Fundamentals of Vocal Fold Anatomy and Physiology

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Neuroanatomy of the Larynx: Central Nervous System

- Cerebral cortex → precentral gyrus in the motor cortex → motor nuclei in the brainstem and spinal cord
- Additional refinement in cerebellum and basal ganglion
- Auditory feedback facilitates fine-tuning

Neuroanatomy of the Larynx: Peripheral Nervous System

- Cranial Nerve X: The Vagus Nerve
  - Innervates the larynx via the superior and recurrent laryngeal nerve
  - Contain all sensory and motor fibers that supply the larynx

Neuroanatomy of the Larynx: Peripheral Nervous System cont'd

- Superior Laryngeal Nerve
  - Internal Branch: Provides all sensory input to larynx
  - External Branch: Motor input to the CT only
- Recurrent Laryngeal Nerve
  - Sensory input below the cords
  - Motor input to the PCA, TA, LCA, and IA muscles

Laryngeal Framework

- Hyoid bone
- Three unpaired cartilages
  - Epiglottis
  - Thyroid
  - Cricoid
- Three paired cartilages
  - Arytenoid
  - Comiticulate
  - Cuneiform cartilages

Extrinsic Laryngeal Muscles: Suprahyoid and Infrahyoid

- Suprahyoid
- Infrahyoid

<table>
<thead>
<tr>
<th>Suprahyoid</th>
<th>Infrahyoid</th>
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<tbody>
<tr>
<td>Stylohyoid</td>
<td>Thyrohyoid</td>
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<tr>
<td>Raises hyoid</td>
<td>Decreases</td>
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<tr>
<td>posteriorly</td>
<td>distance between</td>
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<td>hyoid and thyroid</td>
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<td>Mylohyoid</td>
<td>Sternohyoid</td>
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<td>Digastric (Anterior/Posterior)</td>
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Intrinsic Laryngeal Muscles
- Interarytenoid
  - Adducts arytenoids
- Lateral Cricoarytenoid
  - Adducts vocal processes of the arytenoids
- Posterior Cricoarytenoid
  - Abducts arytenoids
- Cricothyroid
  - Lengthens and tenses the membranous folds, increasing pitch
- Thyroarytenoid
  - Shortens the folds and decreases tension, decreasing pitch

Vocal Cord Histology
- A “multilayered” vibrator.
  - Each level contributes a graduated change in mass and compliance for vibration
  - The area at and around the vocal fold edge moves most markedly during phonation.

Vocal Cord Histology: Five Histologic Layers
- Epithelium
  - Thinnest, consisting of only 6 – 8 cell layers
  - Totally compliant, but requires lubrication
- Lamina Propria
  - Superficial
    - “Rinke’s space”
    - Invasion of lesion or violation of pliability in any way will significantly impair vibratory waveform
  - Intermediate: Made up of elastic fibers
  - Deep: Made up of collagen fibers
  - (Intermediate and Deep Layers = Vocal Ligament)

Lamina Propria: Extracellular Matrix
- Fibrous Proteins
  - Elastin: Large dynamic range, allowing tissue deformation and recoil
  - Collagen: Does not stretch easily but can tolerate a great deal of stress
- Interstitial Proteins
  - Hyaluronic acid: Attracts water to form large, space-filling molecules
  - Seems to act as a cushion, resisting compression and shearing effects
  - Concentration is 3:1 male to female vocal cords, may explain difference in injury types and prevalence

Vocalis Muscle (Thyroarytenoid)
- The terms “vocalis” and “thyroarytenoid” often used interchangeably
- Two components:
  - Thyromuscularis: Lateral component
  - Thyrovocalis (aka Vocalis): Medial component
- The “body” of the vocal cord, provides mass and tonicity
- Because of innervation, the only true “active” vocal cord tissue

Basement Membrane Zone
- Transition between epithelium and superficial lamina propria
- Displays evidence of mechanical trauma and shearing injury in injured vocal folds
### Tissue Variations/ Connective Tissue
- Anterior commissure tendon (Broyles tendon)
- Anterior and posterior macula flava
  - Support vocal cords at points of greatest mechanical stress
- Conus elasticus: Supports inferior border of the folds

### Aerodynamic-Myoelastic Theory
- Accounts for both aerodynamic and muscular forces
- Describes the reciprocal role of airflow, subglottal pressure, and transglottal flow as they interact with vocal cord resistance and elasticity

### Bemoulli Principle
- “The sum of the static and kinetic pressures in a gas is always equal to a constant.”
- An area of negative pressure in the glottis causes the cords to be “sucked” back together

### Body-Cover Theory
- The five layers can be re-classified in a mechanical sense into the...
  - Cover: Epithelium and superficial layer of the lamina propria
  - Transition: Vocal ligament
  - Body: Vocalis muscle
- Cover and transition vibrate passively... vocalis muscle vibrates both actively and passively

### Body-Cover Theory, continued
- Accounts for the mass/stability provided by the vocalis over which the flexible superficial layers oscillate, while the transition serves as the coupling between mucosa and deep muscle
- This oscillation – a visible ripple of tissue deformation and recoil, offers enhanced diagnostic information via videostroboscopy

### Clinical Assessment of Vocal Cord Vibration
- Clinically, vibration should be described in at least three vibratory phases of wave motion.
  - Horizontal (medial to lateral)
  - Longitudinal (anterior to posterior)
  - Vertical (inferior to superior opening and closing)
- Accurate interpretation provides vital diagnostic interpretation!
Parameters to Describe Vibratory Patterns

- Amplitude
  - Medio-lateral displacement
- Phase closure
  - Open/closed
- Mucosal wave
  - Longitudinal flexibility
- Symmetry
- Periodicity
- Vibrating portion
Laryngoscopic Imaging:
The Fundamentals Rigid and Flexible Endoscopy

Barbara P. Messing, M.A., CCC-SLP, BRS-S
April 8, 2011
The Milton J. Dance, Jr. Head & Neck Center
The Johns Hopkins Voice Center at GBMC

The Value of Larynggeal Stroboscopy

Provides information regarding
- Ability of system to achieve an efficient prephonatory/nearly closed configuration
- Pliability of the cover
- Stroboscopy refers to the observation of vocal fold vibratory characteristics and **not** the observation of vocal fold abduction and adduction

Courey, 2006

Larynggeal Stroboscopy: Training for Professionals

- "Although specific experiences may differ among professionals, the interpretation and clinical use of larynggeal stroboscopy information in the assessment and treatment of phonatory function disorders is highly specialized and requires substantial training and knowledge beyond that believed to be available in most graduate speech-language pathology or laryngology residency programs."


Evaluation: Instrumental Assessment

- Ideally, both a rigid and flexible video stroboscopy should be performed
- Rigid endoscopy – looking for vocal fold edge/pliability/wave, glottic closure, open/close phase
- Flexible endoscopy --- looking for vocal fold parameters and supraglottic behavior during actual speaking and singing
- Sustained /i/ at varied pitch and loudness – essential to correct diagnosis

Rigid Endoscopy

- Best image clarity
- 70 or 90 angle lens
- Hyperactive gag response may prevent use
- Often tension artifact
- Normal speech tasks not possible

VIEW OF THE LARYNX USING RIGID ENDOscopy

SCOPING A PATIENT
Performing Endoscopy

- Topical anesthetic and decongestant
- Either patient or examiner holds tongue w/ gauze
- Scope inserted to the base of tongue and angled downward
- Sustained /i/ at varied pitch and loudness

Flexible Endoscopy

- Fiberoptic vs. digital ("distal chip")
- Often better tolerated
- Allows exam during speech/ singing
- Visual biofeedback
- Preferred if motion impairment, SD, or MTD suspected

Flexible Endoscopy

- Topical anesthetic and decongestant
- Either patient or examiner holds tongue w/ gauze
- Scope inserted to the base of tongue and angled downward
- "Thinker" pose
- Sustained /i/ at varied pitch and loudness

http://www.kayelemetrics.com/Product\%20Info/Strobe\%20Systems/9295.htm

Flexible vs. Fiberoptic Flexible Nasoendoscopy

- Ideally, both a rigid and flexible video stroboscopy should be performed
- Rigid endoscopy – looking for vocal fold edge/pliability/wave, glottic closure, open/close phase
- Flexible endoscopy --- looking for vocal fold parameters and supraglottic behavior during actual speaking and singing
- JHH Voice Center Protocol...
In traveling mode, light flashes at different points in the vibratory cycle – slow motion effect.

In locked mode, light flashes at the same point in each cycle – image appears still.

Founded on Talbot's Law
- A contact microphone reads fundamental frequency (pitch)
- Uses a flashing xenon light to sample many single points along multiple waveforms in accordance with pitch produced by patient
- Allows a locked or traveling image of the folds

Light Source - Halogen
- Halogen
  - Steady
  - Continuous light
  - Allows clear visualization of anatomical structures
- Limitations
  - Vibratory behavior of the vocal folds cannot be seen

Halogen vs. Xenon Light

Locked/Traveling Modes

Scope Selection
- Rigid Examination
  - Ideal if close view of pathology is needed
  - Excellent for evaluating vibratory patterns
  - May elicit abnormal muscular movement secondary to unnatural positioning
- Flexible Examination
  - Offers a more natural production
  - Allows observation of voice production during connected speech
  - Subject to intermittent changes in view as patient alters position of the velum, base of tongue, or swallows
Stroboscopy - Disadvantages

- Representation of vibration – not actual cycle
- Two-dimensional
  - Superior surface view - only
  - Unable to evaluate lower lip region when upper lip region is closing or closed
- If patient is too dysphonic, pitch recording, and therefore strobe, not possible

Normal Vibratory Characteristics

- A universal rating system and/ or scale does not exist
- Evaluation is subjective and dependent on the skill of the examiner
- Videostroboscopic Examination of the Larynx, M. Hirano and D. Bless, 1993, Singular Publishing
- Phase closure
- Amplitude
- Mucosal wave
- Symmetry
- Periodicity
- Vertical plane

SAV and SERF

KayPentax Report Module

Visual Perceptual Judgements

- Not vibratory characteristics, but simple observation of
  - Overall structural appearance of the larynx, including remarks on color, mucous
  - Symmetry and movement of arytenoids
  - Vocal fold edge (smooth, rough, edema, lesion, etc.)
- Glottic closure pattern
- Supraglottic hyperfunction

Glottic Closure Pattern

- Complete
- Incomplete
- Bowed
- Hourglass
- Anterior gap
- Posterior gap
- Spindle gap
**Supraglottic Hyperfunction (Muscle Tension Dysphonia)**

- The extent of vertical-lateral excursion, the extent of lateral displacement from midline
- R/L judged separately
- Normal, mild-mod-severely reduced, absent
- Presence of lesion, edema, stiffness, hyperfunction will affect amplitude
- The product of subglottic pressure

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**Amplitude**

- The longitudinal flexibility of the fold, seen as a traveling wave on vibration
- Absence of mucosal wave described as a "non-vibrating portion" or "adynamic segment"
- May appear increased in cases of paresis/paralysis secondary to flaccidity
- R/L judged separately
- Normal, mild-mod-severely reduced, absent

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**Mucosal Wave**

- Based on the degree to which the two folds appear as mirror images of one another
- Consider timing of opening, closing, approach to midline, excursion, etc.
- Symmetrical, sometimes, mostly, always irregular
### Symmetry

- The regularity of successive apparent cycles of vibration
- Periodic vibration is uniform in time and amplitude, aperiodic is not
- Periodicity reflected by a static image in the "locked" mode
- Some application in diagnosis of SD

### Periodicity

- Describes the ratio of open to closed phase
- Open phase may be increased in cases of presbylarynx, glottal lesion, paralysis
- Closed phase may be increased in cases of hyperfunction
- Open phase or closed phase predominates, mostly/somewhat open or closed

### Phase Closure

- Vocal folds should meet in the same horizontal plane
- A vertical discrepancy affects upper lip/lower lip adduction, impacting other vibratory characteristics
- Vertical plane may be affected by paralysis, CA joint injury
- Equal, right/left lower
Vertical Phase Difference
The Value and Implementation of Acoustic Measures

LISA VALASEK, M.S. CCC-SLP

Objective Measurements: Purpose

- When used appropriately, instrumental measures provide critical information about the respiratory, laryngeal, and phonatory behaviors in voice production.

Objective Measures:

- The utility of any tool is only as appropriate as the user’s knowledge.
- Validity and reliability of your measures depends on your knowledge and accuracy of instrument calibration, use, analysis and interpretation.

Objective measures:

- With these tools, can you:
  - Identify the existence of a voice disorder (detection)?
  - Assess the severity or stage of progression of the voice problem (severity)?
  - Identify the differential source of the voice problem (dx)?
  - Serve as a primary treatment tool for modification, biofeedback, or patient education (tx)?

Cautions About Using Normative Data

- There is wide variation in "normal voice".
- Hence large ranges standard deviations.
- Normative data are constantly being gathered.
- Norms vary due to the sophistication of the equipment used to gather norms.
- Voice is dynamic; not constant.
### Acoustic Assessment: Why Add Objective Measures?

