesion

Etiology of Bilateral Vocal Fold Immobility

[Diagram showing percentages of etiologies]

Breakdown of Surgical Causes

- Thyroid and Parathyroid: 13%
- Parathyroid: 29%
- Thyroid: 48%
- Carotid endarterectomy: 5%
- Heart: 5%

Clinical Presentation

- Respiratory symptoms
  - Shortness of breath
  - Stridor
- Voice changes
- Swallowing difficulties
  - Dysphagia
  - Aspiration

Clinical Presentation

- Respiratory symptoms
- Voice changes
- Swallowing difficulties

Timing of symptom onset
- Acute presentation → stridor
- Late presentation → dysphonia (asthenia, loss of projection)

History

- Paralysis - Neurologic etiology
  - Prior neck or chest surgery
- Posterior Glottic Stenosis - Structural etiology
  - Neck trauma
  - Prolonged intubation
  - Rheumatoid arthritis
  - Granulomatous diseases

Physical Exam

- General appearance
  - Jaw thrust
- Stridor
- Dyspnea
- Supraventricular retractions
- Perceptual Voice Evaluation

Physical Exam

- Head and neck exam
  - Ears – middle ear mass
  - Oral cavity – tongue mobility
  - Oropharynx – palate elevation
  - Neck scars
Endoscopic Exam

- Laryngoscopy/ Hypopharyngoscopy
  - Decreased adduction/abduction
  - Pooling of secretions
  - Pharyngeal wall motion
  - Masses, lesions, mucosal abnormalities

- Videostroboscopy
  - Glottic Closure
  - Vibratory Parameters

Bilateral Vocal Fold Paralysis
Posterior Glottic Stenosis

Laryngeal EMG

- Used to differentiate between structural and neuromuscular causes of vocal fold immobility

- Paralysis
  - EMG shows nerve injury
  - Prognostic information on recovery

- Posterior Glottic Stenosis or Joint Fixation/Dislocation
  - EMG shows normal neuromuscular activity
Imaging

- To evaluate course of recurrent laryngeal nerve
- Base of skull to A-P window
- CT
- MRI

Pulmonary Function Test

- If PIF < 1.5 L/sec consider acute treatment
Direct Laryngoscopy

- Palpation of cricoarytenoid joint
  - If immobile → suggestion of structural involvement resulting in immobility

Management Considerations

- Airway
- Swallow
- Voice

- Intervention depends on
  - Balance of functional needs
  - Patient preferences
Treatment Options

- **Tracheotomy**
  - Maximum inspiratory flow
  - Preserves voice quality
  - Can be temporary or permanent
  - Cons: stigma, trach care

- **Glottis enlarging procedure** – “the great compromise”
  - Temporary vs. definitive
  - Endoscopic vs. Open
Types of Interventions

- Resection of anatomical structures
- Retailoring and displacing existing structures with minimal tissue removal
- Displacing existing structures without tissue resection
- Restoration or substitution of missing innervation of the laryngeal musculature

Resection of Anatomical Structures

- Unphysiologic structural change
  - Irreversible
  - Dysphonia
  - Dysphagia
- Resection of the arytenoids
- Resection of soft tissues
Arytenoidectomy

- Removal enlarges posterior “respiratory” glottis
- Earlier reports used open approaches
  - Thyrofissure
  - Posterior lateral approach
- Endoscopic approach
- Use of CO₂ laser

Results of Arytenoidectomy

- Ossoff, Duncavage, Shapshay et al. 1990
  - In study of 28 patients, 27 were decannulated
  - 2 required revision procedure
  - All had reduction in voice quality


Arytenoidectomy-Limitations

- Granuloma and scar formation
  - Removal of covering mucosa
  - Re-narrowing of airway
  - Can occur late after surgery

- Dysphagia
  - Eckel 1994
    - Subclinical aspiration noted in 5/10 patients

Partial Arytenoidectomy

- Endoscopic approach
- Use of CO₂ laser
- Preserves A-E fold
  - Crumley 1993
  - Remacle 1996

Posterior Transverse Cordotomy

- 1908- Citelli introduced chordectomia externa (cordectomy via thyrofissure)
- 1922- Jackson performed “ventriculocordectomy” under mirror visualization or with Kirstein autoscope
  - Reported results very good in terms of airway, but not as successful for voice
Posterior CO₂ laser Transverse Cordotomy

- Introduced by Dennis and Kashima in 1989

- C-shaped wedge of posterior vocal cord excised

- 30-60% of patients needed bilateral or repeated interventions due to scar or granuloma


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Posterior Cordotomy

- Modified by Kashima in 1991

- Transverse incision performed just anterior to vocal process

- Results in retraction of anterior part of TA muscle
  - Widens posterior glottis
  - Increases mass of anterior glottis

