Instrumental Evaluation of Swallowing: Back to Basics

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Seminar Outline

- Videofluoroscopic Swallow Study (VFSS)
  - Purpose
  - Reliability
  - Standardizing protocols
  - Determining specific swallowing impairment

Instrumental Examination

- Purpose
  - Evaluate biomechanical and physiologic function and dysfunction
  - Determine swallowing safety
  - Identify effects of compensatory strategies and maneuvers on swallowing
  - Determine appropriate diet

Instrumental Examination

- Videofluoroscopic swallow study (VFSS)
  - Simultaneous respiratory measure
- Videoendoscopy
- Manometry
  - Currently performed by GI or in research studies
- Must consider individual needs of patient

Instrumental Examination-VFSS

- VFSS
  - Direct assessment of oral cavity, pharynx, and esophagus
  - Evaluate what is happening during the swallow without need to infer
- Radiation Exposure
  - Most comprehensive evaluation with the least amount of radiation exposure
  - Radiation exposure (Zammit-Maempel et al., 2007, Lemen, 2004)

Instrumental Examination-VFSS

- Patient Positioning
  - Lateral view
  - Allows for documentation of bolus flow and structural movement
    - Fluoroscopic tube focused on:
      - Oral Cavity
      - Pharynx
      - Larynx
      - Cervical Esophagus
  - As patients move, use information from CSE to help direct evaluation

Instrumental Examination-VFSS

- Patient Positioning
  - A-P view
    - Some clinicians obtain routinely
    - Others obtain only if postswallow pyriform sinus residue is evident in the lateral view
      - Determine if residue is unilateral or bilateral-can be evident in stroke patients
    - Assess vocal fold functioning
      - Have patient say "ah" and identify movement

Instrumental Examination-VFSS

- If possible, obtain simultaneous respiration swallowing measures
- Respiration and Swallowing-structurally linked via the oropharynx
- Breathing Swallowing Coordination
  - Respiratory pause (apnea)-obligatory cessation of breathing to accommodate swallowing
    - Onset highly variable (Martin-Harris et al., 2005)

Instrumental Examination-VFSS

- Breathing Swallowing Coordination-cont.
  - Respiratory pause (apnea)-obligatory cessation of breathing to accommodate swallowing
    - Frequently occurs with bolus loading or onset of oral transfer (Martin-Harris et al., 2005; Hiss et al., 2004)
    - Resumption of breathing more specific occurring with hyoid lowering (Martin-Harris et al., 2005)

Instrumental Examination-VFSS

- Breathing Swallowing Coordination
  - Respiratory phase pattern
    - Primarily expiration prior to and following swallowing in healthy individuals
    - Mid-late stage of expiration
    - If inspiration brackets the swallow, it is more likely to occur prior to swallowing
    - Inspiration after the swallow frequently associated with aspiration

Instrumental Examination-VFSS

- Nasogastric Tube (NGT)
  - Large bore and small bore tubes
    - May affect timing and increase airway invasion (Wang et al., 2006; Huggins et al., 1999; Robbins et al., 1993) or not (Leder & Suiter 2008)
    - What about residual?
    - Obtain orders prior to VFSS for removal of the NGT
    - If NGT appears to be causing or contributing to dysphagia, remove tube

Instrumental Examination-VFSS

Bolus Presentation Guidelines: My preference

- Self-administered
- Single Swallows
  - 5 ml thin liquid, self-regulated cup sip (or 10 or 20 ml measured volume), semi-solid, mastication (generally cookie)
  - 2-3 trials volume/consistency (Lazarus et al., 1993)
  - Cued or non-cued swallows?
- Sequential Swallowing
  - Continuous self-administered thin liquid without pause

Instrumental Examination-VFSS

Bolus Presentation Guidelines: My preference

- Cued Swallow
  - Posterior oral "hold" thus shorter OTT as start counting at onset of movement after cue
  - Leading edge of the bolus more rostral in the oropharynx; onset of the pharyngeal swallow is "faster"
- Non-cued Swallow
  - No hold, so OTT begins at onset of movement thus longer than with cue
  - Leading edge of the bolus more caudal, frequently in the pharynx at onset of the pharyngeal swallow

Instrumental Examination-VFSS

Bolus Presentation Guidelines: Suggested standard (Martin-Harris et al., 2008)

- Self-administered, non-cued
- Single Swallows
  - Lateral view: 5 ml thin liquid x2, thin liquid sequential swallows, 5 ml nectar thick, sequential swallows nectar thick, 5 ml honey thick, 5 ml pudding barium, ½ barium-coated cookie
  - A-P view: 5ml nectar thick, 5 ml pudding barium
- Radiation exposure: 3-5 minutes

Instrumental Examination-VFSS

Bolus Presentation Guidelines: Suggested standard (Martin-Harris et al., 2008)

