Differential Diagnosis and Management of Vocal Tremor and Spasmodic Dysphonia

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THUS, I RESPECTFULLY REQUEST:

• NO AUDIO-VIDEO-RECORDING, OR PHOTOGRAPHY OF PATIENT EXAMPLES

Starting Point:
Match the examples to the voice disorder

a) Spasmodic Dysphonia
b) Vocal tremor
c) Muscle tension dysphonia

What have we learned since 1871?

SPASTIC vs. SPASMODIC DYSPHONIA

• Psychological vs. Neurogenic

• Dystonia: “syndrome of sustained, uncontrolled muscle contractions resulting in abnormal, unintended actions” during purposeful activity (Schweinfurth, Billante, Courey, 2002)

• Rare idiopathic focal dystonia, or laryngeal dystonia
  • affects 1 per 100,000 dystonia cases (Hunt, Wuepper, Aminoff, Kurzard, 1988)
  • Less than 8% of those with SD have family members with dystonia (Xiao, Zhao, Bastian, et al, 2010)

SPASMODIC DYSPHONIA CHARACTERISTICS

• Idiopathic onset (Schweinfurth, Billante, Courey, 2002; Adler, Edwards, Bansberg, 1991)
  • Frequently occurs subsequent to an upper respiratory infection, laryngeal injury, or emotional stress (Schweinfurth, et al., 2002; Tanner, Roy, Merril, Sauder, Heads, & Smith, 2012)
  • Onset typically occurs during mid-life ages of 30-50 years of age (Schweinfurth, et al., 2002)
  • Women are more often affected than men (60-85% female) (Adler, Edwards, Bansberg, 1997; Schweinfurth, et al., 2002; Bitzer, 2010)
  • Progression is steepest during first year and is chronic thereafter (Udehskil, Dedo, Beles, 1984; Brin, Bitzer, Stewart, 1998)
  • Normal vegetative voice function (Ludlow, 1995)
  • Laughing, Crying, Cough, Yawn, Whisper, Respiration
**SPASMODIC DYSPHONIA TYPES**

- ADDSD
- ABSD
- Mixed

~1/3 develop co-occurring vocal tremor (Weisen & Hartness, 1981; Schwartkuhs et al., 2002; Hallet, Borello, Blinov, Carolla, 2000; White, Klein, Hager, Delgassko, Hallet, Nyberg, Johns, 2011)

**ADDUCTOR SPASMODIC DYSPHONIA**

- Characterized by:
  - Strained-strangled voice quality (Bloch, Hirano, Gould, 1985; Ludlow, 1995)
  - Intermittent voice stoppages during production of vowels (Erickson, 2003)
    - For example: “We eat every day”
  - Over-closure of the vocal folds with voice stoppages (Parnes, Lavorato, & Myers, 1979; Leonard & Kendall, 1999)

**ABDUCTOR SPASMODIC DYSPHONIA**

- Characterized by:
  - Intermittent breathy breaks and prolongation of voiceless consonants (Rontal, Rontal, Rolnick, Merson, Silverman, & Truong, 1991; Rodriguez, Ford, Blas, Harmon, 1994; Edgar, Sapienza, Bids, Ludlow, 2001)
  - Speech sounds associated with breathy breaks: /h/, /s/, /f/, /p/, /t/, /k/
  - For example: “He had half a head of hair”
  - Pitch or voice breaks during vowel production (Edgar, Sapienza, Bidu, Ludlow, 2001)
  - Abduction of the vocal folds during breathy breaks (Leonard & Kendall, 1999)

**Tremor and the Voice**

- Tremor: An involuntary rhythmic oscillation of opposing muscle groups.
- Considered one of the most common neurologic movement disorders seen in clinical medical practice.
Tremor Classification

- **ACTION-INDUCED**
  - Purposeful movement
  - Postural
- **RESTING**
  - Supported from gravity

Etiology of Tremor

- Neural “Oscillators”:
  - Cerebellum
  - Basal ganglia (Thalamic nucleus and Globus pallidus)
- Tremor is characterized by:
  - Pattern of onset
  - Affected structures
  - Rate and amplitude of oscillation
  - Context of onset (rest vs. muscle activation)
  - Neuropathology and other associated factors

