“Working Out”
Dysphagia with Exercise Based Treatments
Lori Burkhead Morgan, PhD, CCC-SLP
Assistant Professor

My perspective
- Practicing SLP since 1994
- Completed PhD in Rehabilitation Science, 2005
- Focus on exercise science & sports training
- How can we (SLP’s) truly do “swallowing exercise??”

Purpose of this talk
- Muscle structure & function
- Response to deconditioning & conditioning
- Activity vs. exercise
- Application of exercise principles in dysphagia rehabilitation

The Challenge
- Critically evaluate & implement findings from research to solve clinical problems
- Provide the best patient care possible
- Treatment must be both time-efficient & cost-efficient

Evidence Based Practice
- Treatment should be based on:
  - Best available evidence
  - Patients wishes
  - Clinicians knowledge & experience

Wisdom from a Snapple cap
- “Relative to size, the tongue is the strongest muscle in the human body”
- Snapple “Real Fact” #810
Neuromuscular Development

How muscles work

Skeletal Muscle Composition
- Type I: Slow-twitch, fatigue resistant
- Type II: Fast-twitch, fatigable
  - IIa: Adaptable, more efficient Type II fiber
  - IIb: Best force generation, but inefficient
- Whole muscle contains blend with a predominance of one type

Oropharyngeal Muscle Composition
- Type II is predominant
- Type I, IIa, IIb and hybrid fibers
- Unique architecture
  - Regional differences in proportion & diameter of fiber types
  - Complex arrangement

Kairaitis, 2010.

Oropharyngeal Muscle Composition
- Muscular hydrostat
  - Tongue
    - Kair & Smith (1985)
    - Pharynx?
    - Kairaitis (2010)

Muscular Hydrostat
- Composed entirely of muscle with complex, 3-dimensional fiber arrangement.
- Maintains constant volume, as a fluid-based muscle structure.
- Shape alteration is dependent on redistribution of hydrostatic tissue pressure.
- Mechanical effect depends upon integrated activity of other muscles within the organ.

Kairaitis, 2010.
Why do we care?

- Do contemporary exercise principles apply to these unique structures?
- In what ways can we maximize function of these muscles?

For more detail


Muscle response to deconditioning & conditioning

**Deconditioned**
- Muscle wasting, cachexia

**Conditioned**

Deconditioning

**Peripheral**
- Atrophy
- Loss in cross sectional area
- Decreased size
- Force-generating capacity (“strength”)
- Fiber-type shift
- More easily fatigued

**Central**
- Decreased neural activation (“drive”)
- Decrease in number of motor units
- Remodeling of motor units

Muscle atrophy & deconditioning

- 4-6 wks bed rest (young, healthy) up to 40% decrease in strength*
- Ill & elderly even more susceptible**

“Vicious Loops” in Dysphagia?

Dysphagia - NPO
Decreased swallow frequency
Dysphagia - asp

Exacerbation of dysfunction

<table>
<thead>
<tr>
<th>Frequency/min</th>
<th>Normals</th>
<th>Dysphagia, - asp</th>
<th>Dysphagia, + asp</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>1.16</td>
<td>.71</td>
</tr>
</tbody>
</table>

Murray et al, 1996

Deconditioning
Exacerbation of dysfunction

PERIPHERAL
- Hypertrophy
  - Increased cross sectional area
  - Increased force-generating capacity
- Fiber type shift
  - Increased endurance

CENTRAL
- Increased neural activation
  - "drive"
- Increased number of motor units

6-12wks.

***Plasticity***

- Cortical reorganization
- Blood flow changes
- Peripheral muscle changes

Therapeutic Exercise:

Exercise vs. Activity

Exercise: What is it?

- Strength, Timing, Coordination, ROM*
- Specificity
- Intensity
  - Overload principle (> 60% MVC)
  - Progressive resistance
  - Volume & frequency of exercise


What qualifies as EXERCISE?

Exercise is activity that challenges the body beyond its typical level of activity

- Exercise that does not force the neuromuscular system beyond usual activity will not elicit an adaptation
- Resistance training recruiting 60-75% effort is required to achieve the greatest improvement
As your muscles get stronger, the challenge must also increase to elicit continued improvement!

