Pharyngeal pressure during swallow:
Tongue base evaluation and treatment
The oropharyngeal swallow consists of two types of muscular components: 1) valve functions such as airway closure, and 2) generation of pressure to drive the bolus through the pharynx and into the top of the esophagus to the level of T2-3. To enable the pressure generated by the tongue base to be effective, the upper esophageal sphincter must open well and the pharynx must reconfigure itself from a respiratory tube to a swallow chamber by shortening and bringing its walls inward. As the pharyngeal chamber becomes smaller in all directions, the tongue base moves backward to meet the inward moving posterior and lateral pharyngeal walls.

This program will use videofluorographic and manometric studies to illustrate normal tongue base and pharyngeal movements and methods for evaluation and treatment of dysphagic patients with swallowing difficulties relating to the tongue base.
Normal swallow requires sequential pressure generated against the bolus tail to propel the bolus through the mouth and pharynx.

- Pressure through the oral cavity applied to the bolus by the oral tongue
- Pressure generation transferred to the pharynx when bolus tail reaches the tongue base as pharyngeal swallow triggers
- Pressure generators in the pharynx
  - Velopharyngeal closure – resists pressure
  - Pharyngeal walls contract sequentially top to bottom, making the pharyngeal chamber smaller.
  - Tongue base moves back to make complete contact with the pharyngeal wall

Neurogenic Dysphagia

History of Patient

- 71 yr. old male
- Hypertension
- Scleroderma
- Hyperlipidemia
- GERD
- Mild depression
- TIAs ’07 (left side) ’08 (temp visual loss)

CT of Head
02/07

- Vascular calcifications of internal carotid arteries at base of skull
- No evidence of acute ischemia
- No acute hemorrhage
- No mass
- Mild white matter changes, nonspecific

Magnetic Resonance Angiogram of the Head (MRA)

2/07 – poor flow within the left vertebral artery and basilar artery secondary to segmental stenosis. Collateral circulation via posterior communicating arteries to the basilar artery for circulation. Mild ectasia near the basilar tip-no aneurysmal formation
Magnetic Resonance Angiogram of the Neck (MRA)

2/07 – severe vertebrobasilar occlusive disease with the left vertebral artery occluded at its origin and reconstitutes with the left transverse foramen. The L vertebral artery appeared to be sole contributor to the basilar artery which appeared to be irregular. R vertebral artery was small and appeared to terminate within the R PICA. The origin of the R vertebral artery was difficult to visualize.

Vertebral Artery Bypass procedure

- 05-09 attempted after angiogram in 1-09
  - Plan was a vertebral artery transposition to the carotid with probable angioplasty of the distal vertebral stenosis.
  - The procedure was terminated-distal vertebral artery was completely occluded.

Vertebral Artery

Results

- Profound bicep and deltoid weakness LUE
- L PICA acute stroke with significant dysphagia, dysarthria, hypophonia, L facial droop, L lingual weakness, LLE weakness
- PEG tube 05-28-09
- Dx – L lateral medullary stroke – Wallenberg’s syndrome
MBS
05-14-09

- Decreased laryngeal elevation
- Insufficient UES opening
- Profound oropharyngeal dysphagia
- NPO (Fibersource HN @ 250 mL x 6 daily)

Rehabilitation

- Inpatient
- Outpatient
- ENT referral
- Additional outpatient

VLS/FEES
06-25-09 [video clip]

Rehabilitative Strategies

- Lingual strengthening and ROM
- Thermal tactile simulation (icing w/mirror)
- Effortful swallow
- Masako maneuver
- Mendelsohn maneuver
- Suck swallow
- Head turn to left
- 1 mL trials of cold bolus
- Vocal exercises with glides up/down, sustained vowels at comfort, comfort high and comfort low pitches
Premature loss over base of tongue

Swallow triggered from the valleculae

Intermittent trace aspiration to level of vocal folds from retained material in pyriforms

Intact sensation – spontaneous cough-spit

**Pharyngeal Phase:**

- Difficulty initiating swallow
- No inversion of epiglottis
- Decreased pharyngeal tone
- Retentions in pyriforms
- AP view – Left pyriform flaccid
- Head turn to left effective in clearing some material with forceful swallow

