USE OF EVIDENCE AND INSTRUMENTATION IN THE TREATMENT OF DYSPHAGIA

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GOALS

- Name appropriate evidence-based exercise(s) given disordered physiology.
- Provide examples of instrumentation to facilitate learning of specific exercises.
- Identify the instrumentation that is best suited to target specific physiologic deficits

CONTENT

Exercises
- Lingual Strengthening
- Mendelsohn
- Super-Supraglottic
- Effortful Swallow
- Shaker
- Chin Tuck Against Resistance

Instrumentation
- IOPI/Swallow Strong
- sEMG
- EMST/IMST
- Endoscopy

Rehabilitating the Swallow

- Specificity
  - The exercise task should correspond with the desired outcome
  - Strength training may work best when paired with task specific practice

- Overload
  - Mechanical
  - Resistive

Disclosures

- All of the speakers on the panel received an honorarium from ISHA for this talk

Rehabilitating the Swallow

- Intensity:
  - Percent maximum performance (power/pressure)
  - Number of repetitions
  - Frequency of practice
  - Duration of training over time

- Feedback
- Accountability
Rehabilitating the Swallow

- Transference
- Cross training and non-specific strength training

Interpretation of Video

- Identify primary physiologic deficits
- Plan of Care
  - What treatment has evidence to support its use
  - What instrumentation/feedback could facilitate learning of the treatment technique

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EVIDENCE AND INSTRUMENTATION
LINGUAL STRENGTHENING, SHAKER AND CHIN TUCK AGAINST RESISTANCE

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SwallowSTRONG
(Swallow Solutions, LLC)

Swallow STRengthening Oropharyngeal Gustatory (Swallow STRONG) program

Project Developers: Jo Anne Robbins, Ph.D, Nicole Pulia, Ph.D, Nasia Saifani M.D, Ph.D, and Jacqueline Hind, M.S.

Grant received by William S. Middleton Memorial Veterans Hospital in Madison, WI

Intensive oropharyngeal strengthening program designed to decrease health-related complications in veterans with dysphagia

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Swallow STRengthening Oropharyngeal Gustatory (Swallow STRONG) program

8 weeks of Isometric Progressive Resistance Oropharyngeal (I-PRO) therapy using the Madison Oral Strengthening Therapeutic (MOST) device (newer version: SwallowSTRONG by Swallow Solutions)

Followed by a simple long-term oropharyngeal strength maintenance program

Main goal: Improve swallowing and eating in veterans with dysphagia by providing strength training and biofeedback.
Pressure is measured, by sensors, at four different locations of the tongue
Sensor locations remain the same given the custom-molded mouthpiece
Electronic interface shows patient performance and calculates therapy targets. (Swallow Solutions)

**Strengthening Protocol**
I-PRO therapy with SwallowSTRONG
Involves active application of pressure by the tongue against stable resistance in the mouth (targets anterior, posterior, left, right, middle and whole tongue)
**PROTOCOL:**
- 10 lingual presses per sensor
- 3 times a day
- 3 days a week
- 8 weeks

SwallowSTRONG software provides knowledge of performance and results for both the patient and clinician.
Provides information regarding accuracy of movement and overall performance. Positive feedback encourages increased motivation
Progressive resistance training can increase strength and structural volume thus decreasing penetration, decreasing oropharyngeal residue and improving quality of life
Cost: Device and one mouthpiece: $3,995.00 (PNA ~$17,000)

Swallow STRONG
Clinical Demonstration Project
Results from first 40 patients enrolled were presented at DRS conference in Nashville, TN, by Nicole Pulia, Ph.D.
Penetration-Aspiration Scale decreased for thin liquids
Isometric pressures increased at front and back sensors
Quality of life subscale scores improved as well as Functional Oral Intake Scale
Several patients progressed from feeding tube dependency to full oral intake
Number of pneumonia diagnoses decreased by 88% and hospital admissions decreased by 79%