[Images of posterior cordotomy procedures]
Results of Posterior Transverse Cordotomy

- Kashima (1991)
  - All patients achieved satisfactory airway and decannulation
  - Subjective voice quality was good in all patients

- Eckel (1994)
  - Prospective study, N=28
  - 18 patients with cordectomy, 10 with arytenoidectomy
  - Airway result equally effective
  - No subclinical aspiration with cordectomy
  - 5 of 10 arytenoidectomy patients with aspiration

Laryngeal Reinnervation

- Crumley
  - attempted reinnervation of PCA with phrenic nerve in 5 patients
  - no patient demonstrated visible inspiratory abduction

- Tucker
  - transposition of active nerve-muscle pedicle to PCA
  - ansi hypoglossi with small part of omohyoid or sternohyoid implanted into PCA
  - improvement in up to 80% of patients
  - results not reproducible

References:

Reversible Temporary Management

- Aforementioned treatments performed only after considerable amount of time from onset (6-12 months)

- Spontaneous recovery in 40-86% of unilateral and bilateral vocal fold immobility cases—if recurrent nerves not transected

Treatment Options

- Intubation
  - short period of time (hours to days)

- Tracheotomy

- Reversible laterofixation
  - Lichtenberger 1st implemented procedure as single temporary measure
Lichtenberger Needle Carrier


Reversible Suture Lateralization
Results of Reversible Lateralization

- Lichtenberger 1999
  - 63 patients over 20 year period
  - 61 patients were able to avoid tracheotomy
  - 2 patients required additional procedure


Experimental New Techniques

- Laryngeal Pacing
- Botulinum Toxin injection
Laryngeal Pacing

- Functional neuromuscular stimulation of PCA during inspiration
- Vocal folds passively relax to midline in expiration to phonate

Itrel II

- Implantable system for chronic pain
- Dorsal column stimulation of spinal cord
- Consists of implantable pulse generator, lead, and electrode
Device Implantation

- Incision and dissection to expose cricothyroid joint
- Larynx rotated to expose PCA
- Electrode inserted into subperichondrial pocket

Device Implantation

- Electrode anchored to cricoid
- Lead tunneled to 2nd incision below clavicle and connected to IPG
Device Activation

- Waiting period of 2 weeks for post-op fibrosis
- IPG programmed through skin by external programmer
- Patient must adjust respiratory rate to stimulus cycle

Study Results

- 6 patients were implanted, all were previously tracheotomized
- With PCA stimulation
  - 3 patients: large dynamic abduction (3.5-7mm)
  - 1 patient: moderate abduction (3mm)
  - 1 patient: large but delayed response with some lateralization
  - 1 patient: stimulated abduction noted on implantation but lost post-operatively

Results cont’d

- All five patients with stimulated abduction met requirements for decannulation
- 3 subsequently decannulated
- No change in perceptual voice quality, acoustic measures, and maximum phonation time

Limitations

- Electrode contacts too large and widely spaced for optimal PCA stimulation
  - Current spread beyond PCA
  - Botox injected to allow uncontested abduction
- Electrode susceptible to corrosion
- Lead breakage
- Lack of sensor to pace stimulation with inspiratory effort

Deep Brain Stimulation Electrode

- Newer electrode style
- Smaller, more closely spaced channels
- 4 annular contacts with 1.5mm width and 1.5mm interchannel spacing


Deep Brain Stimulation Electrode

- Can interface with new IPG that allows current delivery through 2 separate electrode arrays
- Can reanimate both PCA muscles
**Botulinum Toxin**

- Use in BVFP described by Cohen and Thompson (1987) in canine study
- Botox injected into cricothyroid muscle
- CT paralysis decreases tension of the true vocal cord and allows cord to take more lateral position

**Study Results**

- 11 patients with bilateral vocal fold immobility treated with bilateral TA Botox injections
- 10 of 11 had symptomatic improvement and pursued repeat injections
- Patient without relief had bilateral crico-arytenoid joint fixation
- Complications limited to mild dysphagia to liquids

Ekbom DC et al. accepted for publication (Laryngoscope).
Case 1

- 75 y/o female presented 7/25/08 with dyspnea and stridor
- s/p bilateral staged CEA, 6/8/08 and 6/20/08
- Some voice change after 1\(^{st}\) surgery, difficulty breathing after 2\(^{nd}\)
- Home O2, voice improved but still dyspneic

Case 1 Examination
Case 1 Surgery

Case 1- 2 weeks post-op

- Breathing much improved
- Off oxygen
- PIF 1.75 L/sec
- Softer, breathier voice
- Mild difficulty swallowing liquids
Case 1 - 2 weeks post-op

Case 1 - 8 months post-op
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