- To confirm and clarify your perceptions
- To quantify your subjectivity
- To validate your therapy
- Numbers translate to dollars
- They add to but do not replace a trained ear

### Important Acoustic Measurements

- Speaking Fundamental Frequency and Average Volume
  (Cue: “Tell me your name and today’s date at normal pitch and volume”)
- Maximum Phonation Range (Pitch Range)
  (Cue: “Scale from your lowest pitch to your highest pitch”)
- Maximum phonation time
  (Cue: “Take a deep breath and hold ‘ah’ for as long as you can”)
- Frequency Perturbation (Jitter)
- Amplitude perturbation (Shimmer)
- Noise to Harmonics Ratio

### Acoustic Assessment: What do you need?

- Microphone and quiet recording environment
  - Placement of mic is key: constant mic-mouth distance
- Acoustic recording and analysis equipment (i.e. Kay Pentax Sona-speech or CSL)
- Sustained phonation and running speech tasks

### Acoustic Measures of Quality

- **Signal/Harmonic: Noise Ratio** – comparing “good” voice (harmonics) to the “bad” voice (noise – i.e. roughness, breathiness)
  - “Normal” voices are mostly periodic and have high signal or harmonic energy
  - Dysphonic voices have large aperiodic components = lower harmonic energy
  - CAUTION: Variability in measurement (HNR vs. NHR)
- **Frequency perturbation “jitter”** – variations in frequency of successive vocal fold vibratory cycles
  - Jitter increases when pathologic lesion is present on the TVFs
- **Amplitude perturbation “shimmer”** – variations in amplitude of successive VF vibratory cycles
  - MDVP

### Kay Pentax Sona-Speech Menu

![](image)

### MDVP

![](image)
MDVP Analysis

Fundamental Frequency (Fo):
- Rate of vibration of the vocal folds
- Expressed in Hertz (Hz) = cycles per second
- Audioperceptual correlate = pitch
- Fo range = highest to lowest pitch a patient can produce
- Mean Fo = Average (sustained phonation or average in connected speech)
- Good to measure throughout tx to compare pre-and post-tx measures

Pitch (Frequency)
- Determined by vocal fold mass, tension, and length as they relate to vibration
- Adult males: greater mass, longer VF, slower rate of vibration – lower voice
- Adult females: less mass, shorter VF, faster rate of vibration
- To achieve a higher pitch – VF lengthen, tension increases, mass/unit length decreases

Intensity = Amplitude = Loudness
- Amplitude = Acoustic correlate of loudness
- Measured in dB (decibels)
- Important to determine habitual loudness as well as max/min
- Created by increasing glottal resistance, causing build up of subglottal pressure so that when sound wave is released it has greater power (amplitude)

Real Time Pitch

Voice Types: Stemple’s Classification
- **TYPE I**: Normal or mildly impaired voice
  - Acceptable for acoustic analysis
- **TYPE II**: Disordered voice (i.e. glottal fry, tremor, roughness)
  - Random, fluctuating periodicity makes acoustic analysis unreliable
- **TYPE III**: Severe dysphonia
  - Random, aperiodic signals with no identifiable Fo pattern thus unsuitable for acoustic analysis
Are we all on the same page?

Can all voices be analyzed accurately with acoustic measures?
- How are mod-severely dysphonic voices assessed (Type II and III voices)?
  - Limitations of stroboscopy
  - Limitations of perturbation measures
  - Limitations of harmonic : noise ratio
- What's the answer?
  - Audio-Perceptual judgment; make recordings of pre-surgery or pre-tx voices

Applications in Dx and Tx
- Acoustic protocol with all voice evaluations
- Re-assessment at the beginning of each treatment session, monitor progress
- Waveform Editor: RECORD EVERYTHING
- LSVT
- Visual and Auditory Feedback (blue line)
- Helps with “buy-in”
Special considerations for diagnosis and treatment of neurogenic dysphonia

Heather Starmer, MA CCC-SLP
Assistant Professor
Department of Otolaryngology – Head and Neck Surgery
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Vocal system

- Respiration (power)
- Phonation (sound)
- Amplification (resonance)
- Articulation (speech)

Neurogenic influence

- Initiation of motion
- Speed
- Range of motion
- Coordination
- Selective inhibition and disinhibition
- Muscular control-steadiness
- Muscle strength/tone

Common causes of neurogenic dysphonia

- Stroke
- Parkinsonism
- Myasthenia Gravis
- Multiple Sclerosis
- Spasmodic dysphonia
- Essential tremor

Methods of analysis

- Perceptual assessment
- Acoustic and aerodynamic analysis
- Physiologic evaluation (endoscopic/stroboscopic evaluation)
  - Sustained phonation
  - Repetitive, isolated muscle recruitment (sniffs for abduction, sniff followed by /i/ for adduction)
  - Pitch glides
  - Speech tasks

Other important considerations

- Course of symptoms
- Oral motor findings and motor speech
- Expressive and receptive language
- Eating and swallowing ability
- Gait, balance, posture and other neurological findings
- Respiratory difficulties
Pseudobulbar Palsy

- Bilateral damage to corticobulbar tracts
  - Spasticity
  - Weakness
  - Reduced muscular range
  - Slowed movement
  - Emotional lability

Pseudobulbar Palsy: Important background information

- Onset typically after acute neurological insult (CVA, TBI) but rarely associated with MS and CP
- cc: voice, speech, swallowing changes co-occurring with emotional lability

Pseudobulbar Palsy Examination findings

- Subjective - Irregular prosody, articulatory imprecision, hypernasality, monotone, harsh/strained voice
- Endoscopic/stroboscopic – hyperadduction of TVF (closed phase predominates) and reduced amplitude
- Acoustic – reduced dynamic range
- Aerodynamic – Elevated subglottic pressure and decreased airflow

Pseudobulbar Palsy Treatment options

- Voice therapy
  - Coordination of expiratory air and laryngeal muscular forces
  - Pacing strategies for prosodic difficulties
  - Task-specific strengthening exercises for weak laryngeal, articulatory, and velopharyngeal musculature
  - Pitch manipulation activities

Parkinsonism

- Progressive degeneration of basal ganglia
  - Rigidity
  - Slowed movement
  - Tremor
  - Reduced range of motion
  - Reduced vocal loudness and pitch variability

Parkinsonism: Important background information

- Voice and swallowing complaints are often early symptoms - 70-89% experience voice problems (Hartelius et al, 1994)
- Disease severity staged by Hoehn Yahr Scale

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<thead>
<tr>
<th>Stage</th>
<th>Description</th>
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<tr>
<td>I</td>
<td>Isolated unilateral involvement</td>
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<tr>
<td>II</td>
<td>Bilateral or midline involvement</td>
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<tr>
<td>III</td>
<td>Impaired righting reflexes (unsteadiness in turning or sudden change from a standing position)</td>
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<tr>
<td>IV</td>
<td>Severely disabling disease; patient can walk or stand but is otherwise incapacitated</td>
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<tr>
<td>V</td>
<td>Patient confined to bed or wheelchair</td>
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</tbody>
</table>
**Parkinsonism**

**Examination findings**
- Subjective - monopitch, monoloudness, reduced loudness, difficulty with initiation, articulatory imprecision, rough voice
- Endoscopic/stroboscopic – vocal fold bowing, exaggerated amplitude, impaired coordination/effort
- Acoustic – reduced dynamic range, elevated jitter and shimmer, impaired coordination/effort
- Aerodynamic – Decreased subglottic pressure and increased airflow
- Oral motor – Masked facies

**Treatment options**
- Voice therapy
  - Lee Silverman Voice Therapy (LSVT – focuses on loudness, pitch variation, stamina, and re-calibration of self-feedback)
  - Prosodic intervention
  - Respiratory training
- Surgical therapy
  - Injection laryngoplasty
  - Medialization thyroplasty
- Medical/neurological therapy
  - Timing of PD medications
  - Deep Brain Stimulator (DBS)

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**Spasmodic dysphonia**

**Important background information**
- Often gradual in onset
- Onset typically at middle age
- More common in females
- Communicative stress builds in relationship to duration of symptoms
- Symptoms worsen under stressful conditions (e.g. phone)
- May co-exist with other dystonias

**Adductor spasmodic dysphonia**

**Examination findings**
- Subjective – Strangled vocal quality with voice stoppages – better with singing, whispering, falsetto
- Endoscopic/stroboscopic – sporadic hyper adduction of TVF
- Acoustic – Aperiodic segments, frequency shifts, phonatory breaks – especially mid portion of vowel
- Aerodynamic – Low airflow rate and high subglottic pressure
- Oral motor – May co-occur with blepharospasm or other dystonias

**Abductor spasmodic dysphonia**

**Examination findings**
- Subjective – Intermittent breathy breaks
- Endoscopic/stroboscopic – sporadic hyper abduction of TVF – persists during singing
- Acoustic – Elevated voice onset time, extended duration for words/sentences
- Aerodynamic – High airflow rate and low subglottic pressure
### Differential diagnosis

**Spasmodic dysphonia vs. MTD**

- **Consistency**
  - SD: minimal variation day to day, very limited potential for normal voice
  - MTD: may vary widely, may have episodes of return to normal voice
- **Transitions**
  - SD: difficulty with voice-voiceless transitions
  - MTD: no voice-voiceless difficulties
- **Response to therapy**
  - SD: little to no improvement after voice therapy
  - MTD: high potential for improvement from therapy

### Adductor vs. Abductor spasmodic dysphonia

- Passages with predominantly voiced phonemes more difficult for ADDuctor SD
  - “Early one morning a man and a woman were ambling along a one mile lane, running near rainy island avenue.”
  - Counting from 80-89
- Passages with many voice-voiceless transitions more difficulty for ABDuctor SD
  - “He saw half a shape mystically cross a simple path in front of his sister Kathy’s house.”
  - Counting from 60-69

### Treatment options

**Spasmodic dysphonia**

- **Voice therapy**
  - Supportive to other interventions
  - Education
  - Optimization of response to disorder
- **Medical therapy**
  - Botox injections
- **Surgical therapy**
  - Selective de-innervation/re-innervation procedure

### Essential tremor

**Important background information**

- Most common onset around 70 years of age
- ~50% with family history

**Examination findings**

- Subjective - rhythmic variation of pitch and/or loudness – most notable during sustained phonation
- Endoscopic/stroboscopic – normal structure and function with overlaid tremor noted most during sustained phonation
- Acoustic – 3-7Hz tremor during sustained phonation
- Aerodynamic – measures may be normal
- Oral motor – may co-exist with palatal and/or lingual tremor
Essential tremor
Treatment options

• Voice therapy
• Medical therapy
  – Typically managed by neurologist
  – May include Propranolol, Diazepam, Primidone, and/or Clonazepam
    • Reduce tremor amplitude

Conclusion

• Assessment of neurogenic voice disorders requires consideration of the entire vocal tract
• Onset and progression provide vital diagnostic information
• Accurate diagnosis critical for appropriate treatment planning
• Treatment should be multidisciplinary and target the underlying neurogenic deficits when possible

Selected references

Team-Based Approach to Voice Care

Barbara P. Messing, M.A., CCC-SLP, BRS-S
Melissa Kim, M.S., CCC-SLP
The Milton J. Dance, Jr. Head & Neck Center
The Johns Hopkins Voice Center at GBMC
Baltimore, Maryland

Saturday April 8, 2011
2:00 – 3:10 pm

Interdisciplinary Team

- The management of patients with vocal pathologies is complex. All patients need access to a team of professionals with expertise in the management of vocal pathologies and state-of-art diagnostic and treatment tools for optimal vocal improvement to be realized.

Our team

- Laryngologist
- Head and Neck Surgeon
- Speech Pathologist & Voice Specialists
- Singing Teacher - Voice Clinician
- Clinical Research Associate
- Medical Assistant
- Administrative Staff Support

Interdisciplinary & Comprehensive Voice Center

- Our approach
  - A combination of ...
    - Behavioral approaches
    - Medical interventions
    - Surgical options

Interdisciplinary & Comprehensive Voice Center

- Collaboration between otolaryngologists and speech pathologists employing state of the art technology such as stroboscopy, pH probe monitoring, KTP laser, vocal fold injections, voice therapy, etc., in an office-based voice clinic setting is the ideal approach to the diagnosis and treatment of vocal pathologies and optimization of patient outcomes.

ASHA Position Statement

- Performing endoscopy within SLP scope of practice
- Actual right to perform procedure state mandated, facility specific
- No specific competency checklist, only guidelines
- Where are we NOW????
Update on Compliance Requirements for Medicare In-the-Room Physician Supervision

- January 21, 2011: The Centers for Medicare & Medicaid Services (CMS) determined that, effective January 1, 2011, a physician must be in the room when a speech-language pathologist performs a videostroboscopy or nasopharyngoscopy procedure (CPT 31579, 92511) under Medicare Part B.
- The decision was made as the result of a practitioner’s inquiry to a CMS regional office regarding Medicare supervisory requirements.

Patient Flow

- Patient history / interview with SLP including subjective symptom indices.
- Review of medical history
- Laryngeal function studies
- Patient history / medical assessment by laryngologist and SLP
- Imaging: Laryngeal Stroboscopy
- Review study & findings with the patient
- Recommendations for medical and/or therapeutic interventions.

Case Study #1, TF

- Left tvf paralysis, RLN Injury during sx.
- Immediate vocal changes post surgery
- 57 year old male who underwent esophagectomy, jejunostomy tube, pyloroplasty, EGD, bronchoscopy 11/15/2010 for stage II adenocarcinoma of the distal esophagus.
- Right lung abscess: possibly due to dysphagia, aspiration dx’d Feb 18 11.
- Slight improvement in voice over the past 5 months.

Case Study #1, TF: Acoustic Analysis

- Frequency Perturbation: (NL = 15.04%) 6.8% significantly exceeds normal
- Amplitude Perturbation: (NL = 18.8%) 9.6% significantly exceeds normal
- Speaking Fundamental Frequency: 178 Hz elevated pitch (NL = 134 Hz)
- Max Phonation Range: (NL = 18.24 notes) 133.63/3.72 severely dysphonic
- Maximum Phonation Time: .83 seconds
- Average Volume: 64dB
- Resonance: wnl
- Breath Support: wnl
Case Study #2, P.H.

- P.H., a 49-year-old male, presented with the complaint of a nine-month history of gradually worsening hoarseness and eventual aphonia
- Recalls laryngitis associated with URI that never improved
-Expressed a great deal of anxiety regarding his voice problems as he worked as a corporate trainer
- Had been to three previous ENTs, whom all declared him "normal"

Case Study #2, P.H.

- PMH: Hypertension, gastroesophageal reflux disease, seasonal allergies
- PSH: Rhinoplasty and hernia repair
- Medications: Norvasc, Protonix, Allegra
- Non-smoker, non-drinker
- V-RQOL: 30 (Poor)
- RSI: 31 (NL = ≤13)

Case Study #2, P.H.

- Laryngeal stroboscopy performed by physician
- Review of findings
- Reassurance of no pathologic finding
- Diagnosis and definitive treatment of voice therapy encouraged

Case Study #2, P.H.