Vocal Tremor (VT)

- **General characteristics**
  - Involuntary nearly rhythmic modulation of (Gamboa et al, 1998)
    - **PITCH**
    - **LOUDNESS**
  - Best perceived during a sustained phonation task (Brown & Simonson, 1963; Lederle, Barkmeier-Kraemer, & Finnegan, 2012)
  - Significantly slower speaking rate than normal speakers (3 vs. 5 syllables/s) (Lundy, Roy, Xue, Casiano, & Javir, 2004)
  - May improve (reduce vocal tremor) when drinking alcohol, depending on etiology (Sulica and Louis, 2010)

Etiologies of Vocal Tremor (VT)

- Most often associated with Essential tremor (ET):
  - Affects ~3-4 million people in the United States
  - Most often begins with onset of hand tremor, but may also affect the head, legs, and voice
  - Average age of onset is 45 years
  - Action-induced and positional type of tremor
- Additional neurological etiologies include:
  - Dystonia
  - Parkinson’s Disease
  - Other neurodegenerative disorders

Vocal Tremor and Spasmodic Dysphonia

- Co-occur in ~1/3 of patients with SD (Aronson & Hartman, 1981; Schweinfurth et al, 2002; White, Klein, Hagner, Delgaudio, Hanfelt, Hyder, Johns, 2011)
- Vocal tremor type may be:
  - Dystonic tremor of the larynx
  - Co-occurring Essential Vocal Tremor

[Image of tremor classification]

[Image of etiology of tremor]

[Image of vocal tremor]

[Image of etiologies of vocal tremor]

[Image of vocal tremor and spasmodic dysphonia]
Vocal Tremor Case Example

- Sustained phonation
  - Rhythmic modulation of pitch & loudness
- Connected speech
  - Strained voice quality
  - Shortened voicing duration reduce perception of vocal tremor

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Muscle Tension Dysphonia (MTD)

- Functional Dysphonia
- Characterized by
  - Chronic excessive laryngeal and extra-laryngeal muscle tension activation during speaking
  - Vocal fatigue and effortful speaking
  - Observe supraglottal constriction during endoscopy
    - Anterior-posterior
    - Ventricular fold adduction
    - Sphenicteric (both directions)
  - May also see posterior tongue carriage or pharyngeal constriction
  - May observe abnormal shoulder positioning or strap muscle activation during speaking


Muscle Tension Dysphonia (MTD)

- Characteristics of MTD typically remain constant regardless of context
  (Sapienza, Walton & Murry, 2000; Roy, Gouse, et al, 2005)
  - Speech context
  - Vegetative function context

- MTD is highly responsive to voice therapy treatment
  (Roy, Bless, Heisey, & Ford, 1997)

MTD Case Example

- Consistent voice quality:
  - Strained
  - Breathy
  - Reduced loudness
  - Not phoneme specific
- Normal vegetative voicing
- Responsive to voice therapy

Case Example courtesy of: Kristine Tanner, PhD, CCC-SLP
Department of CSD
Brigham Young University

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Clinical Roadmaps

How is SD Diagnosed?

- Primarily based on:
  - Audio-perceptual assessment
  - Case history
- Visual imaging
  - Rule out laryngeal pathology
  - Identify tremor presence & location
Case History

- Pattern of symptom onset
- Speech and non-speech contexts during which voice quality changes
  - Singing vs vegetative
  - Stressful vs non-stressful
  - Consistent vs intermittent nature
- Anything that improves their voice?
  - Relaxation
  - Drinking alcohol
  - Muscle Relaxants
  - Sensory Tricks

Auditory-Perceptual Evaluation

### Speech Tasks
- Sustained phonation at normal pitch and loudness
  - /a/ “father”
  - /i/ “tea”
- Read or repeat two lists of sentences
  - Adductor list
  - Abductor list
- Shout “No!” or “Not now!”

### Auditory-Perceptual Evaluation

**Adductor Sentences**

1. Tom wants to be in the army.
2. We eat eels every day.
3. He was angry about it all year.
4. I hurt my arm on the iron bar.
5. Are the olives large?
6. John argued ardently about honesty.
7. We mow our lawn all year.
8. Jane got an apple for Ollie.
9. A dog dug a new bone.
10. Everyone wants to be in the army.

