LANGMORE FEES 2.0

SUSAN E LANGMORE, PHD

PUBLISHED SCORING SYSTEMS

Many described in the literature; most not validated

For the most part, they score bolus parameters…..

Spillage, penetration, aspiration, residue

A WELL-DEVELOPED MODEL FROM NETHERLANDS (BAIJENS – SENIOR INVESTIGATOR)

Looked at 4 parameters from FEES

- Piecemeal deglutition
- Residue in valleculae
- Residue in piriforms
- Penetration – Aspiration

(what's missing?)

Scored each swallow on rating scale from

- 0 -1 (penet/aspir)
- 0- 2 (residue)
- 0 - 4 (piecemeal deglutition)

- ADD EVERYTHING FOR FINAL SCORE

VALIDATION OF THE MODEL

- Pilz W, et al. Good IRR on these parameters
- Verdonschot Found significant associations of piecemeal deglutition and vallecular residue – with QOL (anxiety, depression)

- Pilz, et al. Observers' agreement on measurements in fiberoptic endoscopic evaluation of swallowing. Dysphagia. 2016;31(2):180–7.
- Verdonschot RJ, et al. The relationship between fiberoptic endoscopic evaluation of swallowing outcome and symptoms of anxiety and depression in dysphagic patients. Laryngoscope 2016; 126(5): E199–207.

ANOTHER EXTERNAL VALIDATION STUDY

- Florie - Found signif association between FEES bolus parameters and MDADI (QOL) in HNC patients

- Florie M, et al. Relationship between swallow-specific quality of life and fiber-optic endoscopic evaluation of swallowing findings in patients with head and neck cancer. Head Neck. 2016;38(Suppl 1):E1848–56.

BAIJENS - IDENTIFIED DIFFERENT PATTERNS OF DYSPHAGIA

205 patients - 3 groups; HNC, PD, Myotonic dystrophy type 1

Parameters:

- Piecemeal deglutition
- Delayed initiation/ spillage
- Vallecular residue
- Piriform residue
- Penetration – aspiration

- Baijens LW, et al. Identifying patterns of FEES-derived swallowing trajectories using group-based trajectory model. Dysphagia. 2015;30(5):529–39.

BAIJENS' RESULTS

- Subgroups were revealed acc to parameters they scored low (better) or high (worse) on
  - **Myotonic dystrophy** patients – higher (worse) for residue; low for piecemeal deglut and Pen-As
  - **HNC** – High (worse) for piecemeal deglutition (oral residue) and pen-asp; low(better) for vallecular and piriform residue;
  - **PD** – high (worse) for Delay Init of swallow ; other parameters variable

WHAT'S MISSING WITH THIS MODEL?

- WHY was residue more a problem in Myotonic Dystrophy? WHY was the residue in the valleculae? Or the piriforms? WHY did HNC have piecemeal deglutition and more Penet/Aspir? Why did PD have Delayed Initiation?

What do the bolus findings mean? Does it lead to a treatment strategy?

WHAT IS A USEFUL MODEL? DOES FLUOROSCOPY HAVE ONE?

- Common models in use/ Major patterns of dysfunction for either tool
  - Safety of swallowing vs Efficiency of Swallowing
  - Oral, pharyngeal, esophageal
  - Bolus findings: aspiration, penetration, residue, spillage
    Criticism: these are only symptoms!!
  - Swallow Physiology parameters
    What is Swallow Physiology???

SWALLOW PHYSIOLOGY ACC/ MBS IMP:

Table 1. Modified Barium Swallow Impairment Profile (MBSImP) physiological components.

Number	Physiological component
1	Lip closure
2	Tongue control during bolus hold
3	Bolus preparation/mastication
4	Bolus transport/lingual motion
5	Oral residue
6	Initiation of pharyngeal swallow
7	Soft palate elevation
8	Laryngeal elevation
9	Anterior hyoid excursion
10	Epiglottic movement
11	Laryngeal vestibular closure
12	Pharyngeal stripping wave
13	Pharyngeal contraction (A/P view)
14	Pharyngoesophageal segment opening
15	Tongue base retraction
16	Pharyngeal residue
17	Esophageal clearance upright position (A/P view)

Note. A/P = anterior/posterior.

PAS added to this

GARAND: CAN PHENOTYPES BE EXTRACTED FROM MBS IMP?

