

The Pediatric Perspective on Pharyngeal Manometry

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CCHMC

678 beds

Level IV NICU

Dr. Sabin -Oral

Polio Vaccine

Dr. Whitsett –

Surfactant



Brief Biography

Jay Paul Willging, MD

Jay Paul Willging, MD

- Born and raised in Cincinnati, Ohio



- Did not know my first name was JAY until I was in first grade – computers DO NOT understand

Education

- University of Cincinnati
 - BS in Biology 1974 - 1978
 - Master's Studies in Vertebrate Ecology 1978 - 1981
 - MD 1981 - 1985
 - General Surgery training 1985 – 1987
 - Otolaryngology – Head and Neck Surgery Residency 1987 – 1991
- Cincinnati Children's Hospital Medical Center
 - Pediatric Otolaryngology Fellowship 1991 - 1992

Professional Activities

- University of Cincinnati
 - Department of Otolaryngology – Head and Neck Surgery 1992 – present
 - Tenured Professor
- Cincinnati Children's Hospital Medical Center
 - Division of Pediatric Otolaryngology 1992 – present
 - Director of the Pediatric Otolaryngology Fellowship training program 1998 – present
 - Director of Clinical Operations 2013 to present
 - Multidisciplinary Clinics
 - FEES, VPI, Craniofacial

Personal Interests

- Married with four adult children
 - 10 grandchildren
- Interests outside of medicine
 - Farm activities
 - Hunting
 - Water sports
 - Flying



Pediatric Otolaryngology

- 35,000 clinic visits per year
- 12,000 surgical patients per year
- 300 FEES exams per year
- 1,400 Interdisciplinary Feeding Team visits per year
- Airway Reconstructions
 - 140 per year
- Cochlear Implantation
 - 60 per year
- Fifteen Pediatric Otolaryngology Faculty as of July 2022

Claire Kane Miller, PhD

Education

Miami University of Ohio

Bachelor of Science in Education, 1980

Master of Science in Speech Pathology, 1982

University of Cincinnati

PhD – Communication Sciences and Disorders, 2006

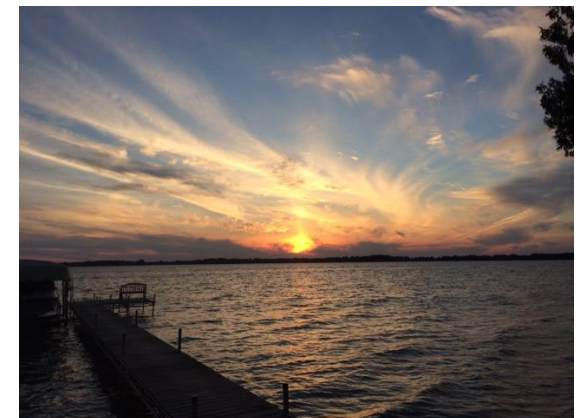
MHA – Master of Health Administration, 2011

Professional Activities

- Cincinnati Children's Hospital Medical Center
 - Senior Clinical Director, Division of Speech-Language Pathology
- University of Cincinnati
 - Adjunct Assistant Professor, Department of Communication Sciences & Disorders
 - Field Service Associate Professor – Affiliated, University of Cincinnati, Department of Otolaryngology

Interests

- Married with 2 (adult) children
 - ½ married
- Interests
 - Reading
 - Travel
 - Lakes, oceans, and sunsets
 - Baking – with a chocolate focus



Division of Speech-Language Pathology

- Base program close to University of Cincinnati
- 8 satellites around city plus Community Health Service Network sites at Mason and Liberty
- 150+ speech-language pathologists
- Inpatient, outpatient, and clinic-based
 - Neonatal follow up clinic
 - Interdisciplinary Feeding Team
 - Voice Clinic
 - Velopharyngeal Insufficiency Clinic
 - Craniofacial Team
 - Video Swallow Clinic
 - Neurodevelopmental Clinic for Heart Institute Patients
 - *Fiberoptic Endoscopic Evaluation of Swallowing Clinic -*integration of HRPM recently into FEES clinics



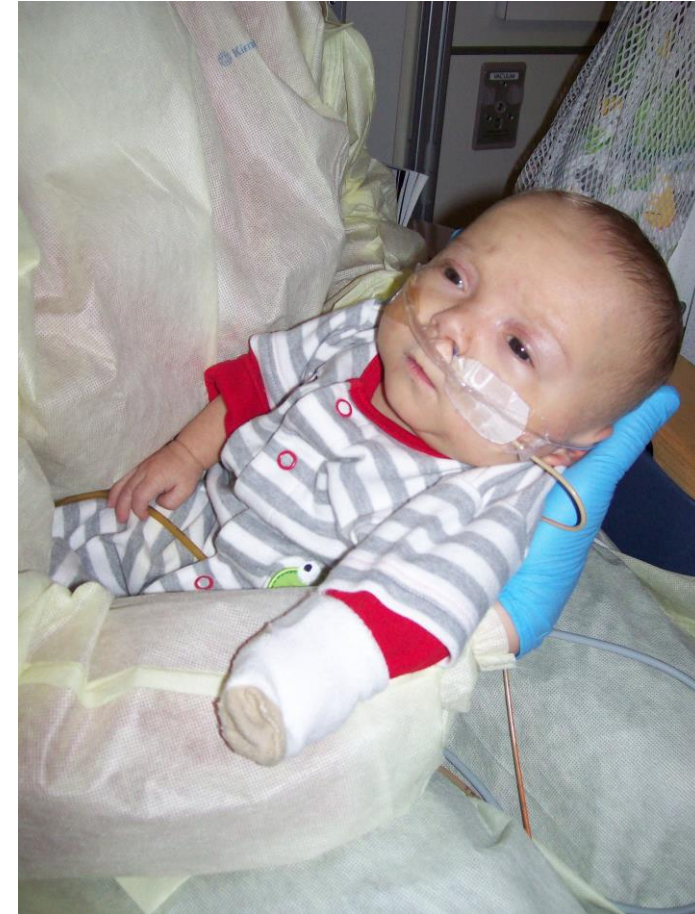
CCHMC Medical Office Building

Objectives: Pediatric Perspective on Pharyngeal Manometry

- Review instrumental pediatric swallowing assessment options—advantages, disadvantages, and what manometry adds
- Begin discussion of the integration of pharyngeal manometry in the diagnostic workup
 - IRB protocol and clinical protocol
- Provide overview of patient conditions and findings

Pediatric Feeding and Swallowing Problems

- Medical and technological progress in last several decades - ↑ survival of infants and children with complex medical conditions
- Structural
- Neurological
- Cardiorespiratory Compromise
- Metabolic
- Mixed Etiologies
- Precise incidence and prevalence data hard to determine – overlap in conditions