**Abductor Sentences**

1. He is hiding behind the house.
2. Patty helped Kathy carve the turkey.
3. Harry is happy because he has a new horse.
4. During babyhood he had only half a head of hair.
5. Who says a mahogany highboy isn’t heavy?
6. Boys were singing songs outside of our house.
7. The puppy bit the tape.
8. See, there’s a horse across the street.
9. Sally fell asleep in the soft chair.
10. The policy was suggested in an essay on peace.

(Taken from: Ludlow et al, 2008: Location of frequent voice breaks are underlined)

### Auditory-Perceptual Evaluation

Assessment of speech tasks (Ludlow et al, 2008)

1. Visual analog scale rating of strain for vowels
2. Presence/absence of vocal tremor during sustained phonation
3. Number of voice breaks per sentence list
4. Presence/absence of strain or voice quality aberrance during shouting

<table>
<thead>
<tr>
<th>Strain</th>
<th>11</th>
<th>10</th>
<th>9</th>
</tr>
</thead>
</table>

Also, conduct auditory-perceptual judgments of vocal tremor across speech contexts:

- Sustained phonation using /a/ and /i/ (laryngeal muscle testing)
  - Comfortable, High, Low Pitches
  - Comfortable + Loud
  - Comfortable + Soft
- Connected Speech (severity judgments)
  - Sentences with all-voiced speech sounds
  - Sentences loaded with voiceless speech sounds
  - Conversation
Auditory-Perceptual Profiles

**Spasmodic Dysphonia**
- **Severity** = # breaks/10 sentences
- **SD Type**
  - One list is associated with more breaks and increased effort
    - Abductor
    - Abductor
- **Symptom-free Shouting tasks**
- Less effort and fewer or no signs during sustained vowels

**Muscle Tension Dysphonia**
- **Equal effort level and aberrant voice quality for both sentence list types and with vowels and shouting**

**Vocal Tremor**
- Rhythmic modulation during vowels

Laryngeal Examination
- No anesthesia should be used
- Determine the presence/absence of pathology
- Repeat speech examination tasks
- Identify presence/location of tremor
- Evaluate laryngeal function during vegetative activities
  - Respiration, cough, throat clear, and whistling

“Wave” of the Future with High Speed Imaging

Quantification of High Speed Imaging Using Kymography Plots

Adductor Spasmodic Dysphonia

Quantification of High Speed Imaging Using Kymography Plots

**Oscillatory break in vocal fold vibration**

**Irregularities in vocal fold vibration**

Images Courtesy of Rita Patel, Indiana University
**Adductor Spasmodic Dysphonia**

Images Courtesy of Rita Patel, Indiana University


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**Voice Therapy as Diagnostic Tool**

- Typical Trial Voice Therapy Approaches:
  - Reduction of excessive tension (MTD)
  - Phonatory-respiratory coordination
  - Modified speaking patterns
    - Resonant voice
    - Casper-Stone Flow Phonation
  - If no improvement:
    - Lidocaine nerve block test (Smith, Roy, & Wilson, 2006)

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**Case Examples**

**Case 1**
- Auditory-Perceptual sentences
- spoken Yell
- whispered Vowels

**Case 2**
- Auditory-Perceptual sentences
- spoken Yell
- whispered Vowels

**Post-Trial Voice Tx**

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**In Summary**

- Spasmodic Dysphonia (SD) is a rare form of a focal laryngeal dystonia
- SD has 3 types, with 1/3 manifesting vocal tremor (VT)
  - ADSD
  - ABSD
  - MIXED
- Diagnosis of SD and VT requires analysis of the
  - Case history
  - Auditory-perceptual patterns across speech tasks
  - Laryngeal imaging
  - Voice therapy may serve as a diagnostic tool
Management of Vocal Tremor and Spasmodic Dysphonia

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Current Treatment Options

• Pharmaceutical
  – Systemic
    • Propranolol, primidone, etc.
  – Local
    • Botox® to laryngeal muscles

• Surgical
  – Deep Brain Stimulation (DBS)
  – Thalamic ablative

• Voice therapy

Adler et al, 2004; Bové et al, 2006; Ludlow, 1995; Moringlane et al, 2004; Sataloff et al, 2002; Sulica & Louis, 2010; Warrick et al, 2000; Barkmeier-Kraemer et al, 2011

I've always wanted to be a mover and a shaker!