Iowa Oral Performance Instrument
System consists of carrying case, 1 connecting tube, 10 tongue bulbs and user manual. (IOPI Medical, LLC, ~$1100.00)

Single air-filled plastic bulb attaches to a hand-held pressure transducer that measures pressure generated when the tongue is pressed against the hard palate
Objectively measures tongue and lip strength and endurance
PEAK function allows measurement of maximum pressure
LIGHTS function provides biofeedback for exercise and endurance
TIMER function allows measurement of time (helpful for endurance)
• Typical Training Protocol
  Elevation at 50% Pmax (max pressure)
  3 sets
  10 reps 3 times a day
  Total 8 weeks
  Squeeze bulb until top green light is on

Tongue Depressors as an Alternative
- In a study by Cathy Lazarus, et al in 2003, three groups (all healthy adults between 20-29 years) were targeted.
  - Group 1: No exercise
  - Group 2: Use of tongue depressors for lingual strength
  - Group 3 Use of the IOPI for lingual strength

Group 2 and 3: Exercised 5 days/week for one month
(10 reps 5x day) targeting tongue lateralization, propulsion and elevation
(Lazarus et. al, Folia Phoniatrica Logopaedica 55(4), 199-2005)

After 4 weeks, results revealed significantly greater change in maximum tongue strength with both exercise groups
No statistical difference was found between the exercise group using tongue depressors or the group using the IOPI

So, what if my clinic has no money???
- Use your thumb! (Anterior tongue press)
  - Place the thumb just behind the top teeth and press the anterior tongue against the thumb
  - Pretend to say “k” (Posterior tongue press)
  - Place the thumb against the hard palate where tongue meets the hard palate for the “k” sound

The Shaker Exercise
- Created by Dr. Reza Shaker, gastroenterologist at the Medical College of Wisconsin.
- Designed to treat pharyngeal dysphagia involving incomplete relaxation of the upper esophageal sphincter
- Targets strengthening the suprahyoid muscles, thyrohyoid, mylohyoid, geniohyoid, and anterior belly of the digastric, as these muscles contribute to the upward and forward movement of the larynx and hyoid bone which results in relaxation of the UES

Sustained Head-Lifts (Do this first)
- Lie flat on your back with no pillow under your head.
- Keep your shoulders flat against the bed or floor.
- Lift your head only and look at your feet (chin tuck).
- Work up to 60 seconds
- Release and rest for one minute, repeat x2
- Complete 3 reps, 3 times a day
Repetitive Head-Lifting:
- Lie flat on your back.
- Repetitively lift your head and look at your feet.
- Let your head go back down (slower speed=greater strength)
- Repeat this 30 times.
- Rest for one minute.
- Repeat two more times (90 total “sit-ups” for your neck)
- Do this exercise 3 x day for 6 weeks

Exercise was found to increase the duration and width of the UES in the normal elderly population
- Shaker et al. in 2002, noted significant change in functional swallow measures
- Shaker et al 1997, Easterling et al, in 2005, and Logemann et al. in 2009, noted improved laryngeal elevation and UES dilation
- Logemann et al in 2009, noted significantly less postswallow aspiration after 6 weeks of using Shaker exercise in tube fed population with severe oropharyngeal dysphagia due to abnormal UES opening

Problems with Compliance
- Elderly may need structured and gradually progressive program to achieve goals
- Isometric exercises (sustained head lifts) were found to be harder than isokinetic exercises and therefore goals achieved less often
- Muscle discomfort and time constraints were also reported
- Head lifts were found to be too demanding for patients with chronic conditions
- Resistance for Shaker: lifting head against gravity

Chin Tuck Against Resistance
- Enhances Suprahypoid Muscle Activity (opening UES) using a Shaker-like exercise
- Used for patients with dysphagia due to upper esophageal sphincter dysfunction
- Aim of study: determine if the CTAR exercise was as effective as the Shaker exercise in raising the sEMG activation levels of the suprahypoid muscles during both isometric and isokinetic tasks.