Strength Defined
- The force-generating capacity of a muscle.
- Lifting a heavy weight
- Swallowing a large bolus of peanut butter

Endurance Defined
- The ability to continually produce force over a period of time.
  - Marathon runner
  - Eating a meal

Power Defined
- Combination of strength & speed
- Ability to exert force quickly in a “burst”
  - Jumping, sprint start
  - Strong, forceful BOT retraction

Speed Defined
- Maximal velocity achieved (how fast one can go!)
  - Sprinter
  - Swallowing liquids

Coordination Defined
- All of the previous components mentioned working in concert to efficiently and effectively perform functional tasks
  - Basketball player in a game
  - Ballet dancer performing
  - My husband ingesting a rack of ribs & a beer.
Functional Reserve

- The proportion of potential force-generating capacity in relation to the effort required to perform a certain task.

Think outside of the box

...or the cage.

Exercise Methods:

“Borrowing” from Physical Therapy & Athletic Training

Exercise: What?

- Strength, Timing, Coordination, ROM*
- Intensity
  - Overload principle (>60% MVC)
  - Progressive resistance
  - Volume & frequency of exercise
- Specificity

Specificity in Oropharyngeal Musculature

- Clark, HM (2012)
- Pilot study of 22 healthy volunteers
- Exercised 3/wk for 4 wks using IOPI

<table>
<thead>
<tr>
<th>STRENGTH</th>
<th>ENDURANCE</th>
<th>POWER</th>
<th>SPEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximal anterior elevation “pause” (5 sets of 5) with IOPI.</td>
<td>Anterior elevation at 50% max, 3 sets at 75% of most recent endurance measure on IOPI.</td>
<td>Anterior elevation at 75% Max, attempting to produce /t/ while achieving pressure goal on IOPI, 3 sets of 10.</td>
<td>Produce /t/ as fast as possible, 5 sets of 10 second trials, No IOPI.</td>
</tr>
</tbody>
</table>

Specificity in Oropharyngeal Musculature

- Study limitations: Small N and gender imbalance
- Effect sizes demonstrated trends for strength, endurance, power (force & speed) but not speed alone.
- Potential for specificity of exercise in oropharyngeal muscle

Specificity in Oropharyngeal Musculature

Clark, HM & Shelton, N (2014)

- 40 Healthy Volunteers
  - 35 females (mean age = 22.3 yrs.)
  - 5 males (mean age = 34 yrs.)
- 4 weeks of training (3 sets of 10, 7d/wk)

<table>
<thead>
<tr>
<th>Condition 1</th>
<th>Condition 2</th>
<th>Condition 3</th>
<th>Condition 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>High effort</td>
<td>Eff. swallow preceded by high-effort sips</td>
<td>Eff. swallow preceded by max. lingual elevation</td>
<td>Eff. Swallow</td>
</tr>
<tr>
<td>Sips from small-diameter straw</td>
<td>Eff. swallow preceded by high-effort sips</td>
<td>Eff. swallow preceded by max. lingual elevation</td>
<td>Eff. Swallow</td>
</tr>
</tbody>
</table>

RESULTS

- Poor compliance (avg. = 3 sets 10, 5d/wk)
- Swallowing pressures did not vary significantly across different straw diameters
  - Larger volume w/ larger diameter = greater pressure
- Effortful swallow showed greatest pressure gains during swallowing

Specificity in Oropharyngeal Musculature

- Swallowing pressures measured in BOTH a “usual swallow” and “effortful swallow condition”
- MOST dramatic improvement noted with EFFORTFUL SWALLOW since THAT is what was trained!
  
  What does this mean?

- If your patient is training EFFORTFUL SWALLOWS in therapy…
  - better FUNCTIONAL carryover with THAT swallow during deglutition (vs. “usual swallow”)

Skill vs. Strength?

- Maybe both?
  - Stronger muscles move more quickly (power)
  - Must some base of strength for movement first

*Yeates et al, 2008; Steele et al, 2011; Steele et al 2013

Steele, C. et al, Toronto Rehabilitation Institute

Case series reveal increased liquid swallowing when accuracy targeted in addition to lingual strengthening tasks*

Ongoing exploratory RCT currently underway
**Exercise: When?**

- The sooner the better
  - "Use it or lose it" principle*
- Early intervention can improve diet tolerance, airway protection & overall nutrition**
- Pre-Treatment exercise beneficial in H&N Ca***


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**Exercise – When??**

- "Our patients are too sick"
  - If you do nothing you will improve nothing.
  - Function may only get worse as you “wait” for the patient to “get better.”
  - Remember the concept of “vicious loops.”