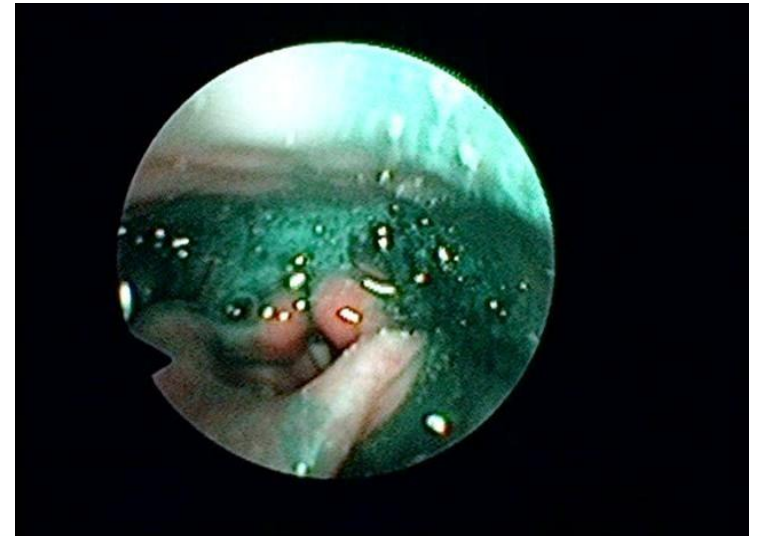
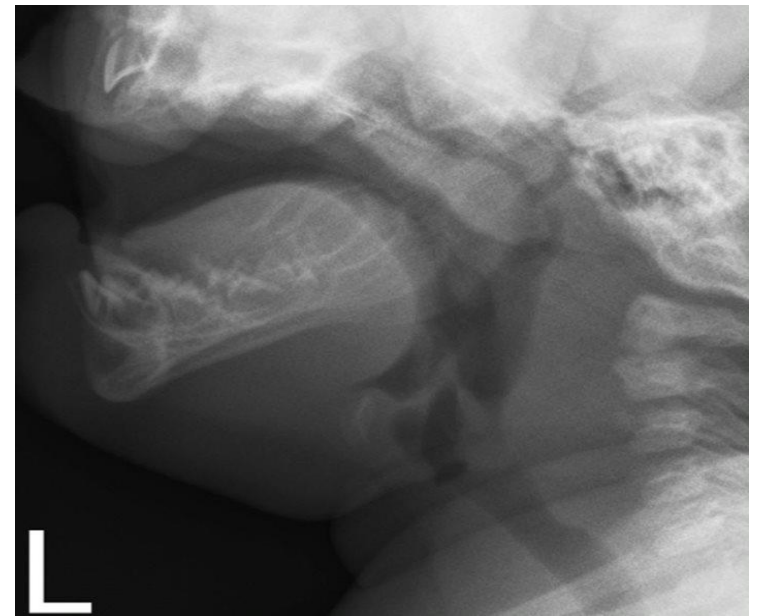
Clinical Evaluation

- Starting point: baseline assessment of feeding status, oral stage problems, related medical problems, identify clinical signs & symptoms of dysphagia
 - *Caretaker/patient perception of problem
- Limitations: cannot assess beyond the oral phase
- Outcome: provides basis for clinical pathway to determine further assessments, instrumental & other

Instrumental Options

Instrumental options

- Videofluoroscopy
- Flexible/Fiberoptic Endoscopic Evaluation of Swallowing (FEES)
- *HRPM



Pediatric Video Swallow Studies

- Radiographic view of oral, pharyngeal, and cervical esophageal phases of swallowing
- Screening view of esophageal phase
- Often described as the “gold standard” for swallowing
- Need more data on outcomes as a result of undergoing video swallows
- Need more data and evidence to base intervals for repeat studies



VFSS Aims

- Define movement patterns of structures in oral cavity, pharynx, larynx, & through upper (cervical) esophagus
- Measure efficiency of swallow
- Determine reason for swallowing dysfunction – bolus propulsion issue or airway protection failure – or both?
- If aspiration occurs, determine when, why, how much, & response or lack of response

VFSS Aims

- Examine intervention possibilities in the context of the study
 - Postural/position changes
 - Compensatory strategies – eg flow rate
 - Diet modifications (viscosity, texture changes)
 - Maneuvers in some children if appropriate

VSS Advantages

Advantages:

- View of all phases of the swallow – oral, pharyngeal, cervical esophageal
- No discomfort
- Opportunity to try compensatory strategies
- Provides ongoing view of airway protection during rapid chain swallowing sequences i.e. bottle-feeds

VSS: Disadvantages

- Radiation exposure – particularly with repeat exams
- Child may resist barium – may not get sufficient sample for meaningful interpretation
- Not feasible if child has negligible oral intake
- *May be dependent on personnel involved

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Final Thoughts - VFSS

- Described as the “gold standard” – but is it?
- Need more evidence as to accuracy in pediatrics and relationship to long term outcomes
- Issues with inter-rater reliability – implications for accuracy of interpretation and appropriateness of subsequent recommendations re feeds
- Controversy/disagreement regarding necessary frame rate
- Exposure concerns – image gently campaign

Development of the FEES Procedure

- Susan Langmore, Ph.D. (1988, 1991)
- Robert Bastian, M.D. (1991, 1993)
- Martyn Mendelsohn (1993)
- Pediatric Applications (March 1993)
 - Willging (1994; 1996)
 - Willging, Miller, Link, & Rudolph (2000); Leder & Karas, 2000; Link, et al., 2000; Hartnick et al., 2000
 - Manrique et al., 2003
 - Leder & Murray, 2008 – efficacy of ped fees
- Thottam, et al, 2015
 - Suterwala, et al., FEES in the NICU, 2017 - breastfeeding
 - Vetter-Laracy et al., 2018 – application during breastfeeding
 - Miller & Willging, 2020 – experience and safety over 25 years of implementation
 - *Zang, et al., 2022 – systematic review and recs for future research
 - Kwa et al., 2022 – FEES in infants with congenital heart disease
 - And many more...

Assessment of Swallowing Safety in 1992

- Oral motor examination
- Videofluoroscopic Swallowing Study
 - Popularized by Jeri Logemann, PhD in 1980's
 - Objective assessment of swallowing mechanics

Opportunity

- Gastroenterologist – Colin Rudolph, MD
- Pediatric Otolaryngologist – Robin Cotton, MD
- New Faculty – me
- Speech Language Pathologist with swallowing expertise – Claire Miller
- Question: think you can put a telescope transnasally into the hypopharynx of a child and watch them swallow?
- Enrolled in Langmore's course in Dallas, Texas

Pediatric FEES Pilot Study

- Permission obtained from IRB to evaluate swallowing in patients already undergoing nasopharyngoscopy (nodules, VPI)
 - Goal to determine feasibility of doing FEES with pediatric patients
- Normative data collected
- Not much to see on a normal swallow



Expansion of Study

- Inclusion of pediatric patients with known or suspected airway protection problems
- First Pediatric FEES at CCHMC March 1993

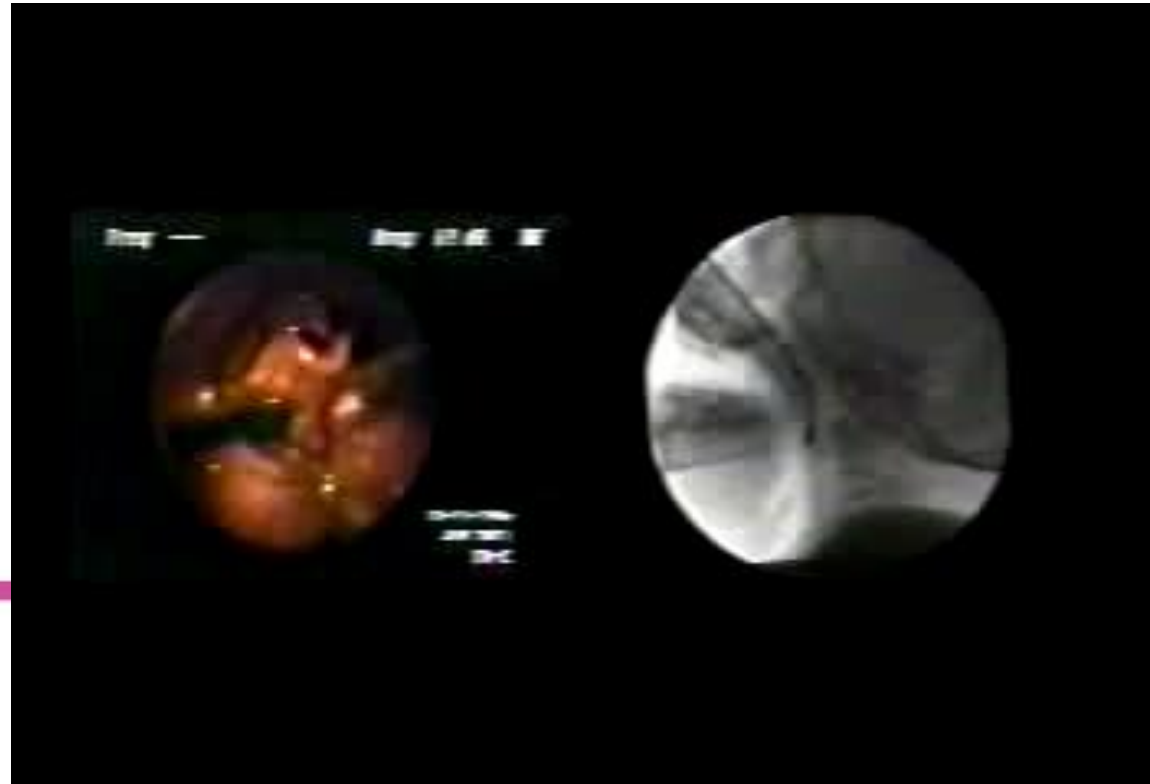


Are We Developing the Same Recommendations

- Retrospectively reviewed findings of VSS and FEES exams that were obtained within 3 months of each other
- Findings grossly the same
 - Minor differences with degree of residue
 - Minor discrepancies with frequency of penetration
- Recommendations generated from the studies were the same