- SLP role
  - Assist with procedure
  - Attempt elicitation of voicing with vocal "tricks"
  - Discussion of diagnosis, etiology, and present treatment plan
  - In some cases, on-the-spot treatment possible
  - With P.H., immediate voice therapy resulted in resolution of symptoms

www.gbmc.org/voice

Patient Quality-of-Life Surveys

Patient Quality-of-Life Surveys

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<th>Item</th>
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<td>Attempt elicitation of voicing with vocal &quot;tricks&quot;</td>
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### Patient Quality-of-Life Surveys

**Questions for Adult Patients:** how do your health problems affect you?

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<td>3. Difficulty eating, drinking, or talking</td>
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<td>5. Difficulty doing things that you want</td>
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<td>6. Difficulty sleeping, feeling tired or restless</td>
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<td>7. Difficulty concentrating or remembering</td>
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**Total**
Considerations for Voice Therapy: Pre- and Post-Operatively

What if Surgery is Recommended?

Pre-Op

• Education
  • The patient must be educated on the risks and benefits of surgery, including scar, expectations for voice rest, limited voice use after voice rest, and any other restrictions

Pre-Op

• Vocal hygiene
  • Proper vocal hygiene can reduce inflammation prior to surgery. The surgical field then becomes a truer picture of what the surgeon is dealing with.
    • Voice rest
    • Discontinuing voice overuse, misuse, and abuse
    • Reflux
      • Acid reflux medications
      • Reflux precautions
    • Hydration/humidification

Pre-Op

• Vocal facilitating techniques to decrease edema/lesion
  • Resonant voice therapy and semi-occluded vocal tract exercises:
    • Current research (not yet peer-reviewed) is leading to speculation that the above techniques have a biological healing factor due to the relatively large-amplitude vibrations of the vocal folds, potentially causing cell deformation and a change in mechanical signaling. (Voice rest has an inherent prevention factor but does not have a healing factor.)

Pre-Op

• Instruction in post-op recommendations and facilitating techniques
  • Post-op can be a difficult time for a patient to learn new vocal habits and skills.
  • The voice will feel and sound different, especially at first.
  • The patient may not be able to rely on their ear as they are used to doing.
  • Pre-op voice therapy can prepare the patient for post-op voice use.
Post-Op

• Education/What to expect
  ▫ Period of voice rest
  ▫ Period of modified voice rest or conservative voice use
  ▫ Period of hoarseness (voice may get worse before it gets better)
  ▫ Role of voice therapy in recovery and prevention of further voice issues

Post-Op Voice Rest

• No talking and no whispering. Write, text, e-mail only.
• Avoid throat clearing or coughing.
• Stay well hydrated.
• No aspirin products or N.S.A.I.D.'s (blood thinners)
• No heavy lifting or strenuous exercise.
  ▫ If you are being treated for reflux, remember to take your medication.

Post-Op Voice Use

• Modified Voice Rest
  ▫ 6 minutes per hour of voice use. NOT ALL AT ONCE!
    1 minute on, 9 minutes off.
  ▫ It is important that the patient uses his/her voice during that minute.
  ▫ Use voice therapy exercises during that minute.
  ▫ Do not whisper. Do not strain. Do not use a tentative voice. (Patient needs to understand what these terms mean and how they are different from healthy voicing.)
  ▫ Avoid throat clearing/coughing.
  ▫ Hydrate, take reflux meds, follow reflux precautions.

Post-Op Voice Therapy

• Voice quality after phonosurgery takes time to return to normal or find a “new normal”
  ▫ Clinician's ear must be tuned to this... can't be listening for the usual cues
  ▫ Patient instructed to rely more on how it feels than how it sounds
  ▫ Patient will likely be nervous: Anxiety can contribute to tension and breath holding
  ▫ Relaxation exercises
  ▫ Non-voiced structure isolation practice is appropriate (lowering larynx, lifting palate, etc.)
  ▫ Short practice sessions repeated throughout the day (5-20 minutes) until muscle strength is developed and technique becomes consistent.
  ▫ Frequent rest periods to reestablish appropriate muscle relaxation.

Post-Op

• Vocal facilitating techniques for scar minimization
  ▫ Resonant voice therapy and semi-occluded vocal tract exercises:
    ▪ There is speculation that these techniques have a biological healing factor due to the relatively large-amplitude vibrations, potentially causing cell deformation and a change in mechanical signaling. (Voice rest has an inherent prevention factor but doesn't have a healing factor.)
    ▪ Glides:
      ▪ Fosters flexibility, decreases rigidity or hypofunction.
      ▪ There is speculation that glides prevent scarring.

Traditional Voice Therapy

• To avoid surgery (fingers crossed)
• To treat prior to surgery (decreasing inflammation and learning new vocal habits/skills for post-op)
• To treat after surgery (preventing scar, reinforcing new vocal habits/skills)
• To prevent recurrence
Therapy Techniques

- Resonant Voice Therapy
  - Lessac Madsen Resonant Voice Therapy (LMRVT)
  - Kittie Verdonlini
- Semi-occluded vocal tract exercises
  - lip trills
  - Ingo Titze
- Stemple’s Vocal Function Exercises
  - sustained phonation
  - pitch glides
- Estill’s False Vocal Fold Retraction and Twang

Physiologic Voice Therapy, cont’d

- Dr. J. Stemple’s Vocal Function Exercises
  - “A series of direct, systematic voice manipulations (exercises), similar in theory to physical therapy for the vocal folds, designed to strengthen and balance the laryngeal musculature, and to improve the efficiency of the relationship among airflow, vocal fold vibration, and supraglottic treatment of phonation.”
    (Clinical Updates in Voice: Voice Therapy for the 21st Century, Symposium October 24, 1999)
  - www.communicarepublishing.com

Role of the Singing Voice Specialist

Joanna Lott, M.A., CCC-SLP
Singing Voice Specialist

Three-Part System
- Power = respiration (breath)
- Source = phonation (vocal folds)
- Filter = resonance (vocal tract)

Vocal Athletes
- Singers are expected to be able to sing 3 octaves without breaks or noticeable changes in tone.
- Singing requires extreme precision and coordination of the three-part system.
- Subtle changes in power, source, or filter leads to:
  - changes in the color or quality of the sound
  - an increase (or decrease) in the ease of voicing
  - Singers literally tune their voice as they sing.

Singing Styles
- Classical
- Musical theater
  - MT legit
  - MT belt
- Jazz
- Pop
- Rock
- Gospel
- Folk
- Folk-rock
- Alternative
- Country
- Choral

Styles and Bias
- Each style has its own specific aesthetic bias:
  - Classical singing requires constant vibrato with a low laryngeal position.
  - Musical theater runs the gamut regarding laryngeal height and vibrato.
  - Rock/pop/gospel: laryngeal positioning varies as does vibrato, but you’ll notice vibrato happening at the onset of a note and then fading away. These styles also often seem to demand hyperfunction.
  - It is also often the case that a song doesn’t fit into just one category.
Pop

Demand

- High C = 1,046 collisions per second.
- Even the C one octave lower = 523 collisions
- How many times per day might one singer’s vocal folds collide?

Coordinating the 3-part system

- How do you do it?
- Part One: Power
- What is it? (breath)
- How do you “support” it?
- How do you train support?
- Is there only one way?

Breath Support

- Vennard - The most efficient breath is a combination of diaphragmatic and abdominal breathing.
- Brown - Breathing exercises taught independently from tone production and linked with posture.
- McKinney - the chest should be comfortably high, the lower abdomen should be for free to move
- Nair - does not employ the intercostals to do the work of inhalation/exhalation
- Reider - The utilitarian value of breath support as a pedagogic practice is highly suspect. It is not based upon a solid functional principle, it leads to a self-conscious awareness of the muscular system and its function, but contributes to the idea that only the muscular system is capable of producing breath support. (A Dictionary of Vocal Terminology, 43)
- Estill - The most effective breath solution naturally varies from task to task. Breath will change with voice quality. (Estill gets in trouble with other vocal pedagogues for describing another way to support the sound, known as “anchoring.”)
- Miller - Appoggio is a system for combining and balancing muscles and organs of the trunk and neck, controlling their relationships to the supraglottal resonators, so that no exaggerated function of any one of them spoils the whole.

Vocal Training

- Some typical instruction:
  - Squeeze your uvula with your tonsils.
  - For an “open throat” the epiglottis must be held low at all times.
  - Put space around the tone.
  - Sing on the breath.
  - Spin the tone.
  - Send it up and over.
  - Put the tone in your forehead.
  - Sing from your diaphragm. (Steve Martin clip)
  - A woman should never belt. It will ruin her voice and shorten her career.

All voice teachers are not created equal

- Belting:
  - My first voice teacher told me never to belt because it would lead to nodules and ruin my voice forever.
  - My current voice teacher taught me to belt, and now it is my favorite singing style, one I often teach in my own studio.
- Larynx position:
  - Some teachers will tell you that you must maintain a low larynx position at all times while singing.
  - Others will tell you that the height of your larynx should vary depending on the tone quality you desire.
- Breath Support
  - Some will tell you that your abdominal muscles are integral to singing.
  - Others will tell you to leave your abs out of it and focus primarily on the muscles of the rib cage
  - Others still will have you grab the underside of a piano and yank up against the weight of it to “support” the sound.
And each of these teachers is likely to tell you that the others are wrong.

Teachers Train by Modeling

"If a teacher has never mastered his or her own instrument sufficiently to be professionally useful, the student may be in real trouble when he or she models the master’s voice!"

- Richard Miller

Untrained singers

- Even untrained singers often have strong ideas about how to sing and may have trouble letting go of unhealthy habits.

Treating the Vocal Athlete

- “When working with singers and other voice professionals, our expectations of normal must be heightened, and stricter criteria must be used to assess these patients.” R. T. Sataloff
- Goal: Not just adequate voice, but excellent voice.
- Correction of minor technical faults required.

Evaluating the Vocal Athlete

- Genre of singing (rock, pop, classical, musical theater, gospel, etc.)
- Voice lessons
- Career goals
- Upcoming auditions/performances
- Typical warm-up/cool-down routine
- Frequency of practice
- Acid reflux – risk factors, symptoms, diagnosis, treatments
- Job in addition to singing – does it require voice use

Vocal abuse checklist

- Sataloff’s Professional Voice: The Science and Art of Clinical Care, Vol. 3, Appendix VI
  - Talking too much, too loudly, too rapidly
  - Talking over noise
  - Exposure to dust, fumes, secondary smoke, dry air, second-hand smoke
  - Inadequate sleep
  - Lack of hydration
  - Use of mouthwash
  - Use of asthma inhalers
Evaluating the Vocal Athlete

• Objective/Acoustic Evaluation
  ▫ Respiration
  ▫ Posture
  ▫ Oral Motor Exam
  ▫ Voice Quality

• Subjective Evaluation
  ▫ Respiration
  ▫ Posture

Singing Evaluation

• Have the patient demonstrate singing. Look for:
  ▫ Tension
  ▫ Breath support/Anchoring of sound
  ▫ Energy vs. Effort
  ▫ Tongue retraction
  ▫ Easily fatigue or hoarse after singing
  ▫ Posterior vs. Oral Tone Focus
  ▫ Difficulties through the passaggio
  ▫ Difficulties at lowest or highest pitches (loss of range)

Rehabilitating the Vocal Athlete

• Focusing on rebalancing three-part system
  ▫ Changes in one function will produce subtle, or not so subtle, changes in the rest of the system
• Voice Therapy techniques are designed to “improve the efficiency of the relationship among airflow, vocal fold vibration and supraglottic treatment of phonation.”
• J. Stemple’s description of Vocal Function Exercises

Techniques (some examples)

• Vocal Function Exercises – a series of voice exercises designed to strengthen and balance the muscles of the larynx.
• Resonant Voice Therapy – focuses on resonance (filter), but in accessing/achieving this forward resonance, power and source are affected (chicken/egg)
• Jo Estill – Estill Voice Training – focus on isolating structures of the vocal mechanism and then combining the structures’ functions to create voice qualities

Speaking voice

• The speaking voice can’t be neglected.
• Singers speak as much as (and probably more than) they sing.
• Often singers don’t carry their knowledge of vocal technique into their habitual speaking voice and must be taught to do so.

Carry-over

• Emphasize carryover into everyday speech and professional activities.
• Remind the patient that:
  ▫ Practicing exercises will NOT automatically make your voice better
  ▫ Exercises are only practice for what they should be doing all the time.
**Carry-over exercises**

- **Reading**
  - Sentences
  - Paragraphs
- **Spontaneous speech**
  - Short answers to questions
  - Longer answers to questions
  - Rehearsed conversation (with repetitions)
  - Unrehearsed conversation
  - Self-monitoring and self-correction

**Post-op Voice Therapy**

- **Can I sing yet? Can I sing yet?**
  - Post-op therapy is much like regular voice therapy with special attention paid to amount of voice use, fatigue, and old habits. This is where the importance of pre-op therapy (when possible) becomes apparent.

**Can I Sing Yet?**

- Yes, you can sing. If:
  - Surgeon and voice therapist agree
  - Patient:
    - Has developed awareness of voice use
      - Can use voice in moderation and knows when to stop
      - Recognizes unhealthy voice use and knows how to correct it
    - Is a responsible patient
      - Attends voice therapy and does homework
      - Shows up for follow-up videos with surgeon

**Singing Exercises to start with...**

- Estill’s Siren (glides on “ng”)
- Verdolini’s Resonant Voice Therapy (humming, chanting, messe di voce with frontal tone focus)
- Glides and lip trills

**Things to Remember**

- Voice quality after phonosurgery takes time to return to normal or find a “new normal”
  - Clinician’s ear must be tuned to this... can’t be listening for the usual cues
  - Patient instructed to rely more on how it feels than how it sounds
- Singers will likely be nervous: Anxiety can contribute to tension and breath holding
  - Relaxation exercises
  - Non-voiced structure isolation practice is appropriate (lowering larynx, lifting palate, etc.)

**Practice and rest**

- Short sessions repeated throughout the day (5-20 minutes) until muscle strength is developed and technique becomes consistent.
- Frequent rest periods to reestablish appropriate muscle relaxation.
- Range limited by patient’s ability to produce note without inappropriate tension.
**Vocal Function Exercises**

All exercises should be done two times each, two times a day.