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**Major culprits in the ICU patient**

- Systemic inflammatory response syndrome
- Critical illness myopathy
- Critical illness polyneuropathy

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**Systemic Inflammatory Response Syndrome (SIRS)**

- HR > 90 bpm
- Body temperature, 36 or >38°C
- WBC count, 4000 cells/mm³
- SIRS + infection = sepsis
SIRS
- Occurs in adults and children
- Up to 50% of ICU pts on vent have SIRS
- 50-70% of those pts develop diffuse myopathy and polyneuropathy

SIRS
- Results in
  - Muscle weakness
  - Difficulty weaning from the ventilator

Critical Illness Myopathy (CIM) & Polyneuropathy (CIP)
- Usually co-occurring
- Presents as ventilator weaning difficulty
- Seen in 25-63% of pts on vent >1 week
- Sensorimotor with motor predominance
- Limbs & respiratory muscle affected most
- Cranial nerves usually spared

Critical Illness Myopathy (CIM)
- Diffuse weakness
- Diagnosed with EMG studies & biopsy
- Type II muscle atrophy or undergo necrosis

“Offenders” specifically impacting communication & swallowing
- Deconditioning
- Endotracheal intubation
- Tracheostomy
- Ventilator dependency

Deconditioning Negatively Impacts Structure & Function
- Muscle atrophy
- Reduced force-generating capacity
- Lower endurance
What about communication & swallowing in the ICU?

- Intubation
- Tracheostomy
- Ventilator dependency
- NPO

Endotracheal Intubation

- Bypasses use of upper airway
- Disuse atrophy
- Desensitization
- Trauma to mucosa, particularly larynx
- Cuff over inflation is common

Airflow Changes with tracheostomy

- Airflow bypasses upper airway
- Deflated cuff and/or fenestration can facilitate some upper airway airflow

Normal Larynx (for reference)

Granuloma

Subglottic Stenosis
Glottic & subglottic trauma

Post-Intubation Ulceration

What contributes to structural deficits?

- Prolonged intubation (>2 weeks)
- Can happen quickly, not just in long-term intubation
- Trauma due to movement/friction

Incidence & Prevalence

- Laryngotracheal injury in 95% (39/41) of previously intubated patients.
  - Stauffer, Olson, & Pety (1981)
- Dysphagia as high as 56% (27/48), with nearly half those pts aspirating silently
  - Ajemian, Nirmul, Anderson, Zirren, & Kwasnik (2001)

But we CAN do something….

Are Our Patients “Too Sick?”

If you do nothing, you will improve nothing - function commonly gets worse as you “wait” for the patient to “get better.”
Lessons from Physical Therapy

- Early intervention
- ROM and facilitation are precursors to rehabilitating functional movement.

Exercise: When?

- The sooner the better
- Muscle atrophy & deconditioning
  - 4-6 weeks bedrest = ~40% decrease in strength*
  - Ill & elderly even more susceptible**

* Bloomfield, 1997  ** Urso et al, 2006

First things first….

- Restore the system to the most “normal” condition as possible
- Passy-Muir Valve use (in-line ventilator use or trach alone)

Goals of ANY Dysphagia Exam

- Assess patient’s perception of problem & determine goals
- Determine premorbid activity level
- Assess **FUNCTIONAL** swallowing ability
  - Effect of consistency, volume, condition
  - Effect of fatigue over time

Approaching Assessment with Exercise Principles in Mind

“Hey, what do you say we get this fella up for nice walk? Yeah…I bet that would feel good to stretch in those legs! If he falls, we can call PT for a consult!”

Goals of ANY Dysphagia Exam

- Determine safest, least restrictive oral intake
- Determine target of rehab efforts
- Determine effectiveness of compensatory strategies & therapeutic techniques
  ... NOT just to determine whether or not someone is aspirating
**Instrumental assessment not just a tool for diagnosis of dysphagia – think physiology!**

- Coordination
- Speed
- Endurance
- Strength
- Various conditions

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**Evaluation: Lessons from Physical Rehabilitation**

<table>
<thead>
<tr>
<th>Ambulation</th>
<th>Swallowing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg strength/ROM</td>
<td>O-P-L strength/ROM</td>
</tr>
<tr>
<td>Standing, balance</td>
<td>Dry Swallow, cough, breath-hold</td>
</tr>
<tr>
<td>Few steps</td>
<td>Few bites/sips</td>
</tr>
<tr>
<td>Greater distance, speed</td>
<td>Greater volume, rate</td>
</tr>
<tr>
<td>Variety of terrain</td>
<td>Variety of consistency &amp; situation</td>
</tr>
</tbody>
</table>