Treatment of Spasmodic Dysphonia & Vocal Tremor

• Botox Treatment is the most common treatment
  – https://www.youtube.com/watch?v=Kl7zEPz0bPI

• Types of Botox (Blitzer, 2005; Dressler & Hallett, 2006; Elmiyeh, Prasad, Upile, Saunders, Yool, Epstein, & Rubin, 2010)
  – Clostridium Botulinum Type A
    • Dysport
  – Clostridium Botulinum Type B
    • Myobloc
    • Neurobloc
  – Botox Types C – H (Type h has not been used with SD)

Figure 1 Diagram showing the SNARE proteins docking a vesicle of Acetylcholine on the plasma membrane. Labels show where each of the botulinum toxins cleave the proteins. (Taken from Blitzer, 2005, Otolaryngol HNS)

Treatment of Spasmodic Dysphonia & Vocal Tremor

• Botox Treatment is the most common
  – Dosage and side effects (Change, Shabot, Thomas, 2007)
  – Site of injection
    • Thyroarytenoid
    • Supraglottal (Young & Blitzer, 2007)
    • Interarytenoid (Kendall & Leonard, 2011)
    • Strap muscles (Gurey, Sinclair, & Blitzer, 2013)
  – Unilateral vs Bilateral (Zwirner, Murry, & Woodson, 1993; Upile, Elmiyeh, Jerjes, Prasad, Kafas, Abola, Yool, Epstein, Hopper, Sudhoff, & Rubin, 2009; Gurey, Sinclair, & Blitzer, 2013)
  – Lidocaine Test (Smith, Roy, & Wilson, 2006)
  – Antibodies and treatment response

Surgical Treatment of Spasmodic Dysphonia

Selective Nerve Denervation/Reinnervation

Thyroplasty Type II Device

Reinnervate With the Sternohyoid branch of the ansa cervicalis

Reinnervate With the Sternohyoid branch of the ansa cervicalis

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Surgical Denervation-Reinnervation Treatment for SD


(Isshiki, 2004)
Behavioral Management of SD

- There are two studies in the literature on this topic:

Voice Therapy Methods Studied

- Address breath use during speaking
- Address excessive contraction of extrinsic and supplementary laryngeal muscles
- Easy voice onset
- Manipulation of voicing during speaking

Clinical Rationale for Voice Therapy

- Sometimes, patients do not want Botox®
  - Repeated laryngeal injections with variable duration of benefit
  - Intolerant of side effects
  - Poor outcomes
  - Develop antibodies to Botox®
- Voice treatment provides:
  - Communication strategies and counseling
  - Strategies for managing Botox® side effects
  - Smooths out cycles of Botox® treatment symptoms
- Methods for managing SD symptoms

Literature on Voice Therapy for Spasmodic Dysphonia

- Murry & Woodson (1995)
  - Voice therapy vs. No voice therapy
  - Voice therapy = 2 weeks longer duration benefit, on avg
  - Considerations
  - No control group (e.g., sham treatment)
  - Group assignment was not random
- Silverman et al (2012)
  - Voice therapy, No voice therapy, Sham groups
  - No differences in outcomes
  - Botox treatment intervals were controlled

Recent Re-consideration of Voice Therapy

- Connie Pike, M.A., CCC-SLP
  - Free to Speak: Overcoming Spasmodic Dysphonia (2005)
  - Free to Speak II: Long Term Management of Spasmodic Dysphonia (2010)
- National Spasmodic Dysphonia Association (NSDA)
  - Invited workshop, panel discussion, and therapy presentations on the topic of voice therapy for spasmodic dysphonia and vocal tremor in 2014

Evidence that behavioral intervention may benefit focal dystonia

- Physiotherapy for focal cervical neck (74%) and hand (62%) dystonias in the UK associated with improvement.
- Intensive repetitive positioning and simple movement patterns associated with change in:
  - Cortical motor organization
  - Somatosensory organization
  - Measurable functional gains
- Suggests behavioral intervention may shape CNS sensori-motor patterns to improve focal dystonias.