**MBS 10-08-10 [video clip]**

- Only small amounts passed UES
- After passing UES remainder of the peristalsis was normal
- **PROBLEM:** cricopharyngeal dysfunction
**Outcome**

<table>
<thead>
<tr>
<th>Clinical Findings</th>
<th>Initial Presentation</th>
<th>Resolved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dysphonia (L TVF Paresis)</td>
<td>Yes</td>
<td>No (not as profound)</td>
</tr>
<tr>
<td>Wet Voice</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Weak Voluntary Cough</td>
<td>Yes</td>
<td>Yes (strong)</td>
</tr>
<tr>
<td>Decrease Facial Sensation</td>
<td>Yes</td>
<td>Some</td>
</tr>
<tr>
<td>Pyriform – pooling</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Tongue weakness</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Decrease Pharyngeal Sensation</td>
<td>Yes (L)</td>
<td>No (L)</td>
</tr>
<tr>
<td>Completed Swallow</td>
<td>No</td>
<td>Some</td>
</tr>
</tbody>
</table>

**Summary**

**Neurogenic Dysphagia**

- NPO – G tube feeds
- Pleasure feeds with small amounts of sherbet or cold drink
- Head turn to left improves some clearance
- Tolerates coughing out secretions when buildup
- Chews food to get taste and spits it out

**Summary**

- Question at first: was dysphagia problem with lingual weakness, pharyngeal weakness or cricopharyngeal dysfunction?
- Dysphagia exercises and pt compliance helped improve some function but continues with CP dysfunction and inability to complete a full swallow consistently
- Lingual strength and range of motion not a problem-functional outcome due to WS secondary to medullary involvement
Summary

- Pt is not a candidate for surgery
- Unsure if he wants to try Botox to CP

References


Tongue driving force

- McConnel in 1988 demonstrated the importance of the tongue driving pressure in moving material through the pharynx using manofluorography


Infer pressure from MBS?

- Increases in pressure wave amplitude are correlated with increased duration of tongue base to pharyngeal wall contact

- Increased pharyngeal residue is related to poor pharyngeal pressure, as expected


Requirements for movement of material through PES

- Cricopharyngeal relaxation

- A compliant PES

- Hyolaryngeal elevation

- Pressure on the bolus – via tongue base approximation to the pharyngeal walls, with a closed pharyngeal chamber
**Important MBS observations**

- Upward and forward movement of both the hyoid bone and the thyroid cartilage
- Closure of the laryngeal vestibule
- Base of tongue approximation to the pharyngeal wall
- Site of incomplete clearing (at maximum pharyngeal constriction)

**Radiation therapy/Chemotherapy**

- Pt is a 60 y.o gentleman
- Right BOT/tonsil cancer (T3N3M0)
- Pt opted for aggressive chemo/radiation
- No surgery
- Induction chemotherapy followed by definitive concurrent chemo RT with complete response

**SLP**

- Referred to SLP 2 weeks following completion of chemo/RT
- #4 Shiley tracheostomy,
- All intake via G-tube
- Odynophagia
- Clinical exam with beginning swallow practice
- Decannulated 2 weeks later (1 mo. post treatment)
- Odynophagia largely resolved
- MBS scheduled
Expectations

- T3 – T4 tumors of the oropharynx (base of tongue/tonsil regions) often result in moderate to severe dysphagia

- In one recent study, 67% of patients with T3 – T4 oropharynx cancers aspirated during MBS done 1-23 months post chemo/RT treatment (median – 5 months)


An additional factor

- Oropharynx cancer patients who have undergone radiation therapy (to 60 Gy or more?) are at risk for UES stricture


Review MBS for contribution of tongue base to pt’s dysphagia

Calibrated liquid swallow

[Video clip]

Pt-controlled sips

[Video clip]

Pudding

[Video clip]

Bread

[Video clip]
Evaluation of the components required for efficient pharyngeal transit

[Video clip]

Aspiration?

■ Is aspiration a major problem for this patient?

Efficiency?

■ Is efficiency of eating a major problem for this patient?