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**The Biggest Lesson from Physical Rehabilitation**

- One successful step ≠ ambulation
- One successful swallow ≠ eating

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**Methods in Evaluation**

**Test variety of volumes**

- Progressively increase volume
  - Start with small boluses and work up
  - Continuous swallows vs. single sips
  - Straw drinking

- tsp → cup edge → cont. swallow → straw

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**Methods in Evaluation**

**Test variety of textures**

- Liquids
- Puree/pudding
  - Loose vs. thick puree
- Solid food
  - Masticated, crunchy, and/or tough
- Particulates
  - Rice, corn bread, etc.
- "Mixed" consistency
  - Requires simultaneous chew & swallow (Fruit cocktail, cereal w/ milk, chunky soup, pineapple, etc.)
- Oral meds w/ liquid
**Methods in Evaluation**

- Allow the patient to feed him/her self!
  - More realistic to assess manner, rate and volume of intake
  - Swallow physiology differs if being fed vs. self-feeding

- “Should I start with liquid or puree?”
  - General consensus among experts is to start with thin liquid
  - Giving thick liquids or purees first may result in residue, thus “muddying the waters” for subsequent trials
  - Decision may vary, given the situation and patient
    - i.e., Patient fearful of liquids
    - Patient you’ve been working with for some time

- Initially, present the least restrictive texture (usually thin liquid) in a small volume
  - If successful, increase volumes
  - Progress to next texture & repeat process
  - If not successful, attempt compensatory strategy with THAT texture/volume

- When to try thickened liquids:
  - If unsuccessful with modified volume of thin liquid or use of a compensatory strategy
  - Physically or cognitively unable to follow directions for compensatory strategies
  - Patient otherwise unreliable in following through with recommendations necessary for safe thin liquid intake

- **TEST FOR FATIGUE**
  - Muscular fatigue
  - Integrity of central pattern generator
  - Respiratory pattern & coordination

- More important with certain conditions, particularly neurologic

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**Madness Behind the Methods**

- Remember….
  - The purpose of a FUNCTIONAL swallow exam is to assess swallowing ability for REALISTIC setting & nutrition/hydration demands
  - …**NOT** just presence or absence of aspiration
The Documentation Dilemma

- Lack of physiologic description vs. “storytelling” or descriptive report
- Wordy/jargony
- Variability across SLP’s, facilities, even for a given SLP from day-to-day

Documenting airway compromise

- Depth of airway compromise
  - Above cords, to cords, below cords
- Response to airway compromise
  - Attempt to clear
  - Success of attempt to clear
- When did it happen?
- Could it be prevented?
- Why did it happen?

Penetration-Aspiration Scale

- Rosenbek et al, 1996.
- Originally designed to describe airway compromise during an MBSS

PAS Score Descriptions

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Does not enter airway</td>
</tr>
<tr>
<td>2</td>
<td>Enters airway, remains above cords, is ejected</td>
</tr>
<tr>
<td>3</td>
<td>Enters airway, remains above cords, not ejected</td>
</tr>
<tr>
<td>4</td>
<td>Enters airway, contacts cords, is ejected</td>
</tr>
<tr>
<td>5</td>
<td>Enters airway, contacts cords, not ejected</td>
</tr>
<tr>
<td>6</td>
<td>Enters airway, below cords, ejected out or into larynx</td>
</tr>
<tr>
<td>7</td>
<td>Enters airway, below cords, not ejected despite effort</td>
</tr>
<tr>
<td>8</td>
<td>Enters airway, below cords, no effort to eject</td>
</tr>
</tbody>
</table>

PAS in FEES

- PAS can be used to document airway compromise in FEES as well as in MBSS
- FEES more reliable for assessing Penetration than MBSS
- MBSS more reliable for detecting severity/depth of aspiration
- BOTH techniques equally effective for discriminating between pen/asp

MBSImP – the future “standard”

- Developed by Bonnie Martin-Harris and a team of dysphagia experts
- Intended to minimize large variances in interpretation and reporting
- Focus clinicians (and research!) on most valuable components of swallowing function and dysfunction to determine an impairment profile
MBSImP – the future “standard”
- Computer-generated report based on scores
- PAS scores are a component of the report
- Narrative included

MBSImP Demonstration

Identify Physiology to Treat Physiology

Once the Problems are Identified…

Exercise: How?
- In skeletal limb muscle, strengthen & stimulate with:
  - Weights
  - Modalities intended to augment exercise (i.e., sEMG biofeedback, NMES, massage, temp.)