1. **Warm-up:** What the voice must be from a long ago, similar, and initial. The sound should be made quietly. Take a deep breath and project your voice slowly, gradually rising or to make a “moom” sound. Notice the vibrations in the front of the face during easy voicing. Imagine an inverted megaphone and focus your sound at the narrow end. Assign a number to the effort level you are using to produce the sound; reduce this by half; reduce by half again.

2. **Exercise:** Slide from your lowest note to your highest note on the word “moom.” a) Down, b) up. The sound should be made quietly. Count the sound and repeat.

3. **Contrasting:** Slide from a comfortable high note to your lowest note on the word “moom,” a) up, b) down. The sound should be made quietly. Count the sound itself if you want to make the sound. Count the sound two if your voice breaks. Count the sound three if your voice breaks.

4. **Power:** Hold the word “moom” without the “a” as long as possible on the musical notes C, D, E, F, G, A. You may blow out loudly before starting the sound. The sound should be made quietly. Check your sound by placing your inner fingers to your lips like a “gum” and listening for the “moom.” Count the sound.

**Estill**

- Figures/Qualities that can be used for voice therapy (for singers or non-singers) include:
  - Twang/narrow AES can be thought of as “over the top RVT”
  - Sop quality
  - Both of these techniques encourage a barely adducted vocal fold posture (or in cases of unilateral paresis, can enhance TVF closure), while allowing for ease at the level of the TVFs
  - False Vocal Fold retraction
  - Effort levels

**RVT**

- **Basic Training Gesture**
  - “Take a deep breath and sustain “moom-mom-molm...” on a comfortable pitch. Notice the vibrations in the front of the face during easy voicing. Imagine an inverted megaphone and focus your sound at the narrow end. Assign a number to the effort level you are using to produce the sound; reduce this by half; reduce by half again.”

---

Evolution of Contemporary Technique

Laryngology in the OR
April 8, 2011

Lee M. Akst, MD  Director, Johns Hopkins Voice Center

Why?

• Know where you’ve been to know where you’re going
• Some important themes carry through:
  1. You’ve got to see it to operate upon it
  2. The better you see it, the better the operation you can perform
  3. Precision counts

Mirror Laryngoscopy

• Levret 1743 – mirrors to visualize polyps in the “nostrils, throat, ears, and other parts”
• Bozzini 1807 “lichttieter” – cannula with candles; certainly used to visualize anatomy, but ? larynx
• Babington 1829 glottoscope – oblong mirror held against palate, saw upper larynx, but didn’t describe TVC motion

Manuel Garcia – 1854

John Singer Sargent. Rhode Island School of Design.

“The Turkish War”

• Ludwig Turck, neurologist, Vienna
  – 1857, used reflected sunlight
  – When sunlight became scarce, loaned equipment to….
• Johann Czermak, physiologist, Budapest
  – Added fenestrated mirror for physiciamm, artificial lightsource
  – 1858 publication credited Turck
  – Later publications did not → the resulting public feud helped publicize laryngoscopy
Morell Mackenzie, the “Father of British Laryngology”

- 1859 – Studied under Czermak (21 yo)
- 1863 – RCS Jackson Prize, “The Pathology and Treatment of Laryngeal Disease”
- 1865 text, The Use of the Laryngoscope in Diseases of the Throat
- 1871 treatise, Growths of the Larynx

Morell Mackenzie & Crown Prince Frederick, 1887

- Frederick of Germany is married to Queen Victoria’s eldest daughter; when he has chronic hoarseness, Mackenzie consulted
- Mirror exam reveals irregular vocal folds
- Mirror-guided biopsy – Missed the diagnosis – Virchow thought cancer started deep and eroded superficially, rather than thinking it was a disease of epithelium
- Without diagnosis, Mackenzie refused to recommend laryngectomy
- Crown Prince (then Emperor) dies, despite palliative tracheotomy, within the year

The Legacy

- There are mumbles of criticism, which Mackenzie refutes
  – Though his actions were not considered unethical, that he wrote a book (to a lay audience!) was
  – Resigns from Royal College
- The irony – not having TL may have prolonged the Prince’s life; average life expectancy at that time post TL was 4 months
- Enduring question: Did manipulation of the tissue create malignant degeneration?
  – This slowed adoption of interventional laryngology

Mirror laryngoscopy in the US

- Ernst Krackowizer was the first, in 1858
- Popularized by Louis Elsberg (New York) and Jacob Solis-Cohen (Philadelphia)
  – Elsberg: “Laryngoscopical Surgery” presented to AMA in 1865
  – Solis-Cohen: starting teaching laryngoscopy in 1866 and became first academic laryngologist, Jefferson 1869
- Then Frederick Irving Knight – Harvard 1870

Mirror Laryngoscopy

- Elsberg, Solis-Cohen, and Knight lead the formation of the ALA in 1879
  – They then serve as first 3 presidents
- American Archives of Laryngology, 1880-4
- The Laryngoscope, 1896-

Why does this matter?

- Elsberg, Solis-Cohen, and Knight lead the formation of the ALA in 1879
  – They then serve as first 3 presidents
- American Archives of Laryngology, 1880-4
- The Laryngoscope, 1896-
Indirect Operative Laryngoscopy

- 1859, Stoerk – laryngoscopically controlled application of silver nitrate
  - Main laryngeal pathology of 19th century was membranous obstruction (diphtheria)
  - Cigarettes were not mass produced until the 20th century; laryngeal cancer was a disease of the privileged
- 1860, Lewin – caustic application, and also partial excision of tumors
- 1865, Sands – transoral biopsy, then transcervical excision

Direct Laryngoscopy

- First described 1852, by Horace Green
  - Removed laryngeal polyp from an 11 yo boy
  - Used a spatula to depress the tongue, see the epiglottis
  - With cough, large laryngeal polyp was viewed; grabbed with hook and then transected at pedicle

Direct Laryngoscopy

- Grows rapidly in 1860’s, 1870’s
- 1886, Fraenkel – mirror-guided resection as sole treatment for early glottic cancer
  - Recurrence required repeat excision x5
  - Ultimately required neck dissection
  - Survival >5 years from diagnosis
- As advanced as mirror-guided surgery became, eventually supplanted by direct laryngoscopy

Indirect Operative Laryngoscopy

- Had been using whale probang to deliver caustics to membranous laryngeal obstruction even in pre-laryngoscopic era (1840s)
  - Was not believed at first
  - He then proved it possible in patient with a tracheotomy
- ALA: “Father of American Laryngology”

Direct Laryngoscopy

- Following Green 1852, it was largely ignored for 40+ years
  - Seemed possible only in cephalad pediatric larynx
  - Depended on ambient light
  - Was limited in absence of anesthesia
- Indirect mirror laryngoscopy seemed the better option

Alfred Kirstein – 1895

- Electrical illumination
- Cocaine
- “Autoscopy”
Stroboscopy

Gustav Killian

- Witnessed Kirstein, then focused on improving direct laryngoscopy
- Refined laryngoscopy spatulas
- Invented suspension laryngoscopy, for anatomic illustration

Chevalier Jackson – early 21st century

Chevalier Jackson

- First textbook on rigid endoscopy of the upper aerodigestive tract, 1907
  - Dedicated to Killian
- Separating, tubular laryngoscope
- Distal rather than proximal illumination
- Human assistants instead of suspension
  - Had to hold laryngoscope with one hand, operate with the other
  - Transferred “sniffing” position to neck flexion, head extension

Direct Operative Laryngoscopy

- Put this in perspective: Direct laryngoscopy, stroboscopy, suspension laryngoscopy, distal illumination ALL were described within 15 years of one another
  - 1911, Brunings – paraffin injection
  - 1915, Lynch – en bloc endoscopic for resection early neoplasia
  - Etc, etc, etc . . .

Direct Operative Laryngoscopy – the 1960s

- Enhanced precision
- 1960: Intubation during laryngeal surgery
  - Initial DL for intubation for general anesthesia was 1910, but not used for laryngeal surgery
- 1962: Microlaryngoscopy, Jako and Kleinsasser
- Late 1960’s: CO₂ laser, Jako, Strong, and Vaughan
Physiology – the 1970s

• Hirano describes the layered microarchitecture of the vocal fold
• Reintroduces “cover-body” model of vocal physiology
• Leads to emphasis on preservation of superficial lamina propria

• Which leads us from evolution to principles….
Medications and the Voice: An Overall Review

Laryngology in the OR
April 8, 2011
Lee M. Akst, MD Director, Johns Hopkins Voice Center

Vocal Health

• “Healthy” = your vocal performance can meet your vocal expectations
  – Professional
  – Performing
  – Social
  – Teaching
  • Special expectations
  • Special challenges
  – Consider the environment of classrooms and auditoriums
  – Acoustics, irritants, audience, etc.

Vocal Health

• Decrease inflammation
  – Style
  – Spending vocal “capital”
  – Avoid vocal abuse
  – Limit reflux

• Optimize efficiency
  – Technique

Vocal Health

• Maintain lubrication
  – Hydration
  – Humidification
  – Nasal saline spray
  – Beware of medications

Medications and the Voice

• Most medications that effect the voice do so by drying the larynx
  – Dry = less lubrication, thicker secretions
  – Dry = effortful, rough voice with early fatigue; occasional diplophonia; “buzz” in voice
  • Even in normal volunteers

Medications and the Voice

• Other topics:
  • Hormone effects
  • Increased risk of hemorrhage
  • Inflammatory mediators
  • Role of PPI
**Drying: Medications**

- Antihistamines (benadryl, claritin, allegra, etc.)
- Decongestants (sudafed, afrin, etc.)
- Antidepressants (prozac, zoloft, elavil, etc.)
- Anticholinergics (detrol, etc.)
- Diuretics

**What to do about drying?**

- **Risks / Benefits**
  - It may be worth it to take these, but be aware of potential dryness or vocal cord irritation
  - Seek the least drying version which is effective for the patient
    - Claritin < Allegra < Zyrtec < Benadryl
    - Topical steroid spray may be better yet
    - Without sudafed < with sudafed
- **Replace moisture as possible**
  - Hydration
  - Humidification
  - Nasal saline spray

**Hormone effects**

- Effects can be unpredictable
- Some women are effected by hormonal fluctuations during menstrual cycle
  - Estrogen → fluid retention → vocal fold edema → lower pitch, effortful voice, loss of high notes
    - Diuretics won’t work – the edema is protein-bound, not free water
  - Oral contraceptives, HRT may create same effects
    - Of course, HRT helps some women who otherwise experience deterioration in their voices with menopause
- In a female singer who is sensitive to these effects, awareness and planning are key

**Vocal Fold Hemorrhage**

- **Risk Factors:**
  - Laryngeal trauma
  - Phonotrauma
  - Aspirin, NSAIDs
    - Anticoagulants
    - Hormone imbalance
  - Blood slowly resorbs
  - Can promote long-term scar

**Inflammation**

- Steroid inhalers create a direct irritant effect
  - It’s generally the propellant, not the steroid
- Also create risk for oral thrush, laryngeal candidiasis
- In patients who need inhalers, poor lung function is itself typically a cause of poor voice
Inflammation

• Oral steroids
  – Can reduce laryngeal inflammation
  – “The show must go on!”
  – However, increased risk for vocal cord hemorrhage

Reflux

• Acid injury of the vocal cords is common
  – Hoarseness
  – Throat irritation, phlegm sensation, coughing, clearing
• Diet: caffeine, carbonation, alcohol, tomato/citrus
• Medications: PPIs, H2 antagonists, antacids

PPIs work!

• Response to empiric PPI should confirm diagnosis
• Multiple studies show statistical improvement in symptoms, signs of LPR
• BID therapy > qD therapy, 4 months > 2 months
  Park et al. Laryngoscope 115:1230-8, 2005
• Jitter, shimmer, and NHR improved over baseline by 1-2 months with treatment, and improvement is maintained at 3-4 months

PPIs don’t work!

• However, many randomized controlled trials with placebo controls don’t show a difference
• Most symptoms may improve over time, even in placebo group
  Noordzij et al. Laryngoscope 112:2192-5, 2002
• Acoustic abnormalities did not change significantly with PPI therapy

Treatment

Proton Pump Inhibitor Therapy for Suspected GERD-Related Chronic Laryngitis: A Meta-Analysis of Randomized Controlled Trials
Mohammed A. Qualls, M.D. 1,2, a Christopher G. Pullen, M.D. 2, b A. prose Lopez, M.D. 1,2
David L. Osgood, M.D. 1,3, c Robert Noonan, M.D. 1,3, c John M. Mi, M.D. 1,3, c Mauro Vicario, M.D. 1,3, c Thomas Myers, M.D. 1,3, c George H. Brown, M.D. 1,3, c and Michael A. Wachtel, M.D. 1,3, c, d, e, f, g

• The good news: empiric treatment might be more effective clinically than placebo

Bnews: PPI only fix voice sometimes
  – Probably depends on whether reflux is actually the cause of the voice problem
  – Many patients with functional dysphonia try PPI without success

Worse news: empiric treatment is not without side effects
Treatment – Side Effects

- Limits calcium absorption
  - Osteopenia
  - Hip fracture
- Increases pneumonia risk
  - (Real risk may be reflux itself)
- Decreases plavix efficacy

Gastroenterology 2009;137:80–87

- PPI may cause reflux in normal volunteers → Rebound Acid Hypersecretion (RAHS)
- 120 healthy volunteers: Placebo vs Nexium for 8 weeks
- Then 4 weeks of placebo, with reporting of symptoms
- 44% Nexium group vs 15% Placebo with ≥ 1 symptom
- Statistically significant for each timepoint, week 9 - 12

So, where does this leave us?

- Dilemma: knowledge vs practice management
- Reality: we need to do something

In summary, patients with suspected extraesophageal GERD syndromes may have GERD as a contributing etiology but rarely as the sole cause. However, the increasing incrimination of GERD as an etiologic factor along with the lack of accurate concomitant diagnostic tests has resulted in widespread overdiagnosis and overtreatment of these conditions. Systematic empirical therapy with twice-daily PPIs for 2 months remains an accepted clinical strategy for patients with these symptoms if they have a concomitant esophageal GERD syndrome. Failing such a trial, etiologies other than GERD should be explored.