Treatment

■ Tongue anchor exercise to maximize BOT to pharyngeal wall approximation
■ Sham gargle exercise to maximize BOT retraction
■ Breath hold exercise to maximize closure of the vestibule

Alternate treatment

■ Pt’s tongue pressure measures via Iowa Oral Pressure Instrument (IOPI) were low for an adult male
■ A tongue press exercise regimen was employed


Progress

■ Feeding tube was removed at 4 months post treatment
■ Decreased reliance on supplements by mouth
■ Improved PSS H&N scores
■ Continues to struggle with inefficient eating
Take away messages

- Organ preservation does not equal function preservation
- Tongue base evaluation is critical
- Analysis of MBS can establish salient impairment(s)
- So that treatment will have the appropriate focus
Case Presentation “CC”
Long-term follow-up and quality of life status

CC

- 64 YOF 15 yrs. s/p T2 SCCC base of tongue
- Non-smoker, non-drinker
- Enrolled on 2 CCSP protocols
  - Effects of flavored bolus on swallow
  - Pt priority scale (List et al., 2000)
- Surgery + post-op XRT
  - Primary closure
  - 6600 Rads

Tumor Staging: Tongue

- T1 - Tumor (T) smaller than 2 cm in greatest dimension
- T2 - Larger than 2 cm but smaller than 4 cm in greatest dimension
- T3 - Larger than 4 cm in greatest dimension
- T4 - Invades adjacent structures (e.g., bone, soft tissue of neck, deep muscles of tongue)

Oral Cavity Reconstruction

- Tongue flaps
  - Grafts
    - Frequently harvested from the thigh
- Provide good coverage
- Assist in achieving good ROM
- No blood supply

- **Pedicle flaps**

- **Free flaps**
  - Tissue, veins, & arteries
    - i.e. iliac crest, radial forearm, lateral forearm, fibula

- **Sensate free flaps**
  - Microvascular flaps including a sensory nerve
  
  Pauloski, 2004

**CC**

- NGT for 3 weeks post-op

- Initial MBS: 2 wks. Post-op
  - Decreased base of tongue retraction
  - Mildly reduced hyolaryngeal elevation
  - Pooling post-swallow valleculae more than pyriform sinuses
  - Trace sensate pen/asp; cleared with cough

**CC**

- **Swallowing therapy**: (pre-xrt and sporadically during tx and then a few session post-xrt)

- Base of tongue retraction exercises
  - Masako
  - Voluntary tongue retraction
  - Gargling
Laryngeal elevation exercises
  - Falsetto & sliding glissando
  - Mendelsohn maneuver

CC

Outcome
  - Resumed near-normal diet ~3 months after completion of xrt
  - Enjoyed new body size (“can finally wear a bathing suit”)
  - Persistent difficulties:
    - Takes longer to eat
    - Difficulty with hard solids

CC: current status

- Oral mechanism
- MBS
- Endoscopy
- QOL measures
  - MDADI
  - PSS-HN

Swallowing problems can develop during the course of organ preservation treatment or can occur long (one year to 40 years) after treatment completion. -Lazarus et al., 1993

Late Effects of XRT on Swallowing

- MBS to assess pts. > 10 yrs. s/p XRT for H&N Ca
Results:

- Decreased bot contact to pharyngeal wall
- Decreased laryngeal elevation
- Decreased vf closure
- Resulted in pharyngeal residue & aspiration after the swallow
- Similar patterns of dysfunction irrespective of tumor site
  - Lazarus et al., 1993

**BOT & Dysphagia**

- >50% resection of BOT correlated w/aspiration
  - Fujimoto et al., 1998
- N=144 pts. w/oral or oropharyngeal lesions; looked at tumor volume resected, nature of reconstruction, & swallow function
  - Results: extent of BOT resected was more related to dysphagia than type of reconstruction
    - Pauloski et al., 2000

**QOL**

**References:**
Flippity Floppity Flap

Case Presentation: ZZ

- 73 y.o. female with an advanced left tonsillar cancer with ipsilateral nodal disease
- Initially treated with chemo and radiation
- Evidence of persistent disease a few weeks after
- Direct laryngoscopy and biopsy
  - T3 N1 Mucoepidermoid carcinoma of the left tonsil and tongue base

Case Presentation: ZZ

- Definitive surgery performed
  - Subtotal glossectomy (involving L BOT)
  - Radial forearm free flap reconstruction
  - Radical tonsillectomy
  - Left hemithyroidectomy
  - Left neck dissection
  - Tracheostomy tube
  - PEG

Radial Forearm Free Flap

- Graft of skin with blood vessels
- Placed in defect
- Small arteries are reconnected
Oral Mechanism Exam

- Lingual function
  - Minimal strength and ROM
- Laryngeal excursion
  - Minimal to moderate
- Articulatory precision
  - Modestly impaired

Expectations?