Exercise: How?
- Strengthen & stimulate swallowing muscle
  - More challenging due to limited access
  - “Direct” versus “indirect” exercises

<table>
<thead>
<tr>
<th>Direct exercise</th>
<th>Indirect exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mendelsohn</td>
<td>Shaker head lift</td>
</tr>
<tr>
<td>Effortful swallow</td>
<td>EMST</td>
</tr>
<tr>
<td>Tongue hold swallow (Masako)</td>
<td>Lingual strengthening</td>
</tr>
<tr>
<td>Etc.</td>
<td></td>
</tr>
</tbody>
</table>
**Exercises & Effects**

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tongue-hold swallow (Masako)</td>
<td>Varying posterior circumferential pressures with various levels of tongue protrusion</td>
</tr>
<tr>
<td>Mendelholz</td>
<td>Suprathyroid group contraction &amp; UES opening</td>
</tr>
<tr>
<td>Effortful Swallow</td>
<td>All aspects of swallow challenged</td>
</tr>
<tr>
<td>Upper hypopharyngeal swallow</td>
<td>Anterior, middle, posterior, &amp; all aspects of swallow</td>
</tr>
<tr>
<td>Shakar Headlift</td>
<td>Improves anterior UES opening &amp; laryngeal elevation</td>
</tr>
<tr>
<td>EMST</td>
<td>Suprathyroid muscle strength, laryngeal elevation &amp; cranial muscle strength</td>
</tr>
<tr>
<td>Tongue press/lingual strengthening (OES with IOPI)</td>
<td>Coordination, speed, strength of oropharyngeal swallow</td>
</tr>
</tbody>
</table>

**Positional Alterations to Challenge Swallowing Musculature**

- Tongue-Hold Swallow (“Masako”)
- Open Swallow Exercise (OSE)

**Tongue Hold Swallow**

Hammer MJ, Jones CA, Mielens JD, Kim CH, McCulloch TM (2014)

- 40 healthy volunteers
- iEMG & HRM during tongue-hold maneuver

**Tongue Hold Swallow**

- iEMG activity
  - Increased in tongue
  - Increased in cricopharyngeus
  - Increased in superior pharyngeal constrictor
  - Maintain stability of pharyngeal pressure?

- HRM
  - No significant change in pharyngeal pressure

**Open Swallow Exercise**

- Uses positioning to impose challenge/resistance to swallowing
  - Incorporates physiologic principles known to affect muscle performance in limb

Background

- Investigation based upon 2 main physiologic concepts:
  - Optimal length & tension in muscle
  - Mechanical advantage

Background & Rationale

- Sliding filament theory*  
- Theory of optimal length & tension**

Theory of Mechanical Advantage*

- Manipulated by alterations in ratio between length & force

Endoscopy of OSE

Purpose

- Determine relationship between jaw and tongue position on suprahypoid muscle activity during volitional swallowing
  - Physiologic impact of positional alterations
  - Implications for treatment paradigm
Hypotheses

- With incremental increases in jaw opening and simultaneous tongue elevation:
  - Suprahyoid sEMG will incrementally increase
  - Hyoid displacement will incrementally increase

Methods

- **Participants**
  
<table>
<thead>
<tr>
<th></th>
<th>Younger (n=20)</th>
<th>Older (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (SD)</td>
<td>34 (7.43)</td>
<td>61 (7.48)</td>
</tr>
<tr>
<td># Men</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td># Women</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

- **Methods**
  
  - Split-block, repeated measures design
  - 6 randomized conditions (dry swallows)

- **Data collection**:
  - Simultaneous VFG, submental sEMG, lingual pressures collected to monitor lingual “lift” versus lingual “push”.
  - Image calibrated with 1.9cm radio-opaque disk on mastoid process.