(Who feels good about this?)
Take Home Tips –
General Hygiene

- Limit screaming or shouting, which stress the vocal cords.
- Drink plenty of water or other non-caffeinated, non-alcoholic beverages. Aim for six-to-eight 8-ounce glasses of water daily.
- Don’t smoke, and avoid smoky, dusty or dry environments which might irritate the vocal cords.
- Avoid excessive throat clearing or coughing – if you need clear a sensation of thick mucus, try taking sips of water instead.
- Use plenty of breath support while speaking or singing, as a strong, clear voice begins with airflow from the lungs.
- Recognize high-risk vocal situations. When there is background noise, you might not realize just how loudly you are speaking.
- Listen to your voice. If it begins to sound rough or feel effortful, your vocal cords may be getting inflamed.
- Rest your voice when necessary.
Vocal Fold Injection: Techniques and Injectables

Laryngeal Procedures in the Office
April 9, 2011

Lee M. Akst, MD
Director, Johns Hopkins Voice Center

Outline

• Where – office vs. operating room
• Why – the reasons to do an injection
• What – the injectables
• How – the techniques

Office-Based Injection – Where

• Office
  – Schedule at your convenience
  – Topical / local anesthesia
  – Several approaches
  – Procedure: 10-15 minutes
  – Set-up, turnover, etc. = 30 minutes total
  – Patient time = 30 minutes

• Operating Room
  – Schedule when you have OR time available
  – General anesthesia
  – Via direct laryngoscopy
  – Procedure: 10-15 minutes
  – Set-up, turnover, etc. = 90 minutes total
  – Patient time = 4.5 hours

Other benefits

• “Financially effective”
  – Average costs - $2505 OR vs. $496 office
  Bove et al. Laryngoscope. 2007 Feb;117(2):226-30

• Anesthesia morbidity greatly decreased
• Ability to judge endpoint of medialization
  – Awake patient can phonate, with stepwise injection
  – Awake patient can demonstrate degree of contralateral abduction

Office-Based Injection – Why

• To improve closure, decrease glottal insufficiency

• Unilateral vocal fold paralysis
  – Improve voice – less breathiness, less effort, better projection
  – Improve swallowing
  – Strengthen cough

• Vocal fold paresis with incomplete or effortful closure
• Presbylaryngis with incomplete closure

• Contour defect (post-resection)
• Steroid – scar, nodules, granuloma
• Botox – spasmodic dysphonia
• Cidofovir – RRP
• New biologics – scar, lost pliability
What to inject

- “What” depends on “why”
- Specific indications for steroid, cidofovir, botox
- Choose concentration appropriate for vocal folds
- Steroid
  - Preservative free dexamethasone 10 mg/cc
  - Methylprednisolone 40 mg/cc
- Cidofovir – concern over inflammatory effect?
- Botox – defer to Dr. Fletcher

What to inject - Permanent

- Teflon
  - Arnold 1962
  - Concern over long-term granuloma
- Radiesse Voice
  - Calcium hydroxylapatite microspheres, 25 – 45 μm
  - Gel-based carrier of water, glycerin, and sodium carboxymethylcellulose – overinject by ~20%
  - Available testing shows results calcium particles reabsorb between 1 – 2 years

What to inject - Temporary

- Gelfoam
  - 4-6 weeks
  - Off market (?)
  - Requires preparation and requires 18g needle
- Collagen
  - Bovine (zyplast) – requires skin testing
  - Autologous – requires skin harvest and processing
  - 3-6 months
- Cymetra
  - Micronized acellular human cadaveric dermis
  - ~3 months; may persist long-term unpredictably
  - Requires processing
- Fat
  - Donor site morbidity
  - Processing (improved with lipivage)
  - Donor site morbidity – general anesthesia?
  - Unpredictable duration
- Radiesse voice gel
  - Water, glycerin, sodium carboxymethylcellulose
- Restylane
  - Cross-linked hyaluronic acid
  - “Off-the-shelf”
  - Biocompatible
  - Good fluid dynamics
  - ~1.5 – 2.5 months
  - Vibratory characteristics???
How to inject

• Two aspects
  – Visualization
  – Injection

• Visualization
  – Monitor
  – Transoral – rigid telescope
  – Transnasal – flexible scope

How to inject - Anesthesia

• Transoral visualization, transoral injection
  – Benzocaine to oropharynx
  – 4% lidocaine to TVC from transoral injection system

• Transnasal visualization
  – Topical anesthetic, decongestant to nose (my clinic – ponticaine with oxymetazoline)
  – 4% lidocaine to TVC via flexible scope or cannula – or –
  – Topical lidocaine via thyrohyoid needle

Risks and Benefits

• Benefits – already discussed
• Risk of discomfort
• Risk of bleeding
  – Down airway – coughing
  – In TVC – expanding hematoma can compromise airway
• Airway compromise
• Inadequate injection, inability to complete injection
• Infection – 1 case report, with cymetra

How to inject - Anesthesia

• Transcervical injection
  – 1% lidocaine with 1:100,000 epi to skin, needle track

• Anesthesia pearl – careful balance:
  – Enough to be comfortable
  – Not so much that there is difficulty handling secretions – this increases gag
  – Patients with TVC paralysis often have some difficulty with secretions to begin with

Transoral Injection

American Society of Clinical Oncology
Transoral Injection

- Precision: good
- Tolerance: patient-dependent
- Learning curve: if already doing rigid strobe, then transoral injection is fairly easily learned
- Set-up/Equipment: need rigid scope; no need for second person
- Pro/con overall: Ability to do it without an assistant, precision of injection make it my preferred technique for patients who tolerate it

Injection Pearls

- Overclosure anteriorly = strain, and can limit injection
- Hyperfunction
- Inflammation may reduce vibration after injection

Transoral Injection - Steroid

Thyrohyoid Injection

**Thyrohyoid Injection**

- Precision: fair; see needle enter, but angle difficult
- Tolerance: good
- Learning curve: angle of injection is difficult
- Set-up/Equipment: no special equipment, but requires a second person to pass the scope
- Pro/con overall: get to see needle enter the cord, which makes this a valuable technique for patients who cannot tolerate oral injection; limited by need for a second person

**Cricothyroid Injection**

- Precision: limited, cannot see needle
- Tolerance: good
- Learning curve: similar to Botox approach, but with patient supine
- Set-up/Equipment: no special equipment, but requires a second person to pass the scope
- Pro/con overall: Prefer thyrohyoid approach because the needle is visible
Cricothyroid Injection

Transnasal Injection

Transnasal Injection

• Described by Harry Hoffman, University of Iowa
  Trask et al. Laryngoscope. 2005 Dec;115(12):2262-65
• Needle: 23 or 25g, 4.0 mm tip
• Sheath 200 cm long, 1.8 mm diameter
• Cymetra: Dilute 2.3 cc (not 1.7 cc) to pass through needle and accommodate the 1.4 cc deadspace
• Zyderm: load 2 1.0 cc syringes, and deliver 0.4 cc
• Saline at the interface decreases waste
• New needle coming?

Lessons

• Too much anesthesia = more secretions
• Aim laterally within the vocal fold for medialization, and medially for steroid
• Measure amount needed during injection
  – Assess closure
  – Assess airway patency
  – Avoid over-closure anteriorly as possible
Lessons

- It's easy
- Don’t expect return of mucosal wave right away
- Supraglottic hyperfunction may persist – voice therapy can help
Pulsed Laser Use in the Office

Laryngeal Procedures in the Office
April 9, 2011

Lee M. Akst, MD  Director, Johns Hopkins Voice Center

Medical Advances

• To improve treatment outcomes
  – In laryngology, move from office to OR was driven by need for increased precision
• To reduce treatment morbidity
• To improve patient safety and comfort
• To minimize costs of treatment, or improve efficiency of care
  – Move from OR back to office when appropriate

Innovations

Office-based injection
Pulsed KTP Laser Photoangiolyis
Transnasal Esophagoscopy

Lasers in General

Common Medical Lasers

<table>
<thead>
<tr>
<th>Medium</th>
<th>Spectrum</th>
<th>Wavelength</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Far Infrared</td>
<td>10,600 nm (10.6 μm)</td>
</tr>
<tr>
<td>Er:YAG</td>
<td>Mid Infrared</td>
<td>2.940 nm (2.94 μm)</td>
</tr>
<tr>
<td>Ho:YAG</td>
<td>Mid Infrared</td>
<td>2.100 nm (2.1 μm)</td>
</tr>
<tr>
<td>Nd:YAG</td>
<td>Near Infrared</td>
<td>1.064 nm (1.06 μm)</td>
</tr>
<tr>
<td>Diode Lasers</td>
<td>Visible &amp; NIR</td>
<td>532 - 1100 nm</td>
</tr>
<tr>
<td>Alexandrite</td>
<td>Near Infrared</td>
<td>755 nm</td>
</tr>
<tr>
<td>Ruby</td>
<td>Deep Red</td>
<td>694 nm</td>
</tr>
<tr>
<td>Krypton</td>
<td>Red, Yellow, Green</td>
<td>647, 568, 504 nm</td>
</tr>
<tr>
<td>Helium Neon, Diode</td>
<td>Red</td>
<td>632, 635, 650 nm</td>
</tr>
<tr>
<td>Dye</td>
<td>Red, Yellow, Green</td>
<td>632, 585, 504 nm</td>
</tr>
<tr>
<td>KTP</td>
<td>Green</td>
<td>532 nm</td>
</tr>
<tr>
<td>Argon</td>
<td>Blue, Green</td>
<td>488, 514 nm</td>
</tr>
<tr>
<td>XeCl Excimer</td>
<td>UV</td>
<td>308 nm</td>
</tr>
<tr>
<td>ArF Excimer</td>
<td>UV</td>
<td>193 nm</td>
</tr>
</tbody>
</table>
**Light Behavior**

Reflect

Scatter

Transmit

Absorption

**Absorption Spectrum**

![Absorption Spectrum Graph]

- **Absorption Spectrum**
- **Water**
- **Melanin**
- **Hemoglobin**
- **Protein**

![Absorption Spectrum Graph](water-melanin-hemoglobin-protein)

**Oxyhemoglobin Absorption**

- **Wavelength (μ - Microns)**
- **100,000**
- **10,000**
- **1,000**
- **100**
- **10**
- **1.0**
- **0.1**
- **0.01**
- **0.001**

**Pulsed Laser Angiolysis**

- **Selective targeting of oxyhemoglobin**
  - Anderson RR et al, Science 1983
- **Used first in dermatology for pigmented skin lesions, hemangiomas, port-wine stains, etc.**

**Pulsed KTP Laser**

- **Selective targeting of oxyhemoglobin**
  - Anderson RR et al, Science 1983
- **Used first in dermatology for pigmented skin lesions, hemangiomas, port-wine stains, etc.**

**OXYHEMOGLOBIN ABSORPTION**

- **Wavelength (μ - Microns)**
  - **532nm KTP**
  - **585nm PDL**

**Tumor Angiogenesis**

- **Jako and Kleinsasser: 1966**
- **Folkman: 1971**
**Pulsed KTP Laser**


**Vascular Malformation**

**Laryngeal Indications**

- **Epithelial Diseases**
  - Papilloma – office, OR
  - Dysplasia – office, OR
  - Early invasive cancer – OR
- **Vascular Malformations**
  - Varix, ectasia, hemorrh. polyp – OR
- **Scar remodeling**
  - Post-surgical, autoimmune, etc – office

**Pulsed Laser Use – Technique**

- Topical anesthesia of nasal cavity
- Flexible scope with light, suction, instrument port
  - Operating flexible laryngoscope
  - Transnasal laryngoscope
- Second suction, smoke evacuator for RRP
- Laser precautions for patient, personnel
  - Eyewear, masks

**Technique (continued)**

- Use the scope to drip 4% topical lidocaine onto the larynx
  - “Laryngeal gargle” can prolong contact
  - Multiple small aliquots
  - Be aware of toxicity
- Treat with settings that confine laser energy to target tissue
  - Pulse width ~15ms
Practice Management

- Typically perform surgery in OR first
  - Done for papilloma, dysplasia
  - OR required for initial biopsy, as well as precise mapping
- Then transition into the office
Dysplasia – Case 2

Results with Pulsed KTP

- 70/72 (97%) Successful Office-Based Procedures
- Dysplasia: 28 patients and 36 procedures
  - 34/36 completed
  - F/U 29/34
  - 75-100% 18/29 (62%)
  - 50-75% 7/29 (24%)
  - 25-50% 4/29 (14%).
- Papillomatosis: 20 patients and 36 procedures

Summary of Pulsed Angiolyis

- 532nm pulsed-KTP laser is effective treatment for laryngeal dysplasia and papillomatosis in an office-based setting.
- Most patients (97%) tolerated office-based management.
- 532nm pulsed-KTP laser was more effective and easier to use than the 585nm PDL by minimizing blood extravasation onto the surface of epithelium and/or into the superficial lamina propria.
- Flexible laryngoscope trauma did not occur with the 4mm fiber; better suction
- Disease regression similar with both angiolytic lasers.