- Deficits?
- Postures?
- Diet?
- Exercises?

Initial MBS

- What do you see?

Recommendations/Plan

- Diet?
- Treatment program?

Recommendations/Plan

- NPO; continue with PEG tube
- Begin behavioral swallowing therapy
  - Improve lingual motion
o Improve hyolaryngeal excursion
o Improve tongue base retraction
o Improve cricopharyngeal opening
o Improve triggering of swallow reflex
o Improve airway protection

**Swallowing Exercises**

- Range of motion tongue exercises (Logemann et al., 1997)
- Resistance exercises (Jordan, 1979)
- Mendelsohn maneuver (Ding et al., 2002; Dodds et al., 1988; Boden et al., 2006)
- Masako maneuver (Lazarus, Logemann, Song, Rademaker, & Kahrilas, 2002; Fujiu & Logemann, 1996)

**Swallowing Exercises**

- Effortful swallow (Bulow et al., 2001; Hind et al., 2001; Huckabee et al., 2005)
- Thermal-tactile stimulation (Sciortino et al., 2003; Rosenbek et al., 1998; Lazarra et al., 1986)
- Breath Hold (Donzelli & Brady, 2004; Ohmae et al, 1996; Martin et al., 1993)

**Endoscopy**

**Most Recent MBS**

- What do you see?
Recommendations/Plan

- Diet?
- Treatment Program?

Recommendations/Plan

- Diet
  - Thickened liquids and pureed PO
  - Majority via PEG
- Postures
  - Left head turn and chin down
- Strategies and Maneuvers
  - Breath hold and effortful swallow
  - Small sips/bolus

Swallowing Progress

- Does not consider pureed diet and thickened liquids “real” food
  - Cultural implications?
  - Very dependent on PEG tube
- Enjoys fact that she can take something by mouth
  - Requires lots of effort
Take Home Message

- HNC treatments involving BOT carcinomas…
  - Usually lead to some degree of swallowing difficulty
  - Can be one of the most challenging populations to treat
- Goal is to provide safest method to achieve least restrictive diet
- Improve QOL

References:
Joy Gaziano, M.A., CCC-SLP, BRS-S  
USF Center for Swallowing Disorders  
Tampa, Florida  

Background History  
- 61 y.o. male with SCCA right base of tongue (2005)  
- First treated with pre-op XRT  
- Then partial pharyngectomy, supraglottic laryngectomy, laryngopharyngeal reconstruction with PM cutaneous flap, and right RND.  
- Developed immediate post-op dysphagia and had PEG tube placed.  

Swallowing Treatment History  
- Multiple swallowing evaluations and 2 courses of treatment (with NMES) without return to any safe oral intake (2005, 2006, 2007)  
- 2007 MBS recognized UES stricture.  
- Attempts at dilation failed, as cervical esophageal lumen was completely occluded.  
- Referred to USF Swallowing Center for consideration for lumen restoration procedure in 2009.  

Pre-ELR MBS  
- Only small volume liquid trials provided  
- Oral containment, swallow response, VP closure functional.  
- Absent epiglottis consistent with supraglottic laryngectomy.  
- Complete cervical esophageal stricture  
- Unable to fully assess pharyngeal constriction, but obviously reduced.  
- Penetration and aspiration with good sensation and redirection.
MBS Video

Combined treatment approach

- Endoscopic Lumen Restoration (ELR)
- Frequent serial dilations
- Pre-post ELR MBS
- Swallowing education and rehabilitation

Post ELR MBS

- After 6 weeks and 6 dilations (18mm. balloon dilator), patient still 100% PEG dependent and taking very small volumes water with occasional cough and choking.