Verification of the Technique - I

- Do we see the same things on FEES and VSS
- IRB approved study to compare VSS & FEES Results
- Split screen studies: simultaneous fluoroscopy and FEES exams



Verification of the Technique - II

- Does the presence of an endoscope create abnormal swallowing parameters in patients
- IRB approval
- VSS
- Immediately repeat VSS with simultaneous FEES
- Compare
 - Initial VSS results with Subsequent VSS
 - VSS findings compared with FEES findings
 - Recommendations from VSS to FEES
- No Differences Found



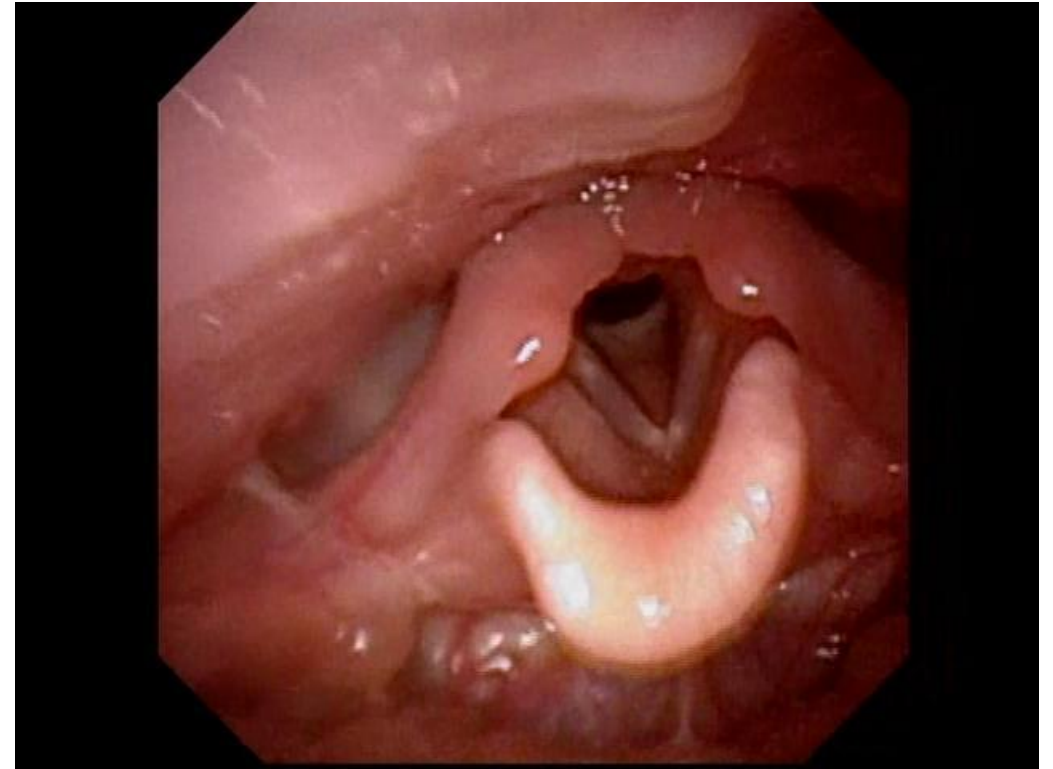
Eventual Development of the Pediatric FEES Clinic

- Collaborative team effort
 - Pediatric Otolaryngologist
 - Pediatric Speech Pathologist
 - Otolaryngology Nurse
- Value of collaboration -multidisciplinary
- Appreciation of specific and overlapping knowledge areas



Advantages of FEES

- Clear view of structures - clear view of functional ability to protect airway
- Allows assessment of a child's ability to manage secretions
- No time limits
- Portability
- Can assess sensory function
- Can help to determine readiness for oral feeds, surgical candidacy
- Does not require alteration of food/liquid with barium



Disadvantages of FEES

- Discomfort with scope passage is possible – usually subsides once stimulation of nasal mucosa ends
- Presence of scope may trigger gagging &/or vomiting
- View disappears briefly during moment of swallow “white out” – therefore unable to detect events during the swallow
- Consistent loss of view during sequential swallowing i.e. bottle intake – implications for interpretation
- Focus limited to pharyngeal phase of swallowing



*Progress – with Standardizing Training and Interpretation

- Langmore, S. E., Scarborough, D. R., Kelchner, L. N., Swigert, N. B., Murray, J., Reece, S., ... & Rule, D. K. (2022). Tutorial on clinical practice for use of the fiberoptic endoscopic evaluation of swallowing procedure with adult populations: Part 1. *American Journal of Speech-Language Pathology*, 31(1), 163-187.
- Recommended best practice guidelines for SLPs conducting and interpreting FEES studies in adults
- Part II – for infants and children

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Tutorial

Tutorial on Clinical Practice for Use of the Fiberoptic Endoscopic Evaluation of Swallowing Procedure With Adult Populations: Part 1

Representatives of the American Board of Swallowing and Swallowing Disorders and ASHA Special Interest Group 13: Swallowing and Swallowing Disorders (Dysphagia):
Susan E. Langmore,^a Donna R. Scarborough,^b Lisa N. Kelchner,^c Nancy B. Swigert,^d
Joseph Murray,^e Selena Reece,^f Trish Cavanagh,^g Leah C. Harrigan,^h
Rebecca Scheel,ⁱ Memorie M. Gosa,^j and Denise K. Rule^k

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Tutorial

Tutorial on Clinical Practice for Use of the Fiberoptic Endoscopic Evaluation of Swallowing Procedure With Pediatric Populations: Part 2

AB-SSD Task Force-Pediatric Group: Claire Kane Miller,^a Jenny Reynolds,^b Lisa N. Kelchner,^c
Donna Scarborough,^d Susan Langmore,^e and Memorie Gosa^f

^aAerodigestive and Esophageal Center, Division of Speech-Language Pathology, Cincinnati Children's Hospital Medical Center, OH ^bNeonatal Intensive Care Unit, Baylor University Medical Center, Dallas, TX ^cDepartment of Communication Sciences and Disorders, University of Cincinnati, OH ^dDepartment of Speech Pathology and Audiology, Miami University, Oxford, OH ^eDepartment of Otolaryngology - Head & Neck Surgery, Boston University School of Medicine, MA ^fDepartment of Communicative Disorders, The University of Alabama, Tuscaloosa

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ABSTRACT

Purpose: This is Part 2 of a two-part tutorial series establishing clinical guidelines pertaining to the administration of fiberoptic endoscopic evaluation of swallowing (FEES) developed by representatives of the American Board of Swallowing and Swallowing Disorders, all of whom are members of Special Interest Group 13. Whereas Part 1 focused on use of FEES with adults and included general information common to using FEES in any population, the purpose of this tutorial is to provide clinicians with updated best practice clinical guidelines for performing, interpreting, and documenting outcomes when using FEES with the pediatric population. This document has two main sections. The first section discusses the history of pediatric FEES, needed knowledge and



Limitations of FEES

- Perceptual nature of exam
- Focus on pharyngeal stage of the swallow
- Progress toward inclusion of standardized scales within exam assists with increasing standardization and comparability of clinical documentation
- But still no absolute/objective measures

High Resolution Pharyngeal Manometry in Pediatrics

- Quantification of pharyngeal and UES lumen occlusive pressures quantify biomechanical measures of swallow strength
- True normative reference ranges are unknown
- Emerging studies in patient groups will help us learn to recognize:
 - Pharyngeal weakness
 - Differentiation of UES relaxation vs opening extent
 - Esophageal issues – eg dx of achalasia