- Gerand (2018) Identification of phenotypic patterns of dysphagia: a proof of concept study, AJSLP
- What is a 'phenotype'? In medicine, it would be a characteristic or trait of a patient or a population of patients with dysphagia; the particular presentation of dysphagia

METHODS

- They sorted the patients by medical etiology (H&N, neurology, pulmonary, & GI) and by primary medical diagnosis and looked for associations in MBSImp parameters with medical diagnoses
- Results: difference in overall severity (H&N, Neuro and Pulm were worse than GI)
- Individual swallow impairments (MBS Imp) revealed some differences eg., pharyngeal stripping wave, but mainly between GI and the 3 other categories
- Their conclusion: This shows potential

MY MODEL: MOVE FROM SCORING/ OBSERVATIONS TO INTERPRETATION OF THE PROBLEM

START WITH OBSERVATIONS OF THE BOLUS: THIS IS OUR BENCHMARK FOR NORMAL VS PROBLEMATIC SWALLOW FUNCTION

BOLUS FINDINGS

⇩

PATTERN OF DYSPHAGIA

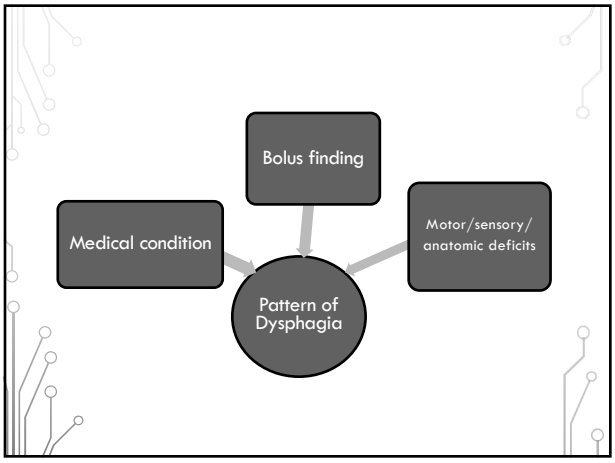
⇩

'MEDICAL' OR FUNCTIONAL ETIOLOGY

⇩

UNDERLYING PHYSIOLOGIC OR ANATOMIC IMPAIRMENT

EVERYTHING SHOULD FIT TOGETHER; DISTINCT PATTERNS SHOULD EMERGE



START FROM OBSERVATIONS OF THE BOLUS

BOLUS FINDING				
SPILLAGE DURING ORAL PREP/ AT INITIATION OF THE SWALLOW				
RESIDUE				
ASPIRATION				
NASAL REGURGITATION				

RELATE THE BOLUS FINDING TO THE SWALLOWING PROBLEM IT REFLECTS

BOLUS FINDING	PATTERN OF DYSPHAGIA		
SPILLAGE ⇒	LEAKAGE; MISTIMED/ DELAYED INITITATION		
RESIDUE ⇒	INCOMPLETE BOLUS CLEARANCE		
ASPIRATION ⇒	INCOMPLETE/ MISTIMED AIRWAY CLOSURE		
NASAL REGURGITATION ⇒	INCOMPLETE VP VALVING		

4 MAJOR PATTERNS OF DYSPHAGIA & THE NECESSARY SKILLS NEEDED

PATTERN OF DYSPHAGIA	MOTOR SKILLS NEEDED
1. Spillage; mistimed, delayed initiation of the swallow	1. Efficient oral preparation; brisk and well-timed initiation of the swallow
2. Incomplete Bolus Clearance	2. Propel and clear the bolus through the pharynx
3. Incomplete airway closure	3. Protect the airway/ close the laryngeal valve
4. Incomplete VP valving	4. Close the VP valve

IDENTIFY THE MEDICAL/ FUNCTIONAL ETIOLOGY

- KNOWN DIAGNOSIS?
- POSSIBLE/ RULE OUT?
- MULTIPLE PROBLEMS?

IDENTIFY THE PRIMARY MOTOR DEFICITS/ PARAMETERS UNDERLYING THE MEDICAL PROBLEM

STRENGTH – reduced/weak

SPEED – too fast, slow; slow to start or stop

RANGE - decreased or variable (stiff; weak; tone)

STEADINESS – unsteady; rhythmic or arhythmic - tremor, myoclonus, tic, spasm, dystonia, fasciculations

TONE – reduced/flaccid; excessive – spastic/ rigid

ACCURACY/TIMING – consistently inaccurate (eg., if weak) or mistimed, incoordinated

WHY ADD THE UNDERLYING MOTOR DEFICITS?

- It explains the dysphagia pattern
- It should be consistent with the medical diagnosis
- This is the final step that guides treatment

SENSATION IS ANOTHER PREREQUISITE FOR NORMAL SWALLOWING

REDUCED SENSATION

- Sensation can be reduced from loss of sensory receptors, altered sensory receptors, peripheral nerve loss, or central nervous system damage
- Manifested by aberrant **motor response** - DELAYED RESPONSE, LACK OF RESPONSE, REDUCED RESPONSE, REDUCED AWARENESS; loss of intact protective and swallow reflexes.
- **Results in spillage, lack of response to residue, lack of response to penetration or aspiration**

ANATOMIC PARAMETERS ARE ALSO CRITICAL FOR SWALLOWING

- Resection -> missing structures
- Reconstruction -> altered structures
- Surface changes = growths, mucosal irregularities, edema, thick, excessive connective tissue
- Foreign body = feeding tube, tumor, osteophyte

EFFECTS OF ANATOMICAL CHANGES ON SWALLOWING

Alters the bolus pathway/ space, channels, for the bolus to flow or reside and normal barriers to keep bolus out.