- Now true oropharyngeal deficits are obvious.
  - Severely reduced BOT to PPW contact
  - Pharyngeal constriction reduced
  - UES opening reduced

- Cervical esophageal stricture now patent
Compensatory Strategies Introduced at MBS

- Liquid wash, multiple dry swallows
- Liquid push for purees
- Head turn right to limit asymmetrical stasis
- Chin tuck to move BOT closer to PPW
- Super-supraglottic swallow to improve airway protection.

Treatment Plan

- Begin trials thin liquid and puree
- Chin tuck, dry swallow, effortful swallow.
- Liquid wash, liquid push
- Head turn right, super-supraglottic swallow
- Exercises:
  - BOT ROM
  - Laryngeal closure
  - Pharyngeal constriction
  - UES opening

9 months later…

- Patient returned to Ohio and received ongoing dilations (12) at OSU. Now at 4 month intervals.
- Urged to get swallowing therapy, but did not follow through.
- No PEG intake for 7 weeks, on soft moist cohesive diet.
- Weight stable, nutrition good, lungs clear.
- Increased liquids, increased mealtimes, chew well, multiple swallows. Pills ok with +liquids.
MBS not pretty but…

- Premature spillage of liquids to UES
- Audible aspiration on retained liquids
- Puree/solids retained in pharynx due to decreased pressure generation, xerostomia.
- “Re-swallow” of solids
- Air swallowing
- Delayed cervical esophageal emptying flows back to pharynx

Points to Ponder…

- Extensive medical treatments (XRT+surgery) posed challenges for swallow rehabilitation.
- Development of stricture could have been prevented with prompt recognition on MBS and early dilation.
- Would swallow physiology differ if patient underwent therapy as recommended? Did it matter?
- Can’t underestimate sheer determination as a prognostic variable!!!
Case History

- 69 y.o. female
- Began to experience oral pain and difficulty swallowing in Jan 2009
- Experienced weight loss (pt was morbidly obese – baseline wt. 310 lbs.)
- Diagnosed with a tongue mass on 2/27/09
- CT & PET scans completed preoperatively showed a tongue mass with no evidence of disease in the neck or any remote sites.

Surgical Intervention

- Underwent CO2 laser excision; right hemiglossectomy of the dorsolateral tongue and tongue base on 3/17/09
- Surgical Pathology: Invasive squamous cell carcinoma; initial margins were positive including the right tongue base. Following multiple excisions, surgical margins were negative.
- Dx: T3N0 squamous cell CA of the right posteriolateral tongue with extension into the tongue base

Medical History

- IDDM
- History of pulmonary embolus
- Hyperlipidemia
- Aortic stenosis
- Osteoarthritis
- HTN
- Previous smoker (1 ppd for 55 yrs. – quit smoking in 2003)

**Postoperative Course / Treatment Planning**

- Consult with Radiation Oncology and Medical Oncology
- Two weeks post-op, patient was taking a puree / semi-solid consistency diet with thin liquids (pt unable to wear her dentures secondary to pain / edema)

**Radiation & Medical Oncology**

- Initial consultation 4/03/09
- When seen, pt reported a 70 pound weight loss since 1/2009
- PET scan completed post-op (3/31/09) demonstrated positive bilateral cervical lymph nodes.
- Recommended: Concurrent chemoradiation therapy & PEG placement

**Chemotherapy**

[www.chemocare.com](http://www.chemocare.com)

- 7 cycles of Cisplatin total (weekly administration)
  - Cisplatin – Chemotherapy drug administered via IV (vein) infusion
  - Side effects may include:
    - Nausea / Vomiting
    - Kidney and Liver toxicity
    - Low levels of magnesium, calcium, & potassium
    - Low WBC & RBC
- Peripheral neuropathy
- Loss of appetite
- Taste changes – metallic taste in mouth
- Hair loss
- High frequency hearing loss / ringing in ears

**Radiation Therapy**

- 5/04/09 to 6/22/09
- IMRT – to the primary site and bilateral necks

**Side effects / Complications**

- Nausea – nearly completely PEG tube dependent
  - Unable to tolerate more than 3 cans of Glucerna per day – Reglan prescribed to increase bowel motility
- Oral candidiasis (treated with Diflucan)
- Continued weight loss