- **Analysis**
  
  - Digital images of hyoid as TIFF files extracted and measured with Scion image analysis software*
    - Reliability on 20% of sample:
      - Interjudge = 96%, Intrajudge = 93%
    - Peak sEMG values were identified across all conditions
      - Reliability on 20% of sample:
        - Interjudge = 90%, Intrajudge = 96%
    - Square root transformation
    - RM-ANOVA, Tukey multiple comparison


Results: Suprahyoid sEMG

![Graph showing results of suprahyoid sEMG](image1.png)

**No sig. age effects**

**J-50%, T-UP**
**J-25%, T-UP**
**J-CL, T-DN (p=.0002)**
**J-CL, T-DN (.0324)**
**J-CL, T-UP (p=.0002)**

**No sig. age effects**
**Results: Suprahyoid sEMG**

Max sEMG (µV)
- Tongue down
- Tongue up

**Results: Hyoid Displacement**

Hyoid Distance (CM)
- Tongue position
  - J-CL
  - J-25%
  - J-50%

**Conclusions**
- sEMG does increase with incremental increase in jaw opening, but it is not significant unless the tongue is up.
  - Supports hypothesis 1 in this population.
- Hyoid excursion does not incrementally increase with incremental increases in jaw opening and simultaneous tongue elevation.
  - Hyoid excursion was significantly greater with the jaw closed/tongue up when compared to all other tongue down conditions, but did not significantly differ from the other tongue up conditions, regardless of jaw position.
  - Does not support hypothesis 2 in this population.

**Useful Therapeutic Tools**

sEMG Biofeedback
- The most effective, evidence-based tool available!
- Detects muscular activity, provides graphic representation
- Teaches control and challenges effort*

**Huckabee & Cannito, 1999; Crary, 1995**

Effortful swallow
- Mendelsohn
sEMG – The Evidence

- One of the oldest evidence-based practices in dysphagia rehabilitation
  - Haynes (1976)
- Outcomes superior with biofeedback when compared with “traditional” therapy alone.
- Effective in a variety of populations
- More cost-effective than “traditional” tx (faster recovery in fewer visits)

sEMG: General Guidelines

- Clean/exfoliate skin with alcohol pad
- Be sure men are cleanly shaven
- Be sure to use gel on electrodes that are not pre-gelled
- ACTIVE contact over muscle belly, GROUND contact off to side when using sEMG patch

Proper Electrode Placement

- Active leads
- Ground lead

Electrode used with Kay/Pentax unit

How to do it: sEMG biofeedback

- Use a smoothed, rectified signal
- Obtain/observe baseline resting rate
  - Head in neutral, relaxed
  - Address tension, as necessary (e.g., massage, stretching, cueing)
- Obtain amplitude of 3-5 baseline swallows

sEMG: General Guidelines

- Teaching Effortful Swallow (ES)
  - Obtain peak amplitude for 3-5 ES
  - Set goal 3-5µV above average, increase as needed to challenge
  - Encourage a “tall, skinny, quick peak”
- “Working out” with ES
  - Obtain peak amplitude for 3-5 best ES
  - Set goal between 60-75% of average max µV
  - Work out for ≥15 min, swallowing Q 20-30 sec
sEMG: General Guidelines

- Teaching the Mendelsohn
  - On hand-held, set goal where pt is successful with maneuver 3-5 sec
  - REMEMBER: Objective here is to increase duration and endurance, not peak amplitude.

- “Working out” with Mendelsohn
  - After goal is determined, instruct pt to do this Q 30-40 sec for ≥15 min

sEMG Biofeedback Resources

- McNeill Dysphagia Therapy Program (MDTP)
  - Developed by Crary, MA & Carnaby GD et al at the University of Florida
  - Intensive exercise-based therapy using sEMG biofeedback as a tool

sEMG resources

- Kay/Pentax
  - Is offered as part of their swallowing signals lab box

- Prometheus Group
  - sEMG alone can be used as hand held device or be coupled to a laptop
  - Check with your PT/OT colleagues to see if they have sEMG equipment already

Endoscopic Biofeedback

- Provides visual reference
- Reinforces need for strategy/effort

Endoscopic biofeedback: General Guidelines

- Have pt face monitor once the scope is in place.
- Practice maneuvers and/or exercises, pointing out the physiologic correlates of these behaviors on the monitor.
- Have the pt practice WITH and WITHOUT looking at the monitor and then judge the swallow/post-swallow effectiveness.
Isometric Lingual Strengthening

- Lingual strengthening
  - Train at >60% of maximal effort for strengthening effect
  - Provides biofeedback on performance