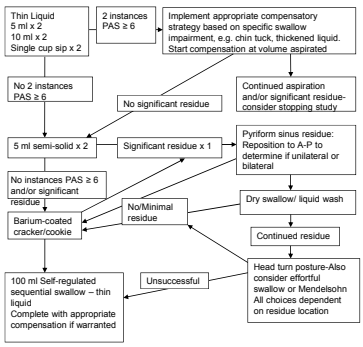
- Results suggest that adequate information on all swallowing parameters except mastication may be obtained from 5 ml thin liquid and 5 ml nectar thick liquid
- Perhaps these 2 consistencies can be used as "screening" to decide whether to continue or halt examination
- Standardized with Varibar products

Instrumental Examination-VFSS

- Bolus Presentation Guidelines
  - If aspiration is evident on the first swallow, generally repeat-may need warm-up
  - If consistent aspiration with liquids, initiate compensatory strategies
  - If aspiration with liquids and minimal residual, test semi-solids, solids

Instrumental Examination-VFSS

- Therapeutic Strategies
  - Objectively evaluate the effects of compensatory strategies
  - Proceed from least to most restrictive
  - Strategy depends on patient's cognitive status and real world
    - Posture
    - Maneuver
    - Consistency
    - Sensory input?



Instrumental Examination-VFSS

- Screen esophagus if significant aspiration is not observed (Martin & Easterling, 2006)
  - Radiologist follows liquid and semi-sold bolus from pharynx to esophagus
  - Radiologist determines if dysfunction and need for further work-up

VFSS-Interpretation

- Anatomic abnormalities
- Bolus flow
  - Timing
  - Direction
  - Clearance
- Structural movement-spatial, temporal
- Response to compensatory strategy
- Treatment plan

VFSS-Interpretation

- Typically identify symptom-determine pathophysiology
  - Pooling
  - Residue
  - Airway invasion: before, during, or after pharyngeal swallow

VFSS-Interpretation

- Oral Phase- dependent upon bolus consistency
  - Containment
  - Mastication/manipulation
  - Transfer

VFSS-Interpretation

- Bolus Flow-Timing
  - Oral Transit Time-measured from onset of bolus head or tail movement until bolus head reaches ramus of mandible
  - Stage Transit Duration-measured from bolus head reaches the ramus of the mandible to onset of maximum hyoid elevation
  - Pharyngeal Response Time-measured from onset of maximum hyoid elevation to bolus tail through UES

VFSS-Stage Transit Duration

- Onset of Pharyngeal Swallow-transition from oral phase to pharyngeal phase
  - Evoked with leading edge of the bolus in the oropharynx
    - Anterior facial arches
    - Ramus of the mandible bisects base of tongue (mandibular angle)
  - Measured from when the leading edge of the bolus reaches the mandibular angle to onset of maximum hyolaryngeal movement

VFSS-Stage Transit Duration

- Onset of Pharyngeal Swallow
  - During mastication and sequential swallowing, the bolus can be inferior to the angle of the mandible at swallow onset (Dua et al., 1997; Palmer et al., 1992; Chi-Fishman & Sonies, 2000; Daniels & Foundas, 2001; Daniels et al., 2004)
  - Also occurs with single swallows particularly in healthy, older adults (Martin-Harris, et al., 2007; Stephen, et al., 2005)

VFSS-Interpretation

- Bolus Flow-Direction (airway invasion)
  - Penetration-material enters the laryngeal vestibule
  - Aspiration-material enters the trachea

VFSS-Interpretation

- Bolus Flow-Direction-Timing of Airway Invasion
  - Before the swallow
    - Material enters the airway before onset of the pharyngeal swallow
  - During the swallow
    - Material enters the airway during the swallow
  - After the swallow
    - Material enters the airway after the swallow

VFSS-Interpretation

- Bolus Flow-Direction
- Penetration-Aspiration Scale (Rosenbek et al., 1996)
  - Depth
  - Clearance
  - Response
- Alternative to “flash penetration”

VFSS-Interpretation

Penetration-Aspiration Scale
1 – No airway invasion
2 – Laryngeal penetration with clearing
3 – Laryngeal penetration with stasis
4 – Penetration to the TVC with clearing
5 – Penetration to the TVC without clearing
6 – Aspiration with clearing
7 – Aspiration with cough but no clearing
8 – Silent aspiration

VFSS-Interpretation

- Bolus Flow-Clearance
  - Postswallow residual
  - Location
    - Oral cavity
    - Valleculae
    - Pyriform sinus-unilateral, bilateral
  - Consistency
  - Amount (Eisenhuber et al. 2002; Perlman et al., 1994; Hind et al., 2001; Daniels et al., 2009)
  - Build-up
  - Postswallow airway invasion

VFSS-Interpretation

- Bolus Flow-Clearance
  - Quantifying amount of residual in valleculae and pyriform sinuses (Eisenhuber et al. 2002)
    - Mild-< 25% of height of structure (space)
    - Moderate-between 25%-50% of height of structure (space)
    - Severe-> 50% of height of structure (space)
    - No discussion of oral cavity, but could same scoring method apply?