Office KTP

Scar Remodeling
Advanced Phonsurgery: Laser Techniques

Laryngology in the OR
April 8, 2011

Lee M. Akst, MD  Director, Johns Hopkins Voice Center

The Basics

• The principles:
  – Know when to operate
  – Good exposure
  – Save SLP
  – Aim small, miss small

• The lasers:
  – PDL
  – Pulsed KTP
  – CO₂ / Omniguide
  – Thulium

Pulsed Angiolysis

• Cutaneous lesions → Vocal Folds

Pulsed KTP Laser

• Papilloma, Dysplasia, Early Cancer
• Vascular Malformations

The Basics

• The principles:
  – Know when to operate
  – Good exposure
  – Save SLP
  – Aim small, miss small

Pulsed Angiolysis

• Pulsed KTP Laser
• Pulsed Dye Laser
• Target oxyhemoglobin
• Pulsed energy (0.45-15 ms)
• Coagulate vessel selectively
• No thermal damage to surrounding tissue
• Anderson RR, et al. Science 1983

Pulsed KTP Laser

• Papilloma, Dysplasia, Early Cancer
• Vascular Malformations

OXYHEMOGLOBIN ABSORPTION CURVE

Chorioallantoic Membrane
Outline

- Pulsed Angiolytic Lasers
  - Vascular malformation
  - Leukoplakia
  - Recurrent respiratory papillomatosis
  - Early glottic cancer
- “Cutting” Lasers
  - Early glottic cancer
  - Cordotomy and partial arytenoidectomy

Vascular Malformations

- Decision-making
  - Is the vascular lesion related to the dysphonia?
  - (When is a small varix or ectasia an incidental finding?)
- Probably related if . . .
  - It’s associated with mass lesion (eg, hemorrhagic polyp)
  - If history / exam support recurrent hemorrhage
  - If history / exam support lesion-related edema that leads to compromised vocal endurance

Vascular Malformations

- Goal is to address the vascular component as necessary
  - Pulsed dye laser
  - Pulsed KTP laser
- Other principles of phonosurgery remain the same, should further dissection be necessary

Pulsed Angiolytic Laser Treatment of Ectasias and Varices in Singers

- Classical: 13
- Pop/Rock: 17
- Musical Theatre: 8
- Gospel 1


- 39 pts, 40 Procedures: 54 VFs
  - 33/54 PDL & 21/54 pulsed KTP
  - 18/39 pts history of bleeding
- No patient with vocal deterioration
- No patient with history of re-bleeding

Vascular Malformation
Vascular Malformation

- Diagnosis
  - Suspected visually
  - Confirmed on pathology
- Therapy
  - Surgical debridement
  - Cold instrument, CO2 laser, soft-tissue shaver
  - Pulsed KTP laser → preserve pliability
  - Adjuvant: cidofovir, indole-3-carbinol, etc.
  - Multiple surgeries are expected

Recurrent Respiratory Papilloma

- Diagnosis
  - Suspected visually
  - Confirmed on pathology
- Therapy
  - Surgical debridement
  - Infusion (based on location)
  - Pulsed KTP
    - Tissue necrosis
    - Addresses vasculature
  - Stepwise debridement
  - Identify, protect normal
- Stepwise treatment
  - 37 pts, 55 procedures
    - 35/55: close enough for short-term follow-up
    - 20/55: distant, returned when disease recurred
    - >90% response 28/35 (80%)
    - 75-89% response 4/35 (11%)
    - 50-74% response 3/35 (9%)
- Lesion: 51/55 anterior commissure disease: no webbing

Neoplasms – Leukoplakia

- Leukoplakia is the visual analog of dysplasia
  - Hyperkeratosis and parakeratosis
  - Pre-malignant lesions
    - Multi-step theory of carcinogenesis
    - Generally seen in smokers
    - Possible in non-smokers
    - Alcohol is a synergistic risk factor
- Voice varies from no change at all (superior lesion) to moderately hoarse (medial lesion)

Dysplasia / Leukoplakia

- Dilemma:
  - Observe, and miss possible pre-malignant or malignant lesion?
  - OR, biopsy and risk worsening voice for what is non-invasive disease?
- Solution(?)
  - Be able to obtain diagnosis and treat the lesion, without going deeper than necessary and therefore preserving voice
Dysplasia / Leukoplakia

- Infusion
- Pulsed KTP
  - Treats vasculature
  - Neoplasm requires angiogenesis

Dysplasia / Leukoplakia

- Epithelial resection
  - Remove disease
  - Thicker disease = thicker epithelium
  - Establish diagnosis
  - Save underlying SLP

Dysplasia

Presentation: April 2008
Pathologic Diagnosis – CIS

4 weeks after 1st OR, June 2008

4 weeks after 2nd OR, August 2008

Laryngeal Cancer

- Estimated 120,000 new cases/year
- Men > Women
- Smoking, EtOH risk factors
- ? Reflux as risk factor?
- >95% squamous cell carcinoma
- ¾ patients present early because of hoarseness
  - No vocal cord fixation
  - No lymph node involvement
  - No extension outside larynx

Early Laryngeal Cancer

- 39 yo with hoarseness
- Outside ENT biopsy – dysplasia
- Followed conservatively, referred when it “looked worse”

- 52 yo male with hoarseness
- Outside ENT biopsy – cancer
- Suggested radiation
- Patient desired photoangiolytic treatment
**Thulium**

**Changing Paradigm - KTP**

- Routine use for dysplasia and papilloma
- Emerging use for invasive cancer

- Staged, stepwise resection that preserves structure
- 22 patients, all with significant improvements in voice, even in patients with bilateral disease

**Pulsed KTP for Cancer**

- Initial presentation
- 6 weeks post-op: OR next day
- 3 months post-op

- 4 months / 2.5 months post-op
- 5 months / 3.5 months post-op
Recurrent Vocal Hemorrhage

Recurrent Hemorrhage – OR
Pharyngeal pH Probe

Laryngeal Procedures in the Office
April 9, 2011

Lee M. Akst, MD
Director, Johns Hopkins Voice Center

Pharyngeal pH Probe

Laryngeal Procedures in the Office
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Disclosure

• I serve on the Clinical Advisory Board for Respiratory Technologies Company (Restech, Inc.)

• I have never been paid for this
  – No grants, no research support, no equipment loans, etc.

Background

• We’ve heard a lot about reflux
• I don’t know about you, but I’m still confused
  – The more I learn . . .
  – The more I realize what I don’t know
• Introduction
• Clinical management
  – Focus on diagnosis
  – Focus on role of pH probe – rationale, not technique (which is simple)

Background – Part 2

• How many of you:
  – Feel that you know reflux when you see it?
  – Feel that you treat it effectively?
• Don’t overtreat it, don’t undertreat it?
• Feel like you’re bouncing patients back and forth to your GI colleagues, who disagree with the diagnosis?

GERD ≠ LPR

GERD vs LPR: Model 1

GERD, with LPR
GERD

Google Image search for “Heartburn”, March, 2010
GERD vs LPR: Model 1, extended

Acid  

GERD, with LPR  

"No GERD, so must not be acid"

GERD symptoms, without GERD

GERD vs LPR: Model 2

Acid  

GERD  

GERD with LPR  

GERD + LPR  

LPR

- Acid can cause LP symptoms even in absence of GERD complaints
- Other etiologies can also cause LP symptoms

GERD vs LPR, Model 2

- Different mucosal susceptibility to injury
  - Receptor-mediated uptake of pepsin by laryngeal epithelium
  - Reactivation of tissue-bound pepsin?
- Different clearance/protective mechanisms
  - No laryngeal peristalsis
  - No laryngeal bicarbonate secretion
- Variable host response to injury at different sites
  - Molecular level – CD1d, NKT cells, etc (MA Birchall)
  - Functional level – depression, anxiety, etc (S Halum)

Introduction

- IF we accept that LPR can exist even without esophageal complaints,
- THEN our challenge is to figure out when laryngopharyngeal complaints relate to reflux and when they relate to other causes

Approaches to Diagnosing LPR

- Patient symptoms
- Physical exam
- Empiric treatment
- pH probes

What is the evidence?

Why are we talking about LPR?

- Increasing recognition of LPR
  - 1990-2001: annual visits for reflux up 306% (especially among ENT), PPI prescriptions increased 14-fold
  - Madison, WI survey of 1854 people – 26% reported both GERD and laryngeal symptoms concurrently, suspicious for LPR
- Increased clinical investigation, increased basic science studies, and increased discussion
Obesity Trends Among U.S. Adults between 1985 and 2008

Definitions:
• Obesity: Body Mass Index (BMI) of 30 or higher.
• Body Mass Index (BMI): A measure of an adult's weight in relation to his or her height, specifically the adult’s weight in kilograms divided by the square of his or her height in meters.

Source of the data:
• The data shown in these maps were collected through CDC’s Behavioral Risk Factor Surveillance System (BRFSS). Each year, state health departments use standard procedures to collect data through a series of telephone interviews with U.S. adults.
• Prevalence estimates generated for the maps may vary slightly from those generated for the states by BRFSS (http://aps.nccd.cdc.gov/brfss) as slightly different analytic methods are used.
Obesity Trends* Among U.S. Adults
BRFSS, 1994
(*BMI $\geq 30$, or ~ 30 lbs. overweight for 5’4” person)

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BRFSS, 2000
(*BMI ≥ 30, or ~ 30 lbs. overweight for 5' 4" person)

No Data          <10%           10%–14% 15%–19%           ≥ 20%

Obesity Trends* Among U.S. Adults
BRFSS, 2001
(*BMI ≥ 30, or ~ 30 lbs. overweight for 5' 4" person)

No Data          <10%           10%–14% 15%–19%           20%–24%          ≥ 25%

Obesity Trends* Among U.S. Adults
BRFSS, 2002
(*BMI ≥ 30, or ~ 30 lbs. overweight for 5' 4" person)

No Data          <10%           10%–14% 15%–19%           20%–24%          ≥ 25%

Obesity Trends* Among U.S. Adults
BRFSS, 2003
(*BMI ≥ 30, or ~ 30 lbs. overweight for 5' 4" person)

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Obesity Trends* Among U.S. Adults
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(*BMI ≥ 30, or ~ 30 lbs. overweight for 5' 4" person)

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Obesity Trends* Among U.S. Adults
BRFSS, 2008
(*BMI ≥ 30, or ~ 30 lbs. overweight for 5' 4" person)

No Data          <10%           10%–14% 15%–19%           20%–24%          25%–29% ≥ 30%

LPR: What we know
(or think we know)

• It’s prevalent, and may relate to multiple different pathologies
  – Reflux laryngitis
  – Vocal cord nodules
  – Polypoid corditis
  – Laryngeal cancer
  – Vocal process granuloma
  – Subglottic stenosis
  – Laryngospasm
  – Paradoxical vocal fold motion
  – Dysphagia
  – Zenker’s diverticulum
  – Cough
  – Asthma
  – Sinusitis
  – Rhinitis
  – Otitis media

LPR Position Statement, AAHNSF, July 2002

Diagnosis

• Diagnosis is sometimes difficult

• Different tools:
  – Symptoms
  – Exam findings
  – Empiric therapy
  – Studies – pH probe

• There are problems with each

• Correlation may be poor

Diagnosis - Symptoms

• “The symptoms of LPR are protean; however, the most common are hoarseness, globus pharyngeus, dysphagia, cough, chronic throat clearing, and sore throat. These symptoms are often intermittent or ‘chronic-intermittent.’”


• Protean: “readily assuming different forms or characters; extremely variable

Dictionary.com
Diagnosis - Symptoms

Within the last MONTH, how did these symptoms affect you?

1. Hoarseness or a problem with your voice 0 = No Problem
2. Clearing your throat 1 = Slight 2 = Moderate 3 = Severe
3. Excess throat mucous or postnasal drip 1 = Slight 2 = Moderate 3 = Severe
4. Difficulty swallowing solid liquids or pain 1 = Slight 2 = Moderate 3 = Severe
5. Complaints after you ate or after lying down 1 = Slight 2 = Moderate 3 = Severe
6. Breathing difficulties or choking episodes 1 = Slight 2 = Moderate 3 = Severe
7. Trouble swallowing or noisy coughing 1 = Slight 2 = Moderate 3 = Severe
8. Sensations of something sticking in your throat or a lump in your throat 1 = Slight 2 = Moderate 3 = Severe
9. Heartburn, chest pain, indigestion, or stomach acid coming up 1 = Slight 2 = Moderate 3 = Severe

Reflux Symptom Index. RSI > 10 suggests LPR


Diagnosis - Exam

Reflux Finding Score

<table>
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<th>Finding</th>
<th>Score</th>
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<tbody>
<tr>
<td>Esophagitis absence</td>
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<tr>
<td>Verruca laryngea</td>
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</tr>
<tr>
<td>Erosive</td>
<td>1</td>
</tr>
<tr>
<td>Vocal fold edema</td>
<td>1</td>
</tr>
<tr>
<td>Vocal fold hemorrhage</td>
<td>1</td>
</tr>
<tr>
<td>Reinforced hypertrophy</td>
<td>1</td>
</tr>
<tr>
<td>Granulomatous edema</td>
<td>1</td>
</tr>
<tr>
<td>Tissue thickness</td>
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Reflux Finding Score ≥ 11 suggests LPR

Validated on pH probe + LPR patients

Intra-observer reliability


Inter-observer reliability


Flexible scopes may be more sensitive, but less specific than rigid scopes in noting findings such as arytenoid irritation, ventricular obliteration, pseudosulcus, etc. – even in asymptomatic volunteers

Milstein et al. Laryngoscope 115:2256-61, 2005

So, exam may be unreliable as well . . .

Diagnosis – Signs and Symptoms

Diagnosis on clinical grounds is okay, but not great

“I know it when I see it”

Justice Potter Stewart, Jacobellis v. Ohio, 1964

Confirmation

– Empiric response to treatment
– pH probe studies

Not surprisingly, controversy exists here too

Diagnosis - Exam

Laryngeal findings attributed to LPR can be found in 86% of normal controls


Flexible scopes may be more sensitive, but less specific than rigid scopes in noting findings such as arytenoid irritation, ventricular obliteration, pseudosulcus, etc. – even in asymptomatic volunteers

Milstein et al. Laryngoscope 115:2256-61, 2005

So, exam may be unreliable as well . . .

Treatment

Response to empiric PPI should confirm diagnosis

Multiple studies show statistical improvement in symptoms, signs of LPR


BID therapy > qD therapy, 4 months > 2 months

Park et al. Laryngoscope 115:1230-8, 2005

Jitter, shimmer, and NHR improved over baseline by 1-2 months with treatment, and improvement is maintained at 3-4 months

**Treatment**

- However, many randomized controlled trials with placebo controls don’t show a difference. Karkos, Wilson. Laryngoscope 116:144-8, 2006
- Most symptoms may improve over time, even in placebo group. Noordzij et al. Laryngoscope 112:2192-5, 2002

**Treatment**

- The good news: empiric treatment might be more effective clinically than placebo.
- The bad news: it’s fairly poor as confirmatory of reflux as etiology of patient complaints.
- Somewhat worse: it doesn’t help us to manage the non-responders.
- Worse yet: empiric treatment is not without side effects.