Can cause…….

Mistimed initiation of the swallow (Tongue intact? Palate intact?) → Early loss of bolus; inaccurate propulsion of the bolus

Reduced bolus clearance: - bolus path altered or obstructed → Misdirected bolus; affects safety and efficiency

Penetration/Aspiration: Is larynx intact? Able to close?

Nasal regurgitation: is the VP sphincter intact?

IS THIS ALL COMPATIBLE?

BOLUS FINDINGS	PATTERN OF DYSPHAGIA	MEDICAL ETIOLOGY	SENS/ANAT /MOTOR DEFICITS
SPILLAGE	MISTIMED OR DELAYED INITITATION ⟺	NEUROLOGIC? HNC? OTHER? ⟺	Speed, strength, etc.
RESIDUE	INCOMPLETE BOLUS CLEARANCE ⟺	NEUROLOGIC? HNC? OTHER? ⟺	
ASPIRATION DURING SWALLOW	INCOMPLETE LARYNGEAL VALVING ⟺	NEUROLOGIC? HNC? OTHER? ⟺	
NASAL REGURGITATION	INCOMPLETE VP VALVING ⟺	NEUROLOGIC? HNC? OTHER? ⟺	

EXAMPLE: SALIENT MOTOR CHARACTERISTICS UNDERLYING CORTICAL STROKE (UMN)

⇩⇩ **STRENGTH –** reduced/weak

⇩⇩ **SPEED** –slow; slow to start; long latency of response

⇩⇩ **ACCURACY –**mistimed, incoordinated

⇩ **RANGE -** decreased amplitude; secondary to increased tone and weakness

⇧ **TONE** - excessive – spastic

⇩ **SENSATION –** reduced central processing of info

These are the focus of treatment!

SALIENT UNDERLYING DEFICITS OF POST RADIATED HNC

Primary deficits:

- **STRENGTH** – reduced/weak?? Long term problem
- **RANGE** - decreased; stiff
- **ANATOMY-** altered/ impedes bolus flow

Secondary deficits

- **ACCURACY** – consistently inaccurate (if weak)
- **SENSATION –** reduced peripheral processing

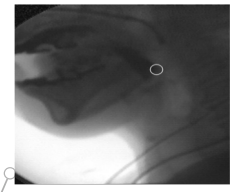
FIRST BOLUS ABNORMALITY = "SPILLAGE"

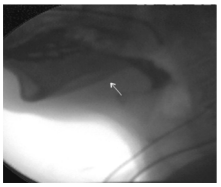
- What is "spillage"?
- Is it ever normal?

SCORING SPILLAGE: WHAT ARE THE CRITICAL MEASURES?

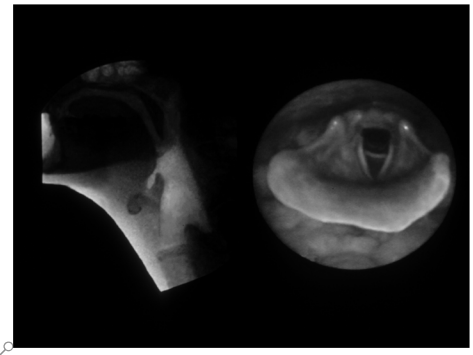
1. Pharyngeal Delay/ **Spillage Time?** = how long the bolus is in the pharynx before the swallow is triggered
2. **Location of lowest/furthest spillage point**

PHARYNGEAL DELAY: NUMBER OF SECONDS TO TRIGGER A SWALLOW





FEES MARKERS: (1) BOLUS IN VIEW (2) WHITE OUT



NORMS FOR PHARYNGEAL DELAY/SPILLAGE TIME *DEPEND ON THE CONDITION*

Early Fluoroscopic norms (1)

- **Liquids < 0.5 second** (0.01-0.42sec) up to 20 ml
  - Robbins, Lazarus, Tracy, Langmore (misc. studies from the 80s and 90s)
- Command to swallow

PALMER RE-DEFINED NORMAL PHARYNGEAL DELAY/ SPILLAGE -

- **One bolus at a time but subject swallows at will → longer normal pharyngeal delay times**
  - Palmer, Hiemae (1992, 1998, 1999
- Up to 2-3 seconds (great variability)

NATURAL EATING, DRINKING

- College students ate entire lunch with endoscope in place (**Dua,** 1997)*

How Long Did the Bolus Dwell?

	Valleculae	Pyriforms	Laryngeal Rim
Liquids	3.2 sec	1.5 sec	0.3 sec
Food	2.1 sec	1.5 sec	0.4 sec

LOCATION/FURTHEST POINT OF SPILLAGE ALSO MEASURED