VFSS-Interpretation

- Structural Movement
  - Temporal-duration of the actual displacement of a structure, e.g., hyoid, UES opening
    - objective measure with counter timer
  - Spatial-distance of displacement
    - Objective measure with special software

VFSS-Interpretation

- MBSImp (Martin-Harris et al., 2008)
  - Observed physiology from VFSS
  - 17 components
    - Oral Domain: 6 components including various measures of oral control, oral residue, onset of the pharyngeal swallow
    - Pharyngeal Domain: 10 components including pharyngeal biomechanics and residue
    - Esophageal Domain: 1 component-clearance

VFSS-Interpretation

- MBSImp (Martin-Harris et al., 2008)
  - Semi-objective
    - Impression of severity
  - Registered MBSImp clinician
    - Re-establish proficiency every 5 years

VFSS-Interpretation

- Pharyngeal Phase- approx 1 second
  - Velopharyngeal closure
  - Laryngeal closure
  - Superior and anterior movement of the hyoid bone and larynx
  - Upper esophageal sphincter (UES) opening
  - Base of tongue (BOT) retraction
  - Pharyngeal constrictor contraction

VFSS-Interpretation

- Bolus Flow-Timing
  - Characterized in general terms of slow or delayed or objectively quantified
  - Objective requires time code generator
    - Oral
    - Evocation of the pharyngeal swallow
    - Pharyngeal

VFSS-Interpretation

- Radiographic Symptom
  - Preswallow
    - Anterior leakage
    - ↓ bolus formation
    - Pooling into the pharynx
    - Airway invasion-generally before onset of pharyngeal swallow
  - Postswallow
    - Oral residual-may yield airway invasion postswallow
- Physiologic Abnormality
  - ↓ Orolingual Control

VFSS-Interpretation

- Radiographic Symptom
  - Preswallow
    - Pooling into the pharynx
    - Airway invasion-generally before onset of the pharyngeal swallow but could be during
- Physiologic Abnormality
  - Delayed onset of pharyngeal swallow

VFSS-Interpretation

- Radiographic Symptom
  - Nasal regurgitation
- Physiologic Abnormality
  - Poor pharyngeal motility

VFSS-Interpretation

- Radiographic Symptom
  - Vallecular residue: may lead to airway invasion after swallow
- Physiologic Abnormality
  - ↓ BOT to PPW approximation
  - ↓ epiglottic deflection
    - ↓ anterior hyoid movement
    - intrinsic changes in supportive tissue

VFSS-Interpretation

- Radiographic Symptom
  - Pyriform sinus residue: may lead to airway invasion after swallow
- Physiologic Abnormality
  - ↓ anterior hyoid movement-
    - ↓ UES opening
  - Intrinsic problem with cricopharyngeus relaxation
  - Unilateral pharyngeal hemiparesis
    - If unilateral residue

VFSS-Interpretation

- Reliability in interpretation
  - Like CSE, for VFSS, each group of clinicians should establish:
    - Consistent protocol
    - Reliability in interpretation-inter and intra-rater (Stoeckli et al., 2003; McCullough et al., 2001)

References

- Chi-Fishman, G., & Sonies, B. C. (2000). Motor strategy in rapid sequential swallowing: New insights. *Journal of Speech, Language, and Hearing Research, 43*(6), 1481-1492.
- Daniels, S. K., & Huckabee, M. L. (2008). *Dysphagia following stroke*. San Diego, CA: Plural.
- Daniels, S. K., Corey, D. M., Hadskey, L. D., Legendre, C., Priestly, D. H., Rosenbek, J. C., & Foundas, A. L. (2004). Mechanism of sequential swallowing during straw drinking in healthy young and older adults. *Journal of Speech, Language, and Hearing Research, 47*(1), 33-45.
- Daniels, S. K., & Foundas, A. L. (2001). Swallowing physiology of sequential straw drinking. *Dysphagia, 16*(3), 176-182.
- Daniels SK, Schroeder MF, DeGeorge PC, Corey DM, Foundas AL, Rosenbek JC. (2009). Defining and measuring dysphagia following stroke. *Am J Speech Lang Pathol,* 18, 74-81.
- Dua, K. S., Ren, J., Bardan, E., Xie, P., & Shaker, R. (1997). Coordination of deglutitive glottal function and pharyngeal bolus transit during normal eating. *Gastroenterology, 112*(1), 73-83.
- Eisenhuber E, Schima W, Schober E, et al. (2002). Videofluoroscopic assessment of patients with dysphagia: pharyngeal retention is a predictive factor for aspiration. *AJR Am J Roentgenol,178*, 393-398.