**Treatment – Side Effects**

- Limits calcium absorption
  - Osteopenia
  - Hip fracture
- Increases pneumonia risk
  - (Real risk may be reflux itself)
- Decreases plavix efficacy

**Treatment – Side Effects**

Long-term Proton Pump Inhibitor Therapy and Risk of Hip Fracture

- Odds ratio of hip fracture:
  - 1 year of PPI: 1.22
  - 2 years of PPI: 1.41
  - 3 years of PPI: 1.54
  - 4 years of PPI: 1.59
- "Long term high-dose PPI": 2.65
Treatment – Side Effects

- PPI may cause reflux in normal volunteers → Rebound Acid Hypersecretion (RAHS)
- 120 healthy volunteers: Placebo vs Nexium for 8 weeks
- Then 4 weeks of placebo, with reporting of symptoms
- 44% Nexium group vs 15% Placebo with ≥ 1 symptom
- Statistically significant for each timepoint, week 9 - 12

Treatment – Conclusions

- Grade B: Treat EER if accompanied by GERD
- Grade D: “Recommend against, fair evidence that it is ineffective or harms outweigh benefits” for potential EER in absence of GERD
- Return to paradigm of models . . .

Treatment – Notes

- Why do they say this?
- Recommendations have GI perspective
  - No Otolaryngologists on the panel
  - “Suspected Extra-esophageal GERD syndromes”

So, where does this leave us?

- Dilemma: knowledge vs practice management
- Reality: we need to do something

In summary, patients with suspected extra-esophageal GERD syndromes may have GERD as a contributing etiology but rarely as the sole cause. However, the increasing incrimination of GERD as an etiologic factor along with the lack of accurate confirmatory diagnostic tests has resulted in widespread overdiagnosis and overtreatment of these conditions. Moreover, empirical therapy with twice-daily PPIs for 2 months remains a common clinical strategy for subsets of these patients if they have a concurrent esophageal GERD syndrome. Failing such a trial, etiologies other than GERD should be explored.

(Who feels good about this?)

So how do we do better?

- Helps to establish diagnosis
- Can assess response to therapy
  - i.e., tell us what to do with the non-responders

pH Probes

- Helps to establish diagnosis
- Can assess response to therapy
  - i.e., tell us what to do with the non-responders
**pH Probe**

- **“Gold standard”** (AAO-HNSF LPR Position Statement, 2002)
- Difficulties with traditional pH probes
  - Can you use an esophageal probe as proxy for what happens in the pharynx?
  - If you re-position a proximal probe from beneath UES to above UES, does it provide valid measurements?
  - What constitutes a positive test?

**Meta-analyses: pH Results and Clinical Diagnoses**

- Significant difference in: Number of pharyngeal reflux (PR) events and mean percentage of acid exposure times
  - PR events occur in 51.2% ± 4.3% of LPR patients
  - Only 38.3% (CI 25.4 – 52.1%) of LPR patients had PR event
  - 22.9% of controls had PR event – not statistically different
    - This review is “biased”
  - “There are 3 kinds of lies: lies, damned lies, and statistics”
    - Benjamin Disraeli, popularized by Mark Twain

**Triple Sensor Data**

- 41 patients with suspected LPR
  - 40/41 abnormal with triple probe; only 29/41 abnormal with dual esophageal probes
  - Significant false negative rate if use esophageal sensor as proxy
- 33 patients with symptoms of LPR
  - 4/17 Pharyngeal + patients negative in the esophagus
  - 6/19 Prox Esoph + patients negative in the pharynx
  - Significant false negative rate if use esophageal sensor as a proxy
  - Significant false positive if use traditional sensor in hypopharynx without esophageal confirmation

**Problems: Esophageal Sensor in Pharynx**

- Esophageal Sensors too low for detection of LPRD
- If the 2nd channel is placed higher it dries out due to air contact
- Sensor can be fouled by mucus
- Mucosal contact can mask reflux events

**Traditional pH Probes**

- Am J Gastro 2007;102:668-685
  - “Pseudo-reflux” with drying artifact

- ACO Practice Guidelines: Esophageal Reflux Testing
  - The range of normals is poorly defined (none to 4 pH drops <7.44 (3.0 to 3.5 months) and 90% of healthy volunteers meet published criteria for normal pharyngeal reflux, suggesting some reflux into the hypopharynx may be normal phenomenon (127). From applying less restrictive pH criteria (i.e., pH drop of 1.0 or 1.5 units rather than 2.0 units) does not selectively discriminate healthy volunteers and patients with suspected reflux related ENT complaints (125). Finally, and most clinically relevant, several studies found that positive results of pharyngeal testing do not predict a more favorable response to antireflux therapy (124, 126). For example, Udalle et al. (129) reported that the degree of symptoms improvement in 19 of 27 patients exhibiting pharyngeal reflex episodes was similar to the remaining eight patients not having pharyngeal reflux; however, these limitations and controversies, the available evidence does not support the routine use of proximal pH monitoring in clinical practice.
Traditional pH Probes

- “Exclusion of pH artifacts is essential for HP monitoring”
  - Single-catheter, 3-sensor probe; suspected LPR pts, off therapy
  - Positive = at pH 4; 3 HP episodes, at least 1% proximal esophagus, and at least 4.2% distal esophagus
  - 2225 HP pH drops: 48% too short (<5s), 17% during meals, 16% liquid swallows outside meals, 16% isolated HP drops, 12% pH out of range, 5% pH drift
  - Yield of HP sensor as predictor of positive test went from 92% → 47% after controlling for these 6 artifacts

- “Esophageal pH testing using pH catheters and wireless pH monitors, once considered the gold standard for diagnosing GERD, have NOT shown adequate sensitivity and specificity for this group of (LPR) patients”

Pharyngeal pH Probe

- Respiratory Technology Company (Restech)
- Nasopharyngeal catheter
- HP probe only – no esophageal measurements

Pharyngeal pH Probe

- Positioned 5-10 mm beneath uvula
- LED aids positioning (no manometry)
- Transmitter secured to collar
- Receiver / recorder worn on belt

Pharyngeal Probe Sensor

- 3.2 mm teardop tip with 1 mm antimony sensor
- 2 Hz sampling rate (vs 0.2 Hz)
- Aerosolized droplets
  - Moisture in exhaled air creates fluid layer which bridges between antimony sensor and reference electrode
- Hydration monitor
- Downward aim limits masking

Pharyngeal Probe Tracks Esophageal Measurements

- Poster with small N
- Subsequent paper with larger sample
- Pharyngeal probe sensitive and specific
- Episodes track over time

Preliminary Comparison of an Oropharyngeal Aerosolized pH Probe and a Standard Dual pH Probe for Diagnosis of Laryngopharyngeal Reflex

- Judith S. Golub, PA; Michael M. Johns III, MD; John M. DelGaudio, MD; Adam M. Klein, MD
**Pharyngeal Probe Tracks**

**Esophageal Measurements**

- 15 patients, simultaneous measured with 2 probes
- All Dx-pH events were associated with distal esophageal drops which progressed antegrade
- Median pH: distal 3.1, proximal 5.2, pharynx 5.6

**RYAN Score**

- Thomas Ryan DeMeester, USC
- 55 normal subjects
- 95th percentile, with thresholds of 5.5 upright, 5.0 supine
- “Overcomes artifacts”

**Pharyngeal pH Probe – Summary**

- It measures what it is supposed to
- It is well-tolerated
- It helps with diagnosis and management of laryngopharyngeal complaints which might or might not relate reflux
- No esophageal information
- Doesn’t factor in non-acid reflux
- May be used in complimentary fashion with esophageal dual pH impedance

**Sample Patient**

- 49 yo female with dysphagia to solids, progressive for 3 years; now limited to liquids, with ~30 lb weight loss over 3 months
- Episodic heartburn, about 1-2x per month
- + globus and throat clearing – “but it doesn’t bother me”
- CP hypertonicity and HP redundancy on MBS, but no Zenker’s diverticulum
- Unwilling to take PPI or H2-antagonist without proof of reflux

**Patient Report**
Pt 2 – Chronic Cough

- 61 yo Female, c/o chronic cough following lung surgery to remove a T1 carcinoid tumor
- Cough improved but persistent on steroid inhalers per pulmonary
- Also c/o occasional globus pharyngeus, throat clearing, and dry throat; no heartburn or acid brash

- Reflux? Or laryngeal inflammation caused by the cough itself?
- Concerned about PPI impact on calcium, preferred pH probe to empiric challenge

- Upright: RYAN score 52.99 (normal <9.41)
  - Mild-moderate reflux
- Supine: RYAN score 6.4 (normal <6.8)
  - No excessive reflux
- AM PPI and PM H2 antagonist peri-operatively
- Switch to BID H2 antagonist for maintenance therapy
Pt 3 – Refractory vocal process granuloma

- 50 yo Male with c/o throat pain, cough, PND, etc during URI
- URI resolves; throat pain persists
- Vocal process granuloma identified; treated with PPI
- Lesion persists and is removed
- Post-op exam, lesion is back → referred to me

- Reflux care maximized, scheduled for pharyngeal pH probe to ensure adequacy of PPI regimen

Pt 4 – Globus and Throat Clearing

- 55 yo male with several year history of persistent globus pharyngeus and throat clearing, started at time of very increased job stress
- Refractory to PPI, upper esophageal dilation, neurontin, and klonopin
- Had tried Prevacid 30 mg daily without response
- Now on Prevacid 15 mg PO BID – with breakfast and 1 hour before dinner
- No heartburn or acid brash on PPI; severe heartburn and acid brash off of PPI
- Reflux? Globus hystericus?

Pt 5 – More globus and throat clearing

- 43 yo female with globus pharyngeus, throat clearing, dry/scratchy throat, occasional non-productive cough x3 years
- Bravo capsule pH probe – “mildly high acid” off of therapy
- MBS – small hiatal hernia
- Nexium 40 mg, 30 minutes before breakfast → no heartburn, but no change in her pharyngeal symptoms
Conclusion

- LPR can be difficult to diagnose
- Difficult diagnosis makes it difficult to manage
  - When empiric therapy works, everyone is happy
  - But what happens when it doesn’t?
  - And what about the risks?

- pH probes can help with both diagnosis and management
  - For LPR, I prefer a pharyngeal probe
General Principles of Microlaryngeal Surgery

Laryngology in the OR
April 8, 2011

Principles
1. Know when to operate
2. Use the right tools
3. Physiology informs technique

These principles are seen in the evolution of the field → get the best possible view, operate to preserve and restore function

Know When to Operate

Pre-operative Decision Making

• Put the puzzle pieces together
  – Joint decision between me and patient
  – Patient complaints
  – Patient voice needs / obligations
  – Exam findings
  – Non-surgical therapies

Pre-operative Decision Making

• Risks
  • Dental injury
  • Tongue numbness
  • Failure to get desired voice outcome
  • Potential to worsen voice

• Benefits

• Alternatives
  • Potential to improve voice
  • (Also: establish pathologic diagnosis, treat malignancy, etc)
Alternatives

- Nonsurgical management
- Voice therapy
- Vocal hygiene / technique
- Reflux management (if contributing)

*Partner with Speech Language Pathology*

Indications for Surgery

- Voice complaints which:
  - Are correlated to the lesion noted on exam
  - Prevent the patient from meeting occupational / social / personal voice needs
  - Persist despite adequate non-surgical therapies as appropriate

Indications for Surgery

- Just seeing a lesion does *not* mean that it needs to come out (if you have a good exam and know it is benign)

Surgical Tools

- Universal modular glottiscope
- Gallows suspension arm
- Infusion needle
- (KTP laser – we’ll get there later….)

Technique – Laryngoscopes
• "Modular"  
  – Different size scopes for different size patients  
  – Can adapt to different suspension arms  
• Triangular to best expose anterior commissure  
• Side ports for instrument placement  
  – Support for the instrument → shorter lever arm  
  – Laterally placed for unobstructed view


• True “suspension”, not lever laryngoscopy  
  – Originally described by Killian  
  – Chest holders popularized in 1940’s  
  – Now most scopes use lever arms  
• Improved vector for suspension  
• “Forces on the mandible, maxilla, oral cavity, pharynx, and larynx are preferable to those associated with holder-stabilizers”

Infusion Needle

• Diagnostic
  – Degree of expansion helps predict depth of lesion / density of intra-SLP scarring

• Therapeutic
  – Tense the cord for cordotomy
  – Expand SLP to limit scarring
    • SLP twice as thick → scar proportionally half as much
  – Add epinephrine for hemostasis

Infusion Needle

Surgical Techniques

Principles of Phonosurgery

• “Phonosurgery” – surgery with attention to improvement and preservation of voice

• Exposure, exposure, exposure
• Save superficial lamina propria
• Save epithelium
• “Aim small, miss small” → magnification

Normal Voice – Superficial Lamina Propria
Benign Lesions – Phonomicrosurgical Resection

- Subepithelial lesion → subepithelial dissection
  - Cordotomy approach
  - Work on deep side of lesion first
    - More important plane is deep, to save SLP
    - Dissect epithelial attachments next
    - Minimize cordotomy defect, save epithelium to minimize scarring

Bilateral lesions – a pointer

- Work on the larger (i.e., more problematic) lesion first
- Based on how things go, be prepared to stage the other side
  - Let the patient know about this possibility ahead of time
  - Goal is not to place both TVC at risk of surgical injury unless there is confidence that the first side has healed (or will heal) well

Nodules

Cyst, Nodule
ICD-10-CM Diagnosis Codes for Audiology and Speech-Language Pathology (International Classification of Diseases, 10th Revision, Clinical Modification)

Beginning October 1, 2013, you will be required to use the new ICD-10 system, which will replace the current ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification) Volumes 1, 2, and 3 used to report health care diagnoses, disorders, and inpatient hospital procedures. The new ICD-10 will include the ICD-10-CM (clinical modification) for diagnosis codes and the ICD-10-PCS (procedure coding system) for inpatient hospital procedures. This page will focus primarily on ICD-10-CM.