Instructions
- Sit up comfortably in chair. Keep shoulders still.
- Place an inflatable rubber ball (~12cm) under the chin
  - A hand may be used to hold it in place
- Tuck the chin as hard as possible against the ball.
  - Hold for 10 seconds
- Next, squeeze the ball as hard as possible by tucking the chin against it 10 successive times

Participants found the sitting position of CTAR to be less strenuous
- Greater maximum sEMG values were noted during the CTAR isokinetic and isometric exercises than during the equivalent Shaker exercises
- CTAR isometric exercise showed significantly greater sEMG values than the Shaker isometric exercise.
- With clinical trials, the hopes are that this exercise is effective as exercising the suprahypoid muscles, achieving therapeutic benefits comparable to the Shaker exercise with the potential for greater compliance.
JOAR: Jaw Opening Against Resistance

Watts (2013) used sEMG to compare the Shaker exercise and the JOAR exercise. Participants were asked to open jaw for 10 seconds against resistance. Suprahyoid muscle activation was found to be greater with the jaw opening exercise than the Shaker exercise. Further clinical research is needed.

Rhythm Slim Chin Muscle Exercise

Developed in Japan as an anti-aging device that also decreases face, neck, and jaw pain. Position under chin and push down for 10 seconds, do for 3 minutes a day. ~$77.00


ISO Swallowing Exercise Device

Co-invented by Page and Jolie Parker (an SLP). Flexible plastic device with padding to allow CTAR and JOAR. Instructions are for isokinetic first and then isometric. Cost: ~100.00
(Swallowingexercises.com)

EVIDENCE AND INSTRUMENTATION
MENDELSOHN MANEUVER, EFFORTFUL SWALLOW AND SEMG

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Strengthening and Compensating

Mendelsohn
Suprahyoid group constriction and UES opening

Effortful Swallow
- Tongue base retraction and pressure generation

Mendelsohn Maneuver
- Can be used as strengthening/skill training/ROM or as a maneuver
- Load= holding larynx in elevated position against resistance
- Using with bolus may increase salience, load
Mendelsohn Maneuver

- Increased activation of submental muscles (Wheeler-Hegland et al, 2008)
- Increased A-P diameter and duration of UES opening (Wheeler-Hegland et al, 2008)
- Improved coordination
- Improved timing
- Increased pressure/BOT-PPW

Effects of MM on Measures of Swallowing Duration Post Stroke

- VFSS completed after each week regardless of whether patient had had treatment
- Improved measures after treatment weeks and not after no treatment weeks
- Increased improvement after 2 vs 1 treatment weeks.
- Worsening of symptoms after 2 vs 1 week of no treatment.
- Significant improvements in MDOHE and MDOHAE
- MUESO trending toward significance
- Improvements noted after 10 sessions. Much better after 20 sessions.
  McCullough et al, (2012)

Effortful Swallow

- Began as compensatory strategy
- Then considered strengthening
- Evolved to skill training
- Task-oriented form of skill training with a strength component from greater muscular activation
- Potential for increased load/resistance by increasing bolus viscosity

Effortful Swallow

- Increased amplitude of submental activation (Wheeler-Hegland et al, 2008)
- Reduced pharyngeal area pre-swallow (Fritz et al 2014)
- Increased pharyngeal closure during swallowing (Fritz et al 2014)
- May consequently affect airway protection and UES activation → earlier onset/longer duration/extent motion
- Increased duration of UES opening (Wheeler-Hegland et al, 2008)
- Significantly higher mean esophageal peak pressure across all sensor locations- striated >smooth>mixed (Naki et al 2012)

High Resolution Manometry of Pharyngeal Swallow Pressure in ES and MM

- MM decreased UES pressure
- MM increased duration VP pressure
- ES may promote increased VP pressure which can overcome decreased BOT pressure
- ES is a FOM rather than BOT event
- Both maneuvers increased minimum pressure at UES
  Hoffman et al, (2012)
**Effortful Swallow (ES)**

- Logemann: As you swallow, squeeze hard with all your throat and neck muscles.
- Huckabee and Steele: As you swallow, push your tongue really hard against the roof of the mouth.