References

- Hind JA, Nicosia MA, Roecker EB, et al. (2001). Comparison of effortful and noneffortful swallows in healthy middle-aged and older adults. *Arch Phys Med Rehabil, 82*, 1661-1665
- Hiss, S. G., Strauss, M., Treole, K., Stuart, A., & Boutilier, S. (2004). Effects of age, gender, bolus, volume, bolus viscosity, and gustation on swallowing apnea onset relative to lingual bolus propulsion onset in normal adults. *Journal of Speech, Language, and Hearing Research, 47*, 572-583.
- Huggins, P. S., Tuomi, S. K., & Young, C. (1999). Effects of nasogastric tubes on the young, normal swallowing mechanism. *Dysphagia, 14*(3), 157-161.
- Lazarus, C. L., Logemann, J. A., Rademaker, A. W., Kahrilas, P. J., Pajak, T., Lazar, R., & Halper, A. (1993). Effects of bolus volume, viscosity, and repeated swallows in nonstroke subjects and stroke patients. *Archives of Physical Medicine and Rehabilitation, 74*(10), 1066-1070.
- Leder, S. B., & Suiter, D. M. (2008). Effect of nasogastric tubes on incidence of aspiration. Archives of Physical Medicine and Rehabilitation, 89, 648-651.
- Lemen, L. C. (2004). A discussion of radiation in videofluoroscopic swallow studies. *Perspectives on Swallowing and Swallowing Disorders (Dysphagia), 13*(3), 5-13.
- Martin-Harris, B., Brodsky, M. B., Michel, Y., Castell, D. O., Schleicher, M., Sandidge, J., Maxwell, R., & Blair, J. (2008). MBS measurement tool for swallow impairment—MBSImp: Establishing a standard. *Dysphagia, 23*, 392-405.

References

- Martin-Harris, B., Brodsky, M. B., Michel, Y., Lee, F. S., & Walters, B. (2007). Delayed initiation of the pharyngeal swallow: normal variability in adult swallows. *Journal of Speech, Language, and Hearing Research, 50*(3), 585-594.
- Martin-Harris, B., Brodsky, M. B., Michel, Y., Ford, C. L., Walters, B., & Heffner, J. (2005). Breathing and swallowing dynamics across the adult lifespan. *Archives of Otolaryngology Head & Neck Surgery, 31*, 762-770.
- Martin-Harris, B., & Easterling, C. S. (2006). Esophageal swallowing physiology and disorders [electronic presentation]. Rockville, MD: American Speech-Language-Hearing Association.
- McCullough, G. Hl., Wertz, R. T., Rosenbek, J. C., Mills, R. H., Webb, W. G., & Ross, K. B. (2001). Inter- and intrajudge reliability for videofluoroscopic swallowing evaluation measures. *Dysphagia, 16*, 110-118.
- Palmer, J. B., Rudin, N. J., Lara, G., & Crompton, A. W. (1992). Coordination of mastication and swallowing. *Dysphagia, 7*(4), 187-200.
- Perlman AL, Booth BM, Grayhack JP. (1994). Videofluoroscopic predictors of aspiration in patients with oropharyngeal dysphagia. *Dysphagia, 9*, 90-95.
- Robbins, J., Hamilton, J. W., Lof, G. L., & Kempster, G. B. (1992). Oropharyngeal swallowing in normal adults of different ages. *Gastroenterology, 103*(3), 823-829.

References

- Rosenbek, J. C., Robbins, J. A., Roecker, E. B., Coyle, J. L., & Wood, J. L. (1996). A penetration-aspiration scale. *Dysphagia., 11*, 93-98.
- Stephen, J. R., Taves, D. H., Smith, R. C., & Martin, R. E. (2005). Bolus location at the initiation of the pharyngeal stage of swallowing in healthy older adults. Dysphagia, 20(4), 266-272.
- Stoeckli, S. J., Huisman, T., Seifert, B., & Martin-Harris, B. (2003). Interrater reliability of videofluoroscopic swallow evaluation. *Dysphagia, 18*, 53-57.
- Wang, T. G., Wu, M. C., Chang, Y. C., Hsiao, T. Y., & Lien, I. N. (2006). The effect of nasogastric tubes on swallowing function in persons with dysphagia following stroke. *Archives of Physical Medicine and Rehabilitation, 87*(9), 1270-1273.
- Zammit-Maempel, I., Chapple, C.-L., & Leslie, P. (2007). Radiation dose in videofluoroscopic swallow studies. *Dysphagia, 22*, 13-15.