The codes in ICD-10 are not valid for any purpose or use in the United States until October 1, 2013.
Advanced Cold Instrument Surgery
Kenneth C. Fletcher, Jr., MD

Microflap Approach

• Submucosal Pathology
  • Make incision through the epithelium at the closest possible location to the submucosal pathology

Microflap Approach

• Submucosal Pathology
  • Disrupt the minimum surrounding tissue to the vocal fold pathology

Microflap Approach

• Submucosal Pathology
  • Stay as superficial as possible

Microflap Approach

• Submucosal Pathology
  • Preservation of overlying normal mucosa (epithelium plus superficial lamina propria)

Cyst
Laryngeal EMG & Botox
Kenneth C. Fletcher, Jr., MD

Laryngeal EMG
- Described as early as 1944 by Weddell
- Evolved into study to analyze peripheral recurrent nerve injury
- CNS diagnoses: myasthenia gravis, Charcot-Marie Tooth, laryngeal dystonia
- Aid in injection of Botox for Spasmodic Dysphonia - Tremor

Normal Motor Unit Action Potentials

Fibrillation Potentials
Recent or ongoing degeneration

Positive Sharp Waves
Seen along with fibrillation potentials indicating recent or ongoing degeneration
Polyphasic Potentials

Reinnervation is occurring and may be a sign of recovery

Large Amplitude Motor Unit

Sign of stability of reinnervation

Normal Recruitment

Few Motor Units Firing Fast

Peripheral nerve injury with fewer motor units firing

Spontaneous and Irregular Recruitment

Spasmodic Dysphonia

EMG

- Diagnostic interpretation of the EMG usually done in conjunction with a neurologist trained in EMG interpretation
- Sometimes seen as a “art form”
Laryngeal EMG

- Determine the state of the recurrent laryngeal nerve in the setting of vocal fold immobility and possibility of cricoarytenoid joint dislocation* or scarring in the setting of an laryngeal injury

- Determine the state of the cricothyroid muscle and the superior laryngeal nerve if there is suspicion for injury

Laryngeal EMG

- Allow monitoring for vocal fold injection for spasmodic dysphonia and/or tremor

*Indications

- Spasmodic Dysphonia
  - Adductor
  - Abductor
  - Mixed
Botulinum Toxin

• Indications
  • Essential Tremor
    • Horizontal versus vertical
    • Isolated laryngeal versus laryngopharyngeal

Botulinum Toxin

• Indications
  • Vocal fold granuloma
    • forced voice rest

Botulinum Toxin

• Indications (relative)
  • bilateral vocal fold paralysis
  • Vocal cord dysfunction

Botulinum Toxin

- Dosing:
  Adductor Spasmodic Dysphonia:
  - Start at 1.25 U per side and escalate
  Abductor Spasmodic Dysphonia:
  - Unilateral 5 U dose with contralateral side titrated after observation for 2 weeks
  - Risk of bilateral paralysis and airway obstruction
  Granuloma
  - Usually unilateral 5-20 U

Botulinum Toxin

• Contraindications to injection:
  • Pregnancy
  • Breast feeding
  • Impaired function of vocal fold for PCA injection (relative)
  • Concurrent aminoglycoside treatment

Botox injection
Botox injection
Laryngeal Framework Surgery

Kenneth C. Fletcher, Jr., MD

Indications

- Vocal Fold Immobility of permanent nature
- Bilateral intervention for paresis/presbylarynges

Anesthesia

- Local Only
- Marcaine + Lidocaine
- Propofol for injection of local
- Tetracaine for nasal cavity (fiberoptic scope)
- Try to avoid anxiolytics
  - Versed, Valium
- Small amounts of Fentanyl for discomfort

Operative Considerations

- Shoulder Roll
- Fiberoptic scope in place for directed visualization of the vocal fold
- Meticulous dissection to prevent swelling of vocal fold
- Bipolar cautery

Laryngeal Framework Surgery

- Medialization Laryngoplasty
- Arytenoid Adduction
- Cricothyroid Subluxation

Laryngeal Framework Surgery

- Timing:
  - at least 6-12 months following injury
  - LEMG
  - at least 4 months following temporary injection (Cymetra / Radiesse Voice)
Laryngeal Framework Surgery

- Medialization Laryngoplasty
- Silastic
- Gore-tex
- Hydroxylapatite
- Titanium “spring”

Laryngeal Framework Surgery

- Medialization Laryngoplasty
- Silastic - technique I prefer as classically performed and described by Netterville using carved silastic
  - Advantages: specifically able to tailor the implant for each individual patient
  - Disadvantages: steep learning curve

Patient Positioning
Laryngeal Framework Surgery

- Medialization Laryngoplasty
  - Gore-Tex - uses a Gore-Tex strip layered through a small thyrotomy
  - Advantages: fast, technically easier than silastic
  - Disadvantages: Harder to fine-tune, implant can change position with time, migration

Gore-Tex

Laryngeal Framework Surgery

- Medialization Laryngoplasty
  - Hydroxylapatite - preformed blocks
    - Application similar to carved silastic however blocks are much larger
    - Advantages: preformed
    - Disadvantages: multiple sizes available that are not customizeable, often allows too much anterior medialization

Laryngeal Framework Surgery

- Medialization Laryngoplasty
  - Titanium “spring” - preformed spring made by Gyrus/Kurz
    - Advantages: Preformed implant, faster OR time, can be standardized with less experienced surgeons
    - Disadvantages: implant is large (3 sizes), may provide medialization at wrong cord position

TVFMI = Titanium Vocal Medialization Implant

Sizes: 6x11 mm, 6x13 mm, & 4.5 x 9 mm

Arytenoid Adduction

- Lengthens the paralyzed vocal fold
- Attempts to recreate the rotation and downward displacement of the vocal fold (“off-level”)
- Does not need to be done in every situation
- Determined at time of surgery (1 in 5) if medialization alone does not achieve the desired voice
Cricothyroid Subluxation

- Designed to also lengthen the vocal fold and “remove laxity”
Laser Safety
Kenneth C. Fletcher, Jr, MD

Laser Safety
• Safety goggles must be worn by
  • Surgeon
  • Operating room personnel
  • Patient (if awake)

Laser Safety
• Eye Protection
• Inhaled Smoke Protection

Laser Safety
• Warning signs must be posted
• Signs must indicate power and wavelength
• For the Aura XP sign should read “Max. of 15 W at 532 nm”
• Doors to treatment room are closed
• Goggles: O.D. 5 @ 532 nm (KTP)

Laser Safety
• ANSI Standard Z.136.3 recommends that ALL personnel in the O.R. wear protective eyewear to prevent accidental eye damage
• The eye is most vulnerable part of body with regard to laser injury
• KTP can cause retinal damage
**Laser Safety**
- All personnel must be trained on specific use for each laser prior to use
- Laser key must never be left in laser other than when in use
- Turn laser to “Standby” when removing fiber from scope
- Communicate “Ready” and “Standby” to Surgeon prior to firing

**Surgical Smoke**
- Lasers and electrosurgical cautery

**Smoke**
- Odor
- Pyrolysis
- Acrolein, Acetonitrile, Acetylene, Allyl benzene, Butadiene, Butene, CO, Creosols, Ethane, Ethylene, Formaldehyde, Free radicals, HCN, Isobutene, Methane, Phenol, Polycyclic aromatic hydrocarbons, Propene, Propylene, Pyridene, Pyrrole, Styrene, Toluene, Xylene

**Smoke**
- Size of particulate matter
  - 1.1 microns
  - surgical masks (0.5 microns)
  - high filtration masks (0.1 microns)

**Smoke**
- Viability of Particulate Matter
  - Bacteria
  - Cells
  - Viruses
  - Documented transmission of HPV to surgeon (anogenital to laryngeal)

**Smoke**
- Inline smoke evacuator
- Red-rubber catheter through opposite nasal cavity
- Activated during laser activation
Office-Based Anesthesia
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Topical Anesthesia
- Laryngovideostroboscopy
- In-office vocal fold injection
- Transnasal fiberoptic laser surgery
- Transnasal esophagoscopy

Laryngovideostroboscopy
- No anesthesia
- Cetacaine
- Transnasal (aerosolized 4% lidocaine)

In-office vocal fold injection
- Route of injection
  - Peroral
  - Transcutaneous
    - Transthyrohyoid
    - Transthyroid
    - Transcricothyroid

In-office vocal fold injection
- Route of injection
- Transcutaneous
- All require similar internal anesthesia
- Also require local site injection usually of 1% lidocaine with epinephrine
Transnasal fiberoptic laser surgery

- Administration essentially the same as for vocal fold injection

In-office vocal fold injection

Transnasal fiberoptic laser

- Application of Anesthesia
  - Cetacaine spray
  - 4% Lidocaine
    - ~ 1 cc tongue base
    - ~ 2 cc epiglottis
    - ~ 2 to 4 cc on phonating vocal folds

4% Lidocaine

- The maximum recommended single dose is approximately 7-8 cc
- 4.5 mg/kg
- ~ 300 mg in a 70 kg patient
- Consider this in patients with cardiac disease

Transnasal Esophagoscopy

- Topical Nasal Anesthetization Only
- Ensure both nasal cavities are thoroughly aerosolized

Anesthesia

- A good anesthetic provides the ability to perform the procedure while limiting side effects that make the procedure more difficult
  - Globus sensation - heightened gag
  - Pooling of secretions

Post-anesthesia

- Patient is reassured that anesthesia will be short-lived and any symptoms of globus, dysphagia will resolve within 1 hour following the procedure
- Patient advised not to eat or drink for the period during which sensation recovers (1-2 hours)
Perioperative Medications and Management

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Anticoagulation Medications

- NSAIDS
- ASA
- Coumadin
- Plavix
- Dong quai, primrose, vitamin E, garlic, gingko, ginger, feverfew, red root

Anticoagulation Medications

- For phonosurgical cases and open laryngeal cases stop 7-10 days
- For direct microlaryngoscopy with biopsy or vocal fold injection generally does not require cessation
- In-office injections generally do not require cessation

Prophylaxis

- Proton-pump inhibitor therapy -
  - Generally advised even without symptoms of laryngopharyngeal reflux to ensure no added inflammation
  - GERD dietary habits discussed
  - Often extended 1-2 months following phonosurgery
  - Debateable

Steroids

- Oral Steroids
  - May be considered preoperatively if surrounding edema present may be masking lesion
  - Not routinely used
  - No routine post-operative role

Steroids

- Dexamethasone IV (10-20 mg):
  - For all general laryngeal cases
  - Prior to induction of general anesthesia
  - No role for extended use following phonosurgery
  - Not usually employed in office-based procedures
### Steroids
- Dexamethasone 10 mg/ml
- Can be used intralesionally for vocal fold scar
- Can be used after phonomicrosurgery should stiffness not improve with expected surgical healing
- Avoid Kenalog due to particle deposits within vocal fold

### Antibiotics
- No role for prophylactic antibiotics in phonomicrosurgical cases
- Ancef or equivalent used for open laryngeal framework surgery especially if implant being used

### Narcotics
- e.g. Hydrocodone -
  - Allows for postoperative pain control (usually minimal)
  - Functions as an anti-tussive
Preoperative Counseling and Informed Consent

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Phonomicrosurgery
- Usually Elective Surgery
- Primary Goal is to improve voice quality
- Reserved for cases where all conservative measures have been exhausted

Phonomicrosurgery
- Timing:
  - Discuss need for adequate recovery
  - Voice rest - ~ 1 week
  - Full speaking - 7 to 30 days
  - Full singing - 30 to 90 days

Phonomicrosurgery
- Timing:
  - Demands for return
    - Intrinsic
    - Extrinsic
    - e.g. school teachers and summer break
    - e.g. college students after college

Preoperative Considerations
- Reduce vocal edema 1-2 weeks prior to surgery (Reduce heavy voice use)
- Control premorbid conditions
  - Reflux
  - Allergies

Preoperative Considerations
- Analyze psychological impact
  - Identification of “self” with voice
  - Performers
  - Discuss this possible anxiety prior to surgery
Preoperative Considerations

- Preoperative voice therapy
  - Helps determine if surgery is necessary due to impasse in progress
  - Allows time to accept need for surgery
  - Helps ensure best recovery

Preoperative Considerations

- Usually Elective
  - Do not delay if...
    - Dysphagia associated with aspiration
    - Impending airway embarrassment
    - Risk for malignancy

Preoperative Considerations

- The most important question that must be answered before deciding for or against proceeding with phonosurgery is: “Can the patient do what they need to do with their voice after undergoing maximum of nonsurgical rehabilitation?”

Preoperative Considerations

- Once surgery is planned:
  - Videostroboscopy within 1-3 weeks of surgery

Informed Consent

- Education with Documentation
  - Discuss vocal abilities, training and post-operative voice demands
Informed Consent

• Success rate should be 95% for appropriately performed phonomicrosurgery

Informed Consent

• Important to make the distinction between voice improvement and restoration of premorbid vocal capabilities

Informed Consent

• Success dependent on:
  • Pathology
  • Patient’s ability
  • Vocal demands

Informed Consent

• Discuss risk of postoperative scarring and permanent dysphonia
  • worse than preoperative status
  • 1-2 %

Informed Consent

• Risk of no improvement
  • 1-2 %

Informed Consent

• With procedures aimed at improving glottal competence
  • Discuss the difference between restoration of strength and volume and clarity and premorbid voice dynamics
Informed Consent

• With procedures where malignancy may be involved:
  • Discuss voice and swallowing affect
  • Discuss possible need for repeat procedures

Informed Consent

• With airway procedures:
  • Discuss the inverse relation of voice and breathing
  • Discuss need for repeat procedures

Informed Consent

• For all patients:
  • Discuss the airway and risk for edema
  • Remote or potential need for tracheotomy

Informed Consent

• For all patients:
  • Discuss risk to non-laryngeal structures
  • Tongue (numbness, taste alteration - may take 6 weeks to recover)
  • Teeth, lips, gums
  • Pharyngeal tears, lacerations

Informed Consent

• For all patients:
  • Discuss general risks of surgery
  • Anesthesia
    • possibility of post-operative muscle weakness and soreness due to muscle relaxants

Informed Consent

• For all patients:
  • The more time spent up front helps with questions later
  • Patients generally recall 20% of what they are told