**Recurrence**

- PET scan to determine the need for neck dissection was completed 10 weeks following conclusion of XRT
  - Pulmonary metastasis (bilateral) was detected
  - 12 Doses of Chemotherapy were administered
    - Taxotere plus Erbitux
  - In March 2010, Taxotere was dropped and Erbitux was continued
Chemotherapy for Metastasis

**Erbitux**
- Used to treat metastatic CA
- Administered by IV infusion
- Side effects:
  - Nausea / vomiting
  - Diarrhea
  - Constipation
  - Poor appetite
  - Headache
  - Mouth Sores
  - Itching / Rash
  - Cough
  - Low RBC count
  - Low magnesium level

**Taxotere**
- Approved to treat advanced H&N CA
- Administered by IV infusion
- Side effects:
  - Fluid retention
  - Peripheral neuropathy
  - Nausea
  - Diarrhea
  - Mouth Sores
  - Fatigue / weakness
  - Low platelet count

www.chemocare.com
Referral to Speech Pathology for Swallowing Evaluation

- Referred for FEES exam 6/10/10
  - Xerostomia
  - Poorly fitting dentures (weight loss – now 155 lbs.)
  - Oral intake primarily liquids (heavy cream, Farina, and thinned pudding)
  - Crushing all medications
  - PEG was removed upon conclusion of XRT (10/09)
  - Metallic taste in mouth (since 9/2009)

Patient reported:

- Experiencing the sensation of foods sticking in the throat region after the swallow
- Using liquid wash to clear foods
- No hx of pneumonia
- Refused FEES – agreed to clinical swallowing exam

Clinical Swallowing Evaluation

- Oral Mechanism Exam: Lingual lateralization mildly reduced, decreased jaw opening (30 mm), vocal quality normal, articulation mildly impaired with distortion of /k, g/
- Noted significantly effortful swallow for increased viscosities and multiple swallows per sip / bite
- Throat clear noted on one occasion after the swallow following liquid wash to clear puree

Recommendations

- Continue on current diet
Videofluoroscopic Swallowing Study

- Concern for stricture/narrowing post XRT based on observed significantly increased effort when swallowing increased viscosities

Videofluoroscopic Swallowing Examination

VFSS Results

- Functional oral transit for liquids – impaired oral transit for puree with slow A-P transit – decreased transit of tablet
- Difficulty with mastication of semi-solids
- Reduced base of tongue propulsion – resulted in residue in the valleculae and hold up of the barium tablet
- Appeared to have a thickened epiglottis and reduced anterior laryngeal excursion – trace supraglottic penetration of thin liquids during the swallow

Added Benefit of VFSS

- Review of exam helped patient gain confidence / willingness to attempt to increase her diet

Swallowing Therapy

- Target increased tongue base retraction
- Target increased laryngeal excursion
- Decrease hypersensitivity to pharyngeal residuals
- Increase jaw opening
- Advance diet to include soft, moist solids
Address xerostomia
  - Caphosol - prescription
  - MedActive
  - Biotene

Trismus – Dynasplint & Therabite

Follow-up treatment
  - Improved xerostomia
  - Some improvement in articulation
  - Improved oral transit and tongue base retraction – taking some soft semi-solids (metallic taste and oral burning persisting)

Medical Oncology
  - Note from September 2010:
    - Dermatologic toxicity related to Erbitux
    - Recommended break from Erbitux “but the psychological impact is likely not worth it”
    - Other chemotherapy agents are an option, but would result in further side effects
    - Repeat CT scans planned for beginning of Oct 2010

Most recent SLP visit
  - Unable to tolerate use of Therabite
  - Unable to tolerate dentures consistently
  - Diet limited – taking mostly liquid / thick liquid / thinned puree
Cathy Lazarus, Ph.D.
Effects of Chemoradiotherapy on Tongue Function in Patients With Head and Neck Cancer, *Perspectives on Swallowing and Swallowing Disorders (Dysphagia)* 18 55-60 June 2009.

Role of SLP

What if???

What now???
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