Addition of HRPM to FEES Clinic Evaluation

- Is HRPM feasible to perform in children
 - What age limitations
- What clinical information can we obtain that changes management
- What patient populations warrant addition of HRPM

Essentials Skills to Acquire to Add HRPM to FEES Clinic Evaluation

- No training in manometry
 - Had exposure to manometry through presentations at Dysphagia Research Society
 - Had GI colleague who was exploring esophageal manometry
 - Manometry identified UES problems
- No training in technology
 - Perfusion sensors
 - Dent sleeves
 - Solid state transducers
 - Advanced soft ware packages

Training in HRP

- Took this course last year for exposure and encouragement
- Obtained IRB approval for our protocol
- Explained the study to families
 - All families were interested in undergoing the examination
 - A common statement – ‘Knowledge is power’
- Read as much as possible
- Don’t be afraid to make mistakes
- Learn on the fly
- Interpreted results in light of FEES exam for proper clinical context

Essential Components of HPRM Examination

- Consensus statement for what should be collected and analyzed
- Lumen occlusive pressures
- HPI IBP
- UES IRP
- UES opening and duration

Problem

- There are no pediatric normative data for any of these measures
- Absolute values can be obtained
 - Look for correlations in clinical parameters
- Integral pressures
 - Time and space calculations
 - New catheters with closer spacing of sensors would increase resolution of the examination and provide better pressure calculations
- Impedance measures
 - Depends on volume and electrolyte content of material ingested
 - Many children have no experience with increased volume
 - Children are very selective of materials they are willing to accept

Problem

- Children have enlarged adenoid pad compared to adults interfering with catheter placement
- Children with neurosensory issues may not tolerate the procedure
- Insertion of the catheter into the airway is possible in neurologically impaired children
- Children do not follow instructions
 - Propulsive pressures are dependent on bolus types and volumes
 - Impedance measures need electrolyte rich media
 - Children swallow when the urge directs them to do so

Problem

- Many children with dysphagia have
 - Limited oral motor skills
 - Unable to take significant bolus size
 - Unable to control the bolus
 - Unable to swallow on command
 - Experience with only certain types of food materials
 - Refuse specific textures and volumes
 - Piecemeal transfer of bolus

Problem

- The software
 - Needs to be 'told' where to look for a swallow
 - Needs traditional pressure morphology of the swallow to recognize a swallow
- Normal morphology of the pressure tracing does not always reflect a functional swallow with bolus transport
- Some parameters utilize impedance for calculations
 - Not all bolus types are great electrical conductors
 - Need to attempt to maximize conductivity
- Need to overlay impedance tracings to ensure the swallow is functional

Problem

- Problems with fire-wall protections of computers connected to their servers
 - Occasional server access is not possible – need to work locally
 - No automatic uploading of studies collected while working locally
 - Limited access to server based program
 - Lack of generic log-in makes assistance with study preparation difficult
- Have all the computers running and loaded with patient demographics
 - Saves time when patient is in the room
 - Reduces anxiety
 - Anticipation is often worse than the procedure

How to Prepare the Room

- Golden rule in pediatric patients
 - Don't let cords cross the child
- Must account for both arms AND legs
- FEES equipment on one side
- HRPM equipment on the opposite side
- Ideal to have a monitor in front of family for them to observe
- Station for utensils and food material preparation
- Everyone in the room knows what is needed and willing to fill in

Anesthetic

- Topical anesthesia
 - Increase cooperation of the child during the examination
 - Spray 1:1 mixture of oxymetazoline and 1% pontocaine
 - Spray must be directed vertically
 - Avoid numbing the hypopharynx
 - 2% Viscous Lidocaine applied directly to catheter and scope
- Not necessary, but improves cooperation in children
- Avoid topical spray
 - Infants less than 1 year
 - Neurologic deficit
 - Inability to handle secretions
 - Known allergy to Pontocaine or Afrin
 - Gut feeling the patient won't do well

Anesthetic

- 0.025% Afrin / 1% Pontocaine
 - 1:1 mixture
- Health Care Logistics spray bottle
 - 0.05 and 0.1 ml per activation
 - The largest atomizing bottle on the market delivers 0.2 ml per activation
 - With our dilution, each 0.1 ml delivers
 - 1 mg tetracaine, and 0.025 mg oxymetazoline
- 3 – 6 kg child
- 6 – 9 kg child we give 2 puffs
- 9 – 12 kg child we give 3 puffs
- Greater than 12 kg we give 4 puffs
- Well within the safety profile range
 - 1 puff for a 5 kg child
 - max dose assuming 1 mg / kg would be 5 mg for 5 kg infant
 - We are delivering 1 mg tetracaine in this scenario

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Passage of the Catheter in Children

- Adenoid pad in children is enlarged compared to the adult
- Recommend bending the tip of the catheter to assist with placement
- Need to keep the catheter on the floor of the nose and on top of the velum
- May need to twist the catheter to assist it in slipping past the adenoid pad
- Difficult to have the patient swallow during insertion
 - Many have feeding issues and cannot comply
 - Many are too young to follow instructions
- Be patient when the catheter is at the UES
 - Steady pressure will allow it to pass

How to Secure the Catheter

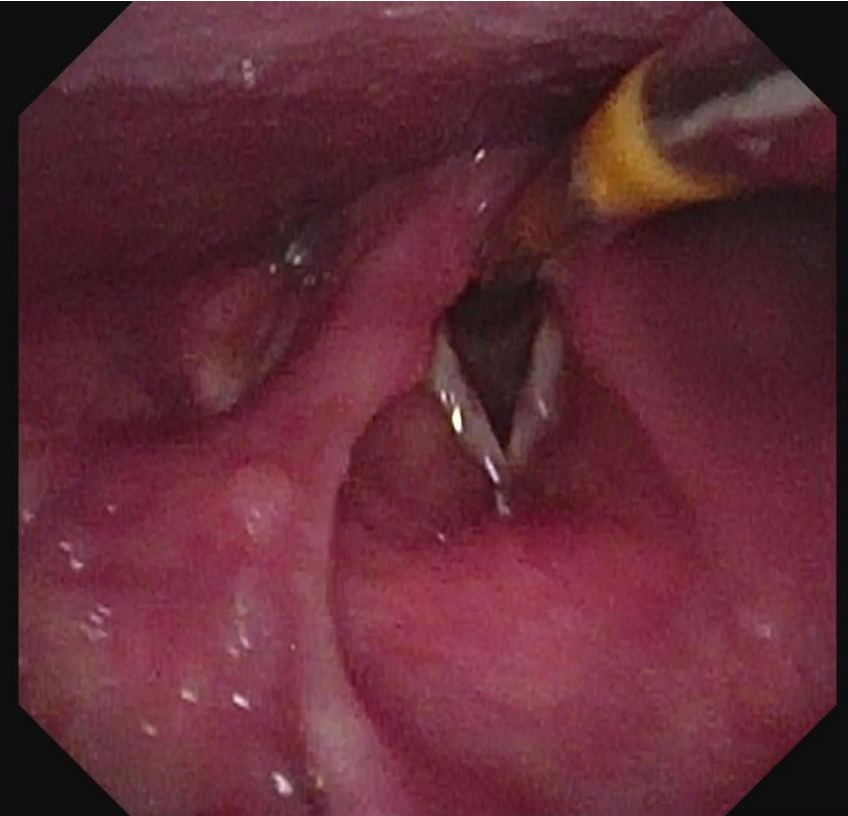
- Pass the catheter till all the sensors are within the nasal vault
 - Ensure the sensors are protected from damage from tape
 - Larger children may need catheter inserted further to be sure all zones of interest are being evaluated
- Need someone to tape the catheter in position
 - Nasal alae
 - Cheek