**Mendelsohn Maneuver (MM)**

- When you swallow, hold your Adam’s apple up for 2-3s by squeezing your throat and neck muscles.
- Swallow normally and in the middle of the swallow when you feel your Adam’s Apple lift, hold it up for 2-3s with your throat muscles before you finish your swallow.

**sEMG**

Biofeedback: Use of equipment to measure body functions that are not monitored consciously
Steele (2004)

- sEMG: Surface electromyography
- A visual or auditory display representing muscle activity
- A linear relationship between the force of muscle contraction and the amplitude of an EMG signal

**sEMG**

- One of the oldest evidence-based practices in dysphagia rehabilitation
Haynes (1976)
- Teaches control and challenges effort
- Outcomes superior with biofeedback when compared with “traditional” therapy alone.

**sEMG**

Potential Benefits
- Objective feedback
- Immediate feedback
- Relative information re: amplitude and duration of muscle activity
- Safe, easy, noninvasive
- Limitations
- No norms for submental sEMG activity
- Does not provide information re: specific muscle activity
- Does not measure specific amount of muscle activity
- Cost: $1395.00- $1795.00
sEMG

- Hand-held portability
- 9V Battery
- Easy to operate
- USB communication to PC
- Automatic data storage
- Continuous operation or work/rest prompts
- Session number
- Locked/unlocked mode
- Functional electrical stimulator interface
- Goal types include: Above Tone, Below Tone, Above Stim, Below Stim, Maximum Display with Marker. A/B Ratio for Dual Channel Systems

sEMG Protocol for MM and ES

(Steele et al, http://www.intechopen.com)

- Attach electrodes under the chin
- Ensure signal quality and appropriate graded amplitude response
- Record baseline series of 5 regular effort saliva swallows-(RESS)1/30 seconds
- Determine RESS reference range
- Practice RESS with target set at 100% of RESS reference range: series of 3-5 x5 swallows
- Practice effortful saliva swallows (ESS) with target set at 100% of RESS reference range and increase by increments of 10-20%; series of 3-5 x5 swallows
- Practice MM at lower threshold 30% of reference range. Goal is to prolong contraction for 2-3 seconds above this level.

sEMG Protocol for MM and ES

- Protocols developed at Swallowing Rehabilitation Research Laboratory, Toronto Rehabilitation Institute
- Software developed Biofeedback Foundation of Europe
- Practice approximately–60 saliva swallows/session
- Participate in 20-24 treatment sessions/2x/week
- Focus is target amplitude practice for effortful swallow and prolonged muscle contraction for Mendelsohn

So You Don’t Have sEMG………..

- Mirrors
- Imagery
- Palpation
- Auscultation

EVIDENCE AND INSTRUMENTATION

EXPIRATORY AND INSPIRATORY MUSCLE STRENGTH TRAINING

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Inspiratory and Expiratory Muscle Trainers

- Individual breathes into a tube with nose clips on or into a mask.
- On the end of the tube or mask is a resistance.
- Resistance makes it difficult to breathe in or out.
- Expiratory: EMST 150 from Aspire Products.
- Inspiratory: PowerBreathe (can buy on Amazon).

Basic Muscle Training Guidelines

- Specificity of training:
  - Train with the task you are trying to improve.
  - Muscle trainers do this to a point (especially in expiratory muscle training).
  - You are training with a downstream resistance and speech is breathing with a downstream resistance (larynx and articulators).
  - But do not use the trainers instead of speech therapy, only in conjunction – continue to work on speech.
- Must overload the muscle:
  - Low resistance, high repetition.
  - High resistance, low repetition.
- Must repeat the movements:
  - But do not go to the point of exhaustion.