Non-exhaustive Recent Literature on Focal Limb Dystonia

Voice Therapy Approaches to Consider

- Phonation-Respiratory Coordination
  - Accent therapy
  - Semi-occluded vocal tract methods
- Speaking methods
  - Resonant Voice therapy
  - Casper-Stone Flow Phonation

Accent Method

- Increases pulmonary output
- Reduces inefficient laryngeal valving during voicing
- Decreases excessive muscular contraction
- Improve VF vibratory patterns during voicing


Accent Method

- Progression from:
  - Practice using /s/, /f/, or “sh” using chest wall while sitting, standing, and walking
  - Use rhythm and accentuation to practice use of respiratory system
    - Nonsense sounds & syllables (zh-zh-zh, etc)
    - Melody of phrases
    - Reading passages
    - Monologue
    - Conversation

Semi-occluded vocal tract methods

- Improves voicing efficiency
- Optimizes positioning of the vocal tract
- Balances pressures above and below the vocal folds to optimize vocal fold vibration
- Reduces laryngeal muscle tension
- Lowers phonation threshold pressure
- Online demonstration: [http://www.youtube.com/watch?v=a0JgR-WF-0](http://www.youtube.com/watch?v=a0JgR-WF-0)


Resonant Voice Therapy

- Increase intensity of vocal output with minimal effort
- Improve use of vocal tract to amplify the voice
- Decrease laryngeal muscle tension during voicing
- Increase efficiency of vocal fold approximation and vibratory pattern along the membranous vocal fold
Resonant Voice Therapy Basics

- Train barely adducted/abducted vocal fold configuration
- Produced with semi-occluded vocal tract (e.g., /m/)
- Experiential rather than analytical training
- Intensive variable practice in varied environments
- Gradually carry over to conversation

Example Case

- Example of ABSD first session using:
  - Resonant Voice Therapy approach combined with
  - Semi-occluded vocal tract technique
  - Chewing method

Pre-Treatment CAPE-V Voice Session #1 Examples

Casper-Stone Flow Phonation

- Reduces vocal fold collision forces
- Improves use of the respiratory system during speaking
- Can achieve normal intensity levels

- After each utterance ask:
  - Did you lose all your air?
  - Did it feel easy?
  - Must do both to be correct
- Start with simple task
  - Single number each full exhalation from 1-10
  - Two numbers each full exhalation from 1-10
  - Three numbers from 1-12
  - Single syllable words
  - Progress to reading, conversation

Casper-Stone Flow Phonation Example

Voice Evaluation Recording

Voice Therapy Session #1

Circumlaryngeal Massage

- Pair this technique with breathing and voicing exercises for best outcomes
  - Massage the thyrohyoid space using small circular motion
  - Gradually enlarge the circular motion to above and below the hyoid bone (up and down movement)
  - Massage the thyrohyoid space from front to back (horizontal movement)
  - Massage in a “C” shape upwards and downwards from the thyrohyoid space to the cricoid cartilage.

Augmentative Communication Devices

- Utilize basic picture board or other manual methods for assisting communication
- Cue-based communication
- Technology assistance for communication
  - Text-to-speech (e.g. iPhone)
  - Augmentative communication device

Colton RH, Casper JK. Understanding voice problems. Williams and Wilkins, Baltimore, MD.