Endotracheal Placement of Catheter

Correct placement



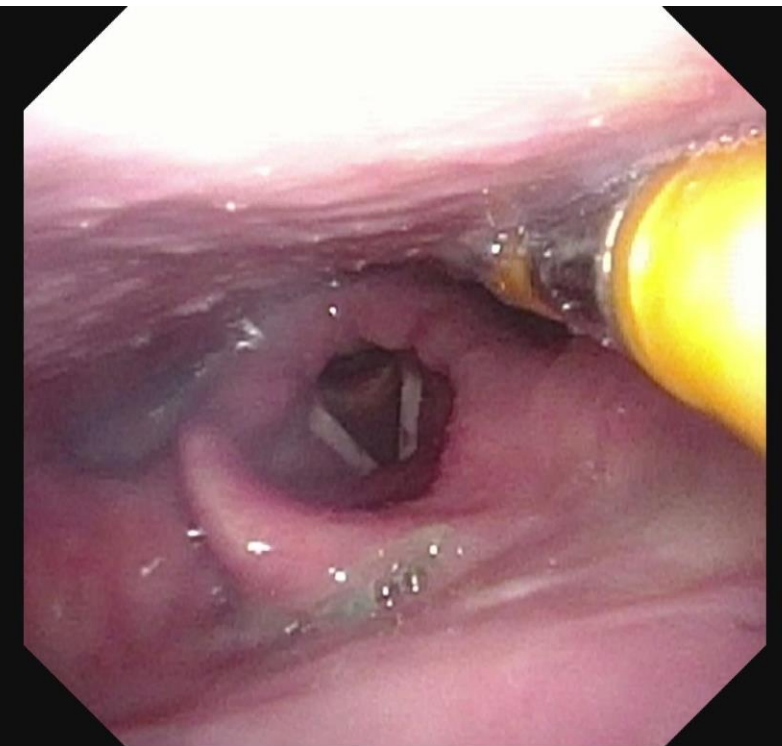
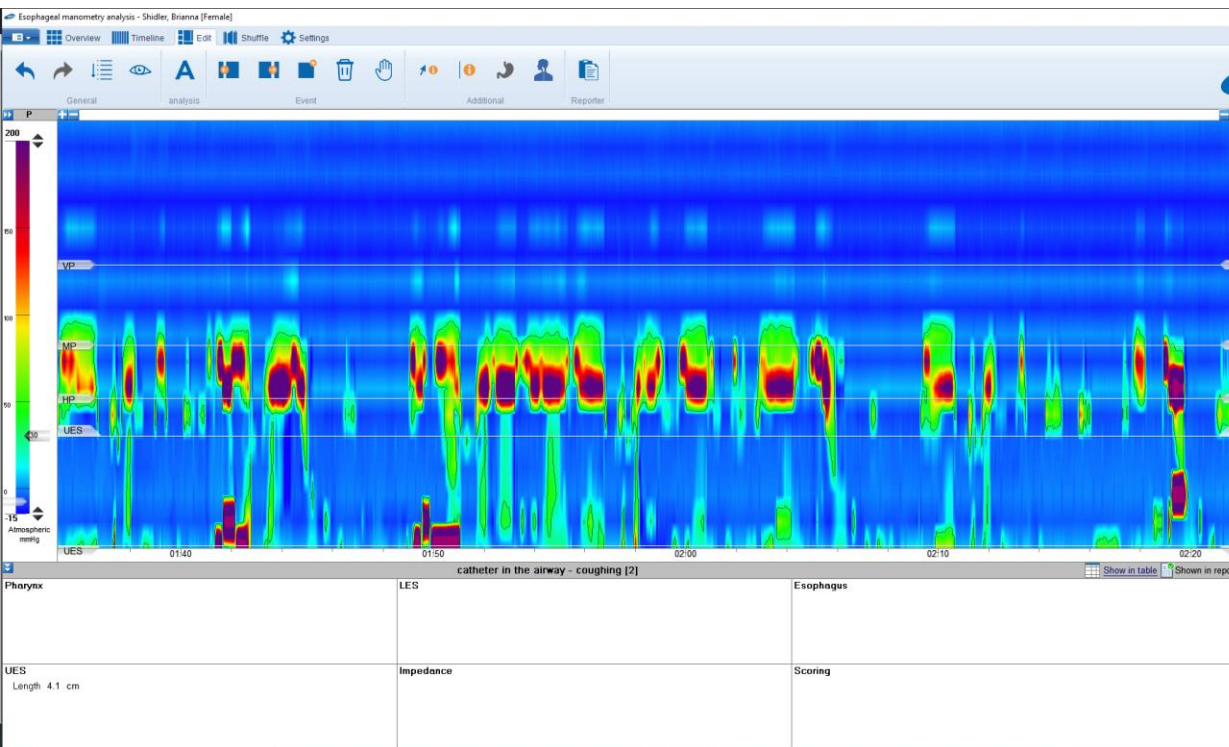
Wrong placement