Lingual Strengthening – The Evidence

- Robbins et al (2005)
  - 8-week progressive resistance exercise with IOPI in older, healthy volunteers
  - 100% increased their isometric pressures and also oral pressure during swallowing tasks
  - 5.1% volume increase in tongue bulk on MRI

  - 10 dysphagic stroke pts 51-90 y.o. (6 acute, 4 chronic)
  - 8-week progressive resistance with IOPI
  - 10 reps, 3x/day, 3 days/wk at 60% on week1, then 80% on weeks 2-8.
  - All increased isometric pressures and oral swallowing pressures
  - Airway protection improved with liquids
  - Tongue volume increased on 2 subjects

Isometric Lingual Strengthening

- Robbins et al (2013)
  - Case Study
  - 56 y.o. female, 27 months s/p brainstem CVA
  - PEG dependent, expectorating saliva
  - “Traditional” therapy plus NMES in the home

- 8 wks. Isometric Progressive Resistance Oropharyngeal Therapy (I-PRO)
  - 10 reps anterior & posterior 3x/day, 3 days/wk.
  - 5 wks. detraining
  - 9 wks. Maintenance (NO device)
  - Anterior & posterior tongue press to palate, 3 sets of 10, 3x/day, 1 day/week.
Isometric Lingual Strengthening

- Isometric lingual pressures
  - Decreased some following detraining, with some rebound in anterior after maintenance phase
- Maximum oral pressures during swallowing
  - Some increases, particularly in anterior tongue
- Bolus flow kinematics
  - Decreased residue, increased safety (PAS scores)

Isometric Lingual Strengthening

- Lingual volume
  - 8.3% increase
- Swal-QOL
  - Significant gains with reported comfort eating in most social situations.
- Diet
  - General oral diet, PEG removed

IOPI: General Guidelines

- Place bulb just behind alveolar ridge at midline
- Instruct pt to close mouth but not bite down
- Instruct: “Press tongue to roof of mouth as hard as possible”
- Calculate average over 5 trials within 5% of each other
- Set goal at ≥60% of maximal effort

IOPI: General Guidelines

- Have pt press tongue to hard palate for 3-5 seconds or quick presses, depending individual pt deficits
- Allow adequate time for muscle reperfusion between repetitions (approximately 10-15 sec)
- Work out for ≥15 min

Another Lingual Strengthening Option
Another Lingual Strengthening Option

- Swallow Strong (formerly the MOST-Madison Oral Strengthening Therapeutic device)
- 4-sensor mouthpiece coupled to notebook computer

Lingual Strengthening Device Resources

- Kay/Pentax – part of the swallowing signals lab
  - Kayelemetrics.com
- IOPI (Iowa Oral Performance Instrument)
  - www.iopi.info
- Swallow Strong
  - Formerly known as the MOST (Madison Oral Strengthening Therapeutic device)
  - Swallowsolutions.com

EMST

- Expiratory muscle strength training (EMST)*
  - Patients exhale against ≥ 60% MEP
  - Suprathyroid complex activation, similar to swallow
  - Following training, swallowing function shown to improve
  - Can also increase strength of protective cough

  *Sapienza et al 2002; Kim & Sapienza, 2005

EMST – The Evidence

- EMST compared to wet & dry swallows showed increased muscle activity and hyoid excursion in healthy volunteers.
- EMST can improve muscle contraction as well as neuromuscular control of suprathyroid muscle, which is important for laryngeal elevation/airway protection.

EMST – Pressure Threshold Device

- EMST 150
  - www.EMST150.com

EMST – The Evidence

- EMST can improve cough strength, pulmonary function and vocal loudness as well as swallowing function.
Other Respiratory Trainers

- Threshold PEP
- The Breather

Working out with EMST

- 3-5 sets of 10, 3-5 x/day at ≥60% MEP
- If unable to calculate 60% of MEP, can use perception of 6 on a 1-10 scale

NMES

- Neuromuscular Electrical Stimulation ("VitalStim")*
  - Biphasic, pulsed current stimulating motor unit
  - Fixed phase duration & frequency, intensity ≤25mA
  - Boost effect of exercise
- IMPORTANT: NMES does not improve swallowing function….good exercise does!