When To Use Strength Training?

- Is weakness present?
- Does the weakness interfere with speech functioning?
  - Speech only requires 10-20% of the max force of the lips.
- Are there contraindications for strengthening exercises?
  - Will the course of the disease make strengthening exercises futile?
  - Will the person fatigue to the point of not being able to complete everyday activities (communication, swallowing)?

Cautions About Strength Training

- Do not delay other interventions until you are done strengthening the muscles.
- Only use with individuals who will do drills at home daily.
- Do not use EMST with patients who are not safe to perform a Valsalva maneuver.
EMST Improves Cough Dynamics in PD

EMST Improves P-A Score (but not in all patients): 33% of treatment group

EMST Program (Sapienza and colleagues)
- 5 sets of 5 breaths completed 5 days per week
- Do the training in the seated position at the same time of day
- Set muscle trainer to 75% of the patients maximum expiratory pressure (MEP)
  - Obtain by asking patient to breathe to top of VC and then blow hard and fast into pressure meter
  - Or set the device to the highest level the patient can manage
- Can follow a similar protocol with inspiratory training
- Sapienza recommends training for 4 weeks, but that is likely not long enough for people with motor disorders

EMST Patient Instructions
- Place nose clips on your nose
- Completely inhale until you cannot breathe any more air in your lungs.
- Make sure your lips are completely sealed around the mouthpiece.
- Hold your cheeks with one hand.
- Breathe out as hard as you can.
- Remove the trainer from your mouth.
- Inhale again.
- Rest between each breath on the trainer.

IMST Patient Instructions
- Place the nose clips on your nose.
- Make sure your lips are completely sealed around the mouthpiece.
- Completely exhale until there is no more air in your lungs.
- Breathe in as deeply as you can.
- Exhale again.
- Rest between each breath on the trainer.

EVIDENCE AND INSTRUMENTATION
SUPER SUPRAGLOTTIC SWALLOW AND ENDOSCOPY AS BIOFEEDBACK

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### Physiology of Super Supraglottic Swallow Maneuver

- Improve closure ABOVE the glottis
  - Arytenoids adduct and move more anteriorly
  - Closure of the true and false vocal cords
  - Reduce aspiration risk before, during, and after the swallow

### When to Utilize the Super Supraglottic Swallow Maneuver

- Decreased/delayed TVC closure
  - Improve airway protection
- Delayed pharyngeal swallow
  - Expedite airway protection
- Difficulty coordinating the swallow respiratory cycle
  - Improve conscious awareness to "normal" swallow-breathe pattern
- Silent aspiration
  - Improve airway protection despite reduced sensation

### Super Supraglottic Swallow Technique

- Hold your breath
- Bear down with your stomach/push your stomach muscles into your back
- Swallow
- Cough
- Re-swallow

### Defining Biofeedback

- Crary et al., 2004
  - External means to provide feedback to patient with the goal to increase rate of motor learning
  - Result=improved efficiency of therapeutic process
  - In short, enhance new learning
Biofeedback and EBP

- Denk and Kaider (1997)
  - 33 HNC patients
  - Control group=conventional therapy
  - Experimental group=conventional therapy with biofeedback

Results showed biofeedback group exhibited:
- Reduced occurrence of aspiration
- Reduced pharyngeal residue
- Improved pharyngeal wall movement
- Faster return to oral feeding compared to control group (no biofeedback)

What if you do not have access to instrumentation?
- Endoscopic Evaluation and Treatment of Swallowing Disorders, Langmore 2001:
  - Hum
  - Hold Breath/squeeze neck muscles=suspend vocalization
  - Patient did not fully occlude airway if vocalization or audible air leakage is noted
- Establish a protocol with local diagnostician
- Accompany patient to diagnostic testing