Endotracheal Placement of Catheter

Glottic closure against the catheter

Localized trauma to anterior vocal folds bilaterally

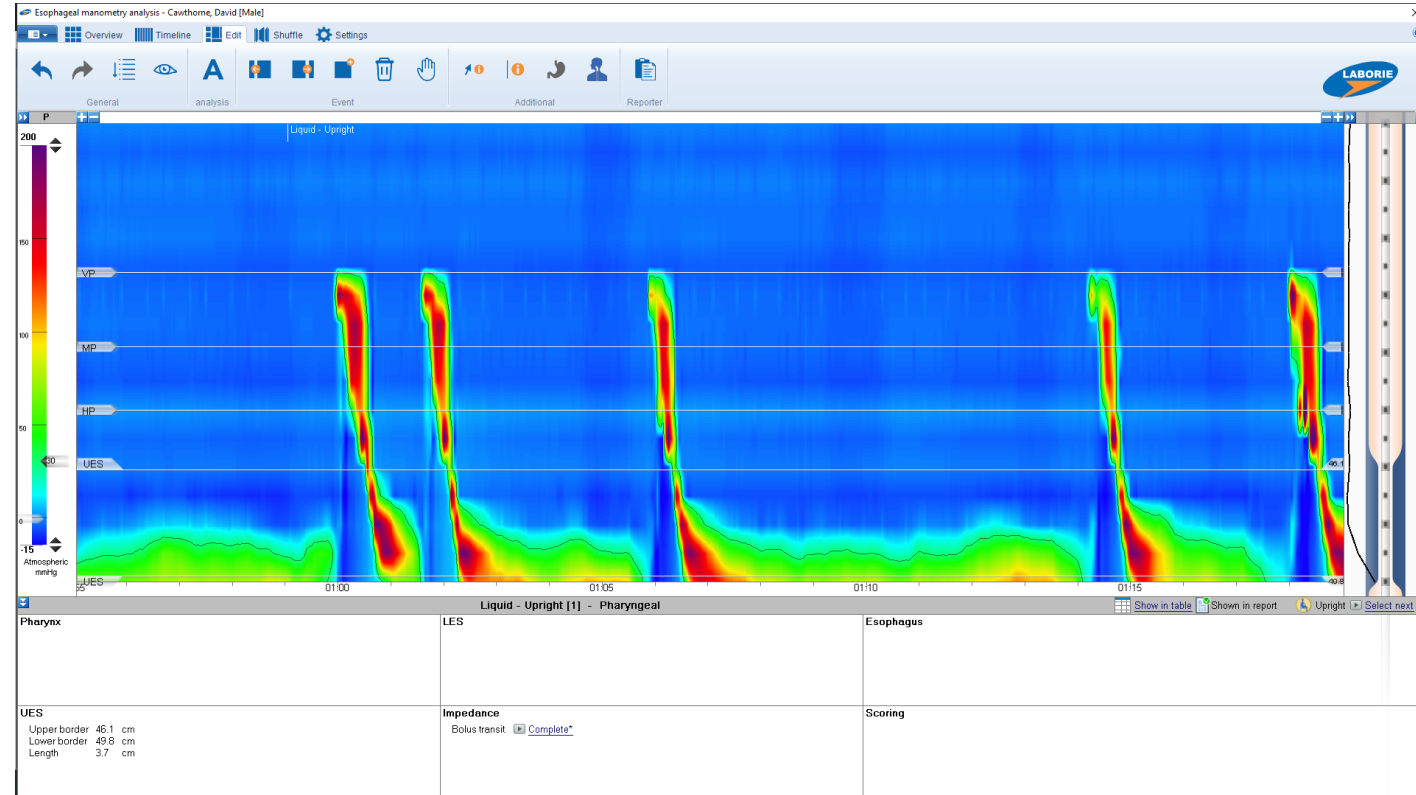


Endoscopic Guidance with Placement



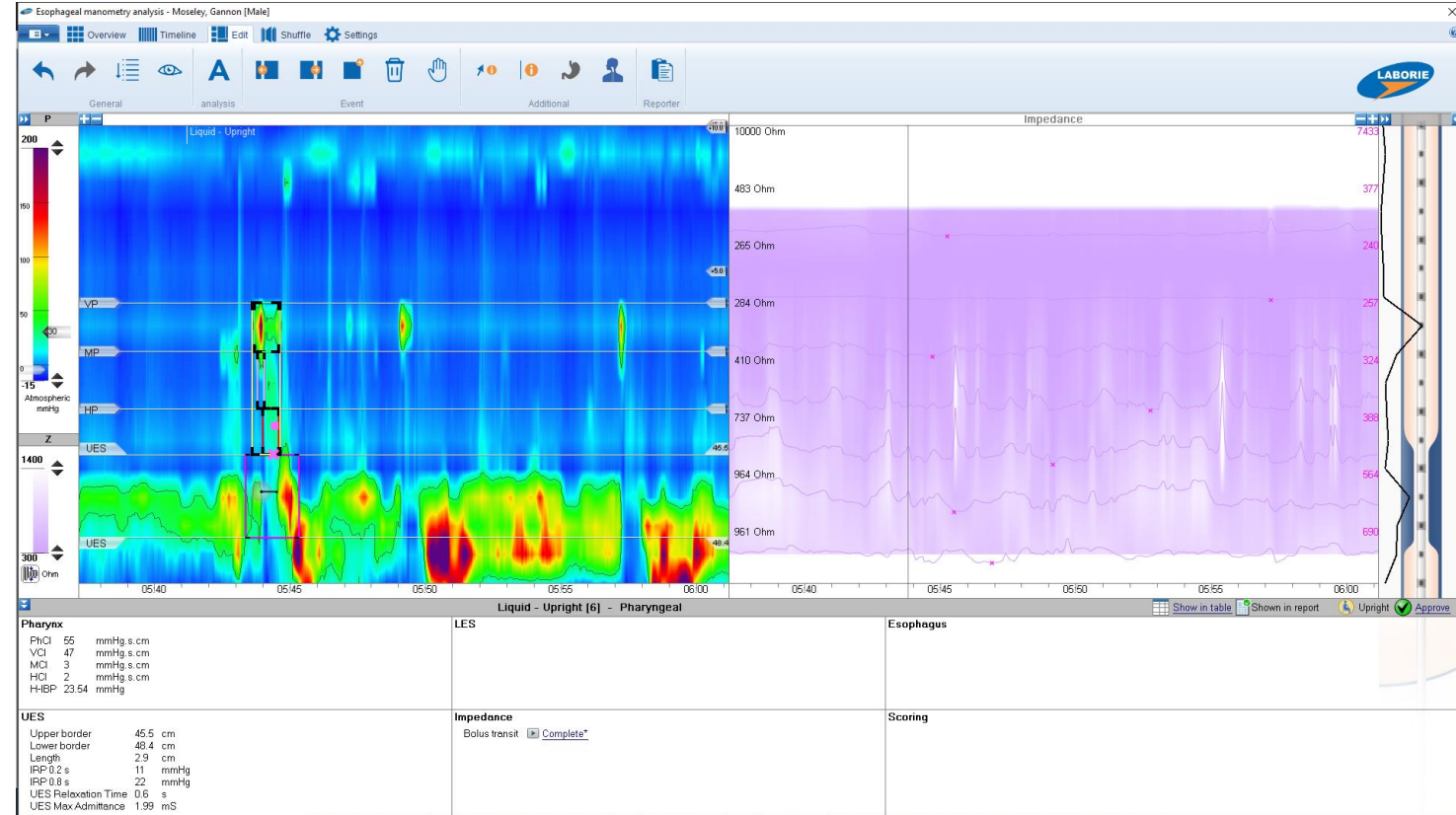
Reviewing Data After the Study

- Topography of the pressure tracing can be used grossly to determine swallow function
- But not always

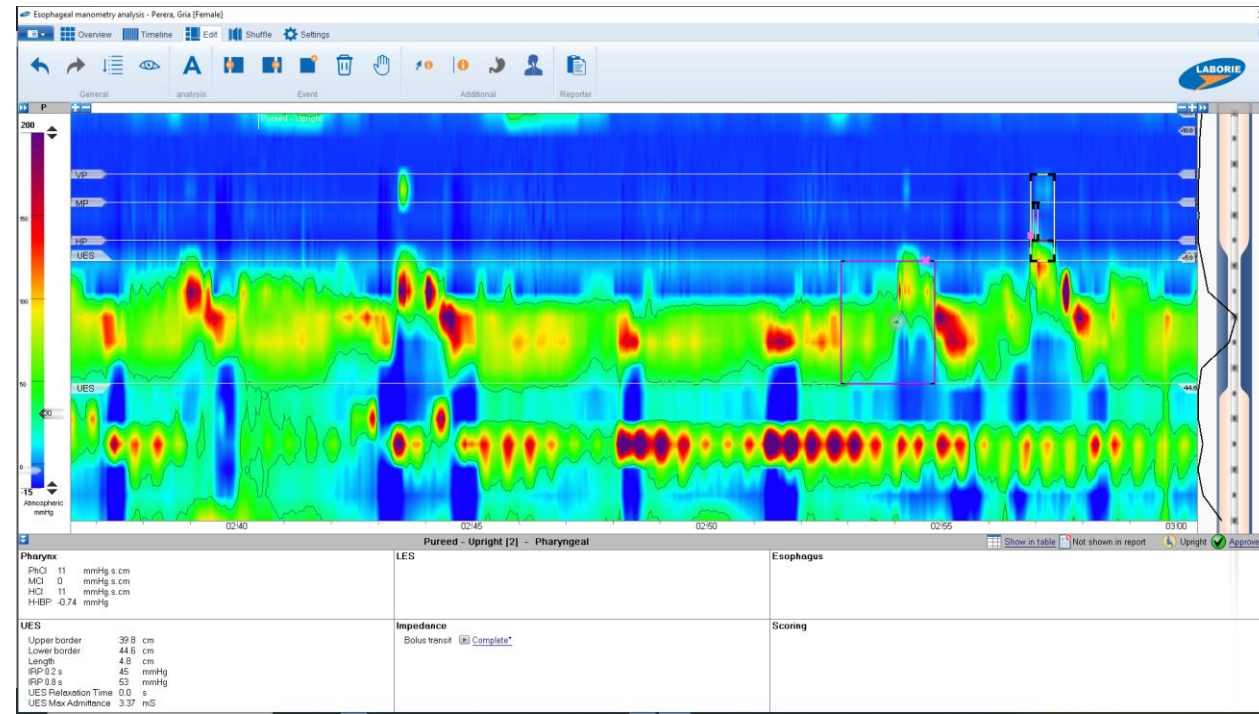
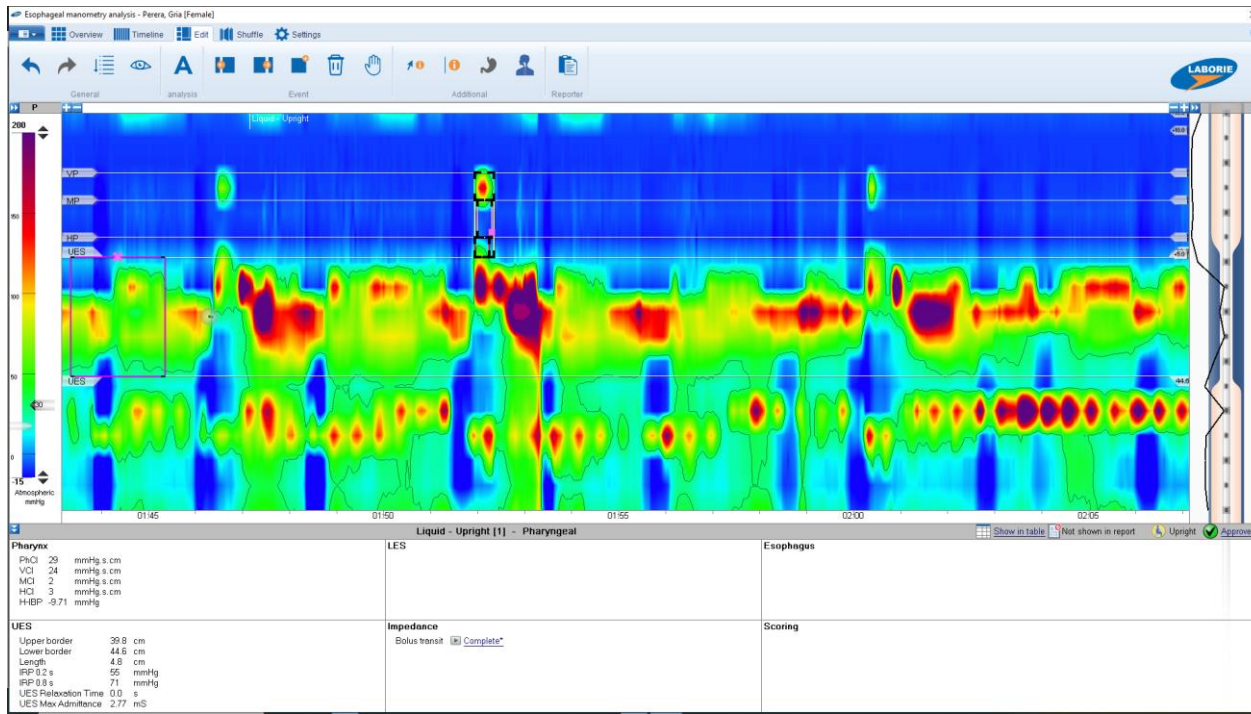