Outcome Examples

Adductor-Type SD  Abductor-Type SD

Case examples courtesy of Connie Pike, M.A., CCC-SLP

Behavior Treatment for Vocal Tremor: Information from the evaluation will drive the treatment:

• Determine the speaking patterns that elicit greater or lesser vocal tremor magnitude by:
  – Speech Context (severity level)
  – Pitch Level (laryngeal muscle involvement)
  – Loudness Level (laryngeal muscle involvement)
  – Determine whether the individual can produce shortened voicing duration on purpose
    • Production of the “h” sound paired with vowels
  – Determine whether increased airflow during voicing lessens vocal tremor

Basic premise for speech therapy for vocal tremor

• Vocal tremor is an action-induced tremor
  – Worsens with increased activation of affected muscles
  – Typical rate is between 4-8 Hz
  – Magnitude of tremor is inversely related to rate
    • Reflects severity or degree of muscle activation
• Common patient strategy for speaking with a predictable perturbation (i.e. tremor)
  – Slowed speaking rate with prolonged voicing durations
    • 3 syllables/sec vs 5 syllables/sec

Basic premise for speech therapy for vocal tremor

• Reduce degree of muscle contraction in the larynx (typically affected)
  – Typically reduces tremor magnitude
• Shorten duration of voicing during speaking
  – Phoneme duration averages 100 – 150 ms
  – Vowel duration is easiest to shorten vs. Consonants
  – Voicing duration target < 500 ms

Overview of current speech therapy approach to manage vocal tremor:

• Address phonation/respiration coordination first
  – Increased respiratory drive = Decreased laryngeal tension
• Shorten voicing duration
  – Use easy onset with “h” words, build toward all words
  – Shorten voicing duration using phrase context
    • Load with voiceless sounds
    • Load with all-voiced sounds
  – Shape toward sentences, reading paragraphic, conversation
    • Insertion of pauses and phrase breaks
• Address other patterns affecting tremor perception (e.g. pitch inflection patterns during speaking)
• Carryover to conversation

Case Example: Pre-treatment
Case Example: Progression through therapy sessions

Considerations...

- Responsiveness to therapeutic probing during the evaluation
  - The extensiveness to which the speech mechanism is affected by tremor
  - The ability to manipulate speaking patterns
- Motivation to pursue behavioral intervention (related to adherence)
- Emphasize that this approach provides speaking strategies, not a cure
  - To date, strategies have not been reported to be automatic, but intentional

Treatment Case Examples: Learning from successes, mistakes, and recognizing limitations

Case #1: Acoustic samples pre-treatment

- Sustained phonation of /a/
- “We rolled along Long Island Avenue”
- “We mow our lawn all year”

1 year later...

Case #1: Acoustic samples post-treatment

- Sustained phonation of /a/
- “We rolled along Long Island Avenue”
- “We mow our lawn all year”

- Progression of her vocal tremor undermined ability to implement original methods
- Re-oriented to focus on increased breathiness as only successful strategy
- Used telephone bill-paying and ordering as feedback of success
Case #2: Severe vocal tremor

Case #2: Treatment session examples
- Pre-treatment speech recording
- Treatment speech recordings
- Post-treatment speech recording

Case #3: Treatment session intervals matter

Case #3: Treatment session examples
- Pre-treatment speech recordings
- 1 month later
- Post-treatment speech recordings
- WHAT WAS LEARNED:
  - Due to commuter barrier and scheduling conflicts, intervals > 2-3 weeks results in poor progression

Case #4: Supplement to Botox® Treatment

Case #4: Treatment session examples
- Pre-Botox® treatment speech recordings
- Post-Botox® speech treatment session recording
Case #5: When all goes well

Case #5: Treatment Outcomes

- Pre-treatment speech recording
- Treatment session #3
- Post-treatment speech recording

Treatment Considerations...

- Severity of tremor and its progression over time
- Structures affected by tremor
- Individual speaking patterns that worsen or lessen the perception of tremor
- Motivation to pursue behavioral intervention (related to compliance)
  - Strategies never automatize ("I always have to think about what I’m doing")
- Ability to attend treatment sessions consistently
- Adaptation with disease progression
- Consider as a supplement, or complement to Botox®

What needs to be studied...

- Determine the ideal treatment dosage for optimal effectiveness
- Determine the treatment effect with and without Botox® intervention
- Determine the treatment effect for different types of tremor etiologies
  - Essential tremor
  - Dystonic tremor (e.g. spasmodic dysphonia)
  - Other (e.g. vocal tremor co-occurring with Parkinson Disease, cerebellar degeneration, MS, etc.)
- Varied benefits when tremor affects specific, or combined speech structures

Discussion

REFERENCES

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