NMES – The Literature

- Controversy:
  - Initial study flawed
  - Strong marketing efforts over evidence
  - Some negative findings
    - Stim at rest produces hyoid depression
- Promising findings:
  - Improved function after 40 consecutive treatments compared to “traditional” Tx
  - 61% improvement in stim vs. “traditional” Tx in retrospective review
  - Hyoid depression may actually help turn swallowing exercise into resistance exercise
- Park et al (2009)
  - 16 healthy volunteers; 2 groups (NMES + exercise vs. exercise only)
  - Daily sessions: 20 min, 5 days/wk, 2 wks.
  - ONLY the experimental group had improvement in hyoid elevation/excursion
What does the field of exercise science tell us about NMES?

- NMES can maximize gains in strength, ROM, awareness of voluntary control and decrease spasticity of agonist muscles.
  - Sheffler & Chae (2007)
- NMES alone (without activity/exercise) is **NOT** effective
  - Requena Sanchez et al (2005)

NMES – what if we choose to use this?

- Consider all the evidence
- Be thoroughly trained and thoroughly informed before proceeding.
- Think physiology & understand the pt’s underlying disease – don’t follow a “cookie cutter” approach
- Don’t think of this as a panacea!!

Try NMES under fluoro/FEES before giving oral trials with stim to insure adequate airway protection under the stim condition

If you use it be certain to pair it with GOOD exercise – NMES alone is NOT effective

Be watchful for negative effects

Heck, Doeltgen & Huckabee (2012)

Healthy volunteers (N=20)

80Hz stimulation, 4 sec duration

60 volitional saliva swallows

Manometry of oropharynx, hypopharynx, UES

5 min, 30 min, 60 min following stimulation

Decreased peak pressures in hypopharynx and UES that lasted up to 1 hour post-stim.

NMES for Swallowing

Ampcare
Regardless of the tool used…

…be mindful of exercise principles, the patient’s specific target areas, and the patient’s disease process.

In ALL things…
- Be a critical consumer of the research
  - Blend that with knowledge & experience
- Look outside of our field when necessary
  - i.e., When doing exercise, learn about “exercise”
- Conduct focused, function-driven, purposeful treatment versus “task-driven” treatment

“I found the best trainer at my new gym”

***REMEMBER***
*The stimulus must increase in proportion to strength to elicit continued improvement!*

Be that motivator for your patients!
- Encourage your patients!
- Even the most motivated patients can do *junnassst* a little bit more if you push them
International Classification of Functioning, Disability & Health (ICF) WHO, 2001

Food is meant for more than eating

Quality of Life
- Not part of the ICF nomenclature but a integral part of it
- QOL measures:
  - Attitudes affecting activity and participation
  - Underlying causes affecting compliance
  - Discrepancies between activity (“CAN”) vs. participation (“DOES”)

Why Look Beyond Body Structure/Function?
- Body parts & movements ≠ activity or participation
- Surrogate endpoint*
  - “Physical sign used as a substitute for a clinically meaningful endpoint that measures how a patient feels, function, or survives”
- Function is under reported by pts & overestimated by clinicians**

** Fried et al, 1991; Sager et al, 1992; Ward et al, 2002

Disability & Dysphagia
- Swallowing specific measurements
  - MDADI
  - SWAL-QOL & SWAL-CARE
  - FOIS

Case examples
- Note the following:
  - Prior therapy had plateaued
  - Intensity and use of tools for progressively increasing resistance/challenge were key in progress
  - Progress was dramatic in a relatively short period of time

NOT measures of PHYSIOLOGIC FUNCTION!
Tools to detect attitudes/perceptions and level they are FUNCTIONING IN THEIR ENVIRONMENT.
Case Report #1

- 60 y.o. man
- Hx/o right CVA
- Severe dysfunction, silent aspiration
- Pt carried “spit cup”
- PEG dependent
- 1 yr. of IP & OP Tx
- Referred for Myotomy

- 8 weeks of therapy:
  BOT and pharyngeal strengthening & laryngeal closure
- Used sEMG & NMES
- Pt resumed unrestricted oral diet
- PEG removed

Case Report #2

- Hx/o 2 left CVA’s, DM, renal failure w/ transplant, heart disease
- 4 months Severe dysphagia following C-spine surgery
- PEG dependent, frank aspiration w/ ice chips
- In dysphagia tx 3x/wk at local rehab
- Had ~ 1 yr Tx, prior

- 16 weeks of therapy: oral & pharyngeal strength, airway protection, timing
- Used EMST, isometric tongue strengthening, sEMG
- Unrestricted oral diet; chin tuck with liquids
- PEG removed

Thank you for your attention.
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Anyone awake for questions?