Reviewing Data After the Study

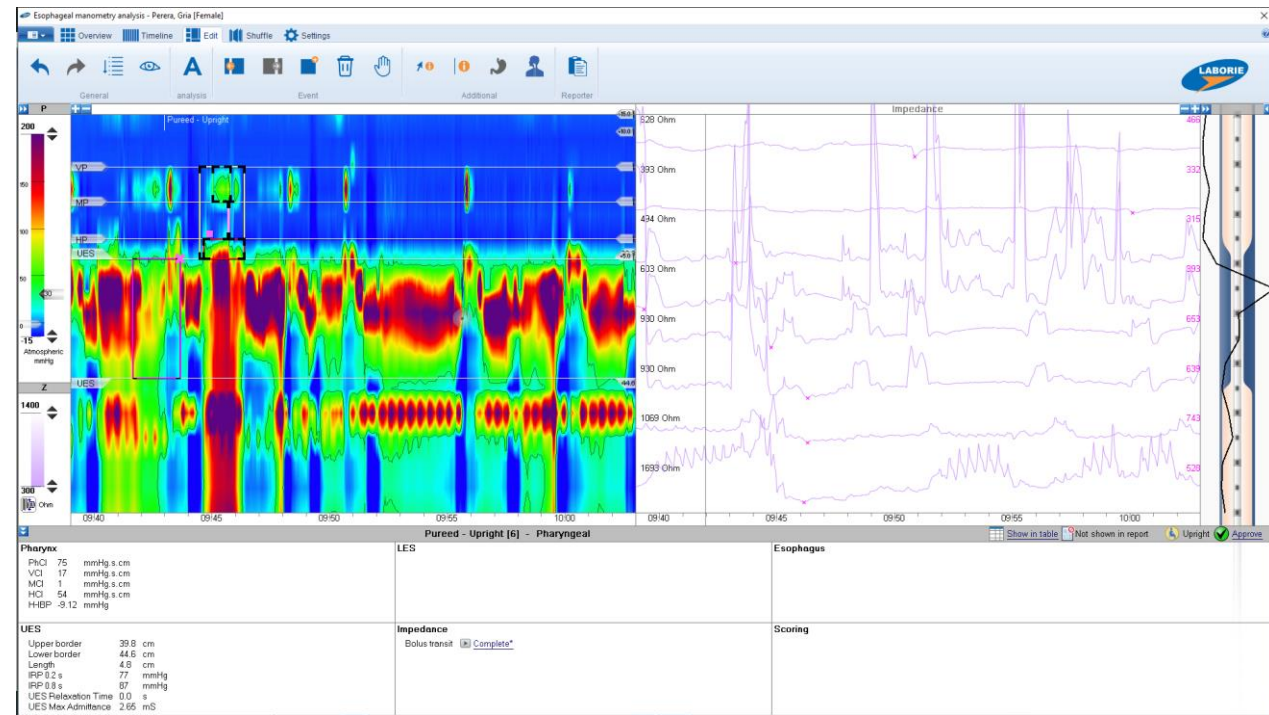
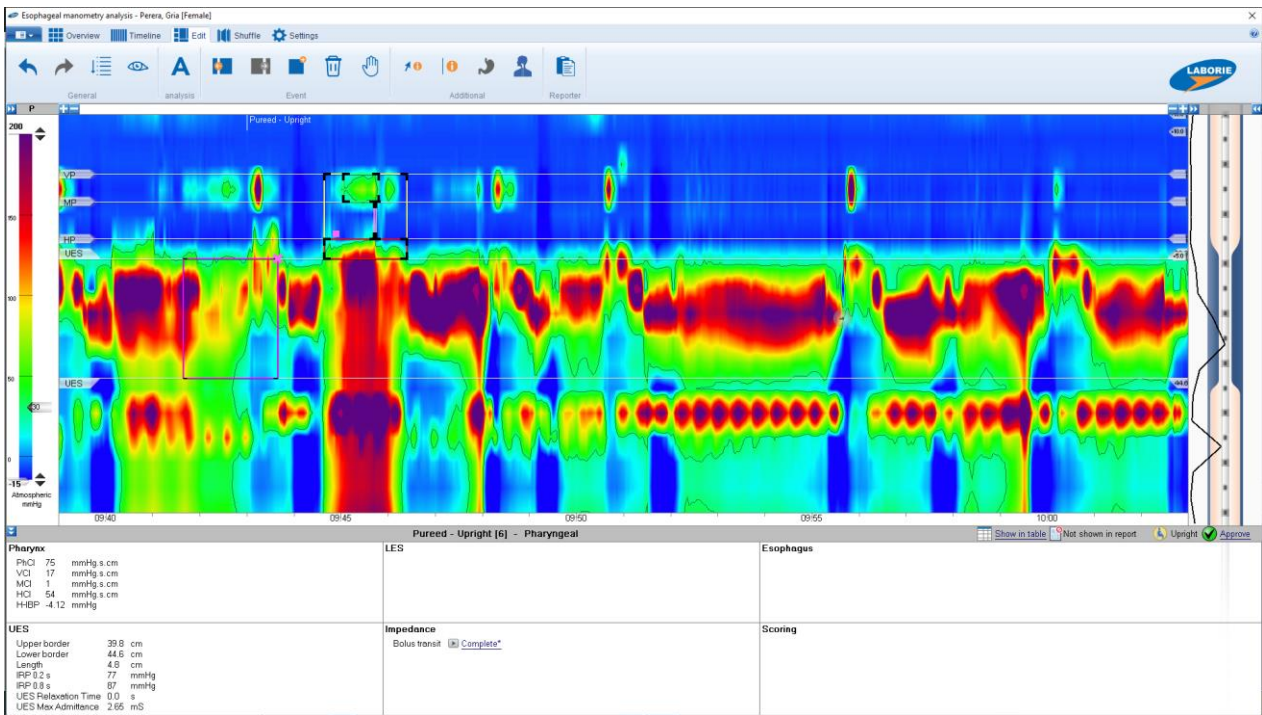
- Weak topographical plot of contraction
- Appears to be functional
- Impedance tracing does not show any flow
 - Limited bolus size
 - Bolus material with limited electrolyte composition
 - Correlate with clinical exam



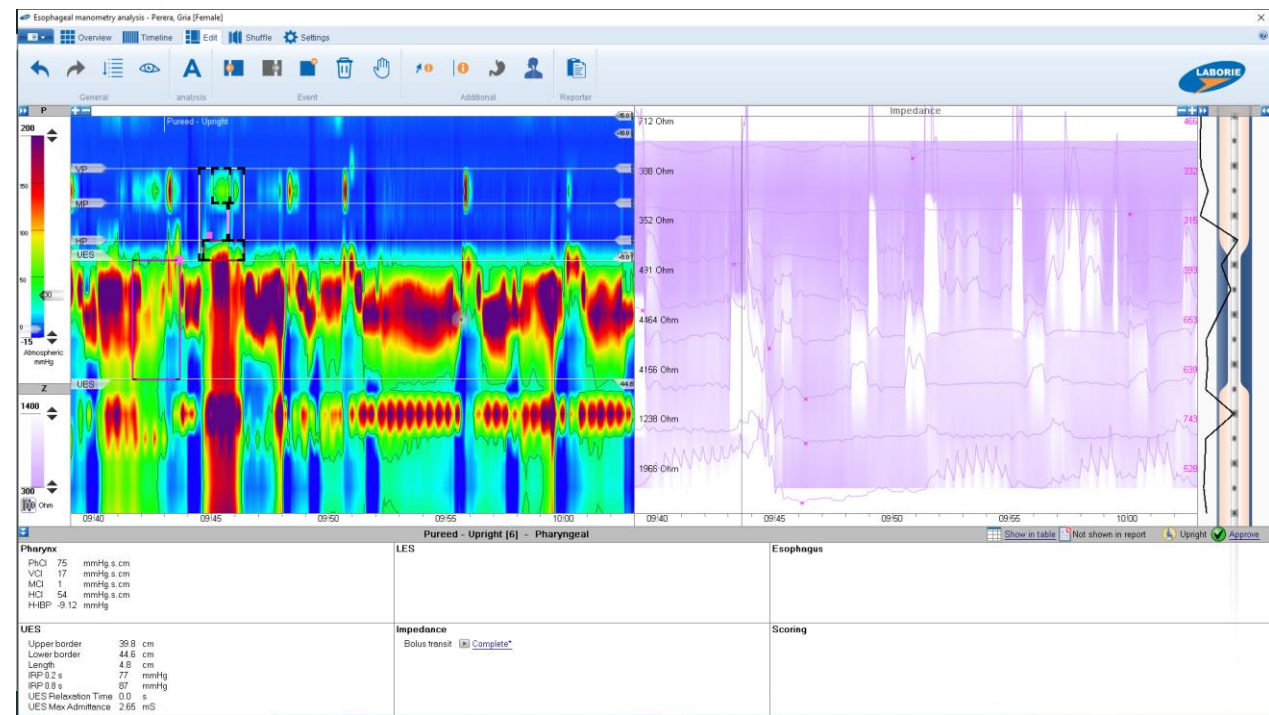
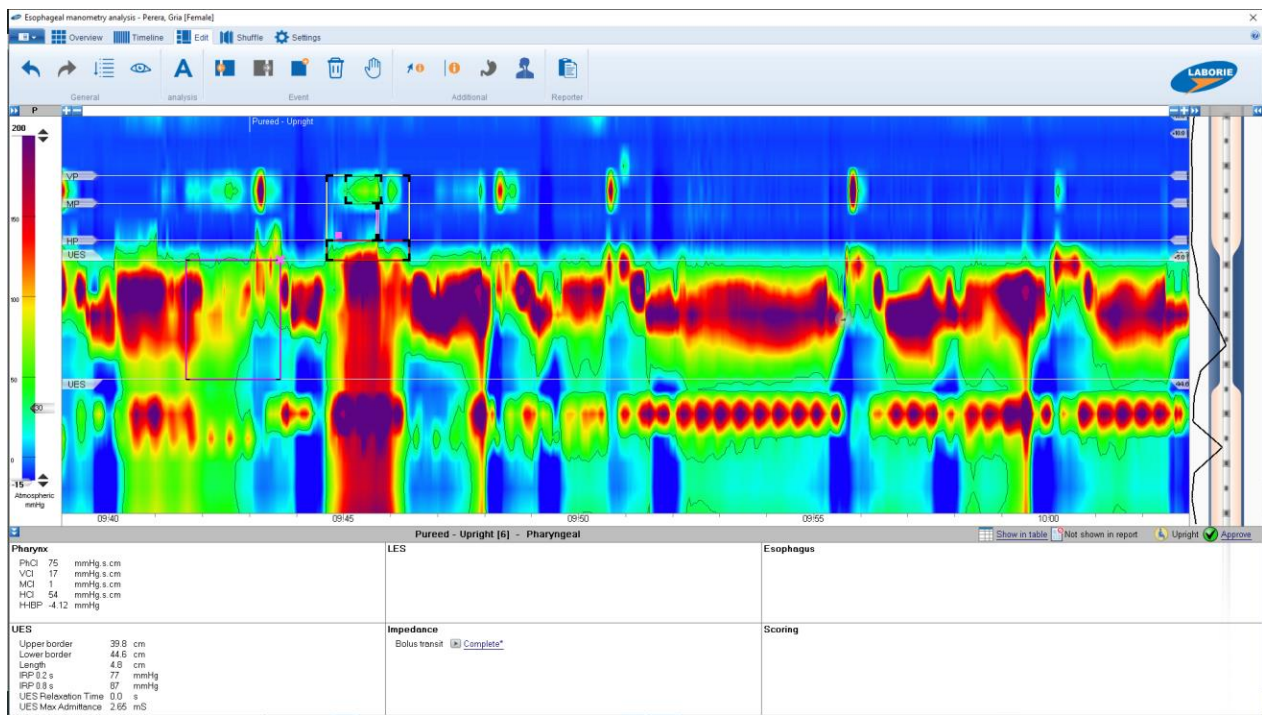
Software Can Have Difficulty Identifying Swallows



Software Can Have Difficulty Identifying Swallows



Software Can Have Difficulty Identifying Swallows



Current Protocol

- Insert catheter in examination room
- Observe tracing during the insertion to ensure proper placement
- Begin exam
 - Offer food materials
 - Attempt to mark when swallow occurs with various food types
 - Try to offer bolus sizes that are consistent in volume
 - Would like 5 swallows of a given consistency
 - Offer as many consistencies as are realistic
- Insert flexible endoscope and repeat exam
 - Offer same food materials as during first portion of exam

Proposed Protocol

- We have purchased a video capture board that will allow simultaneous capture and synchronization of the HRPM study with a FEES (of VSS) exam
- We will be able to perform the entire test in one pass, rather than needing to repeat the study
 - Will result in half the total swallows to analyze when the new hardware arrives

Summary

- Children do not like the manometry catheter
- Children tolerate the manometry catheter
- Endoscope and manometry catheter should be on the same side
- Habitual vomiting patients will demonstrate their habitual vomiting
- Children do not follow directions
- Older patients are more cooperative than younger patients
- Topical anesthetics improve cooperation
- Need to account for the patient's feeding repertoire and volumes

Summary

- The software package has difficulty identifying swallows when they are abnormal
- Software often selects portions of different swallows in the analysis – must be the same swallow
- Pressure topography may not always represent a functional swallow
- Using impedance tracings helps with identification of productive swallows
- There are no pediatric normative values

References

- AB-SSD Task Force-Pediatric Group:, Miller CK, Reynolds J, Kelchner LN, Scarborough D, Langmore S, Gosa M. Tutorial on Clinical Practice for Use of the Fiberoptic Endoscopic Evaluation of Swallowing Procedure With Pediatric Populations: Part 2. American Journal of Speech-Language Pathology. 2023 Jan 11;32(1):55-82.
- Langmore SE, Scarborough DR, Kelchner LN, Swigert NB, Murray J, Reece S, Cavanagh T, Harrigan LC, Scheel R, Gosa MM, Rule DK. Tutorial on clinical practice for use of the fiberoptic endoscopic evaluation of swallowing procedure with adult populations: Part 1. American Journal of Speech-Language Pathology. 2022 Jan 18;31(1):163-87.
- Willging JP. Endoscopic evaluation of swallowing in children. *Int J Pediatr Otorhinolaryngol*. 1995;32 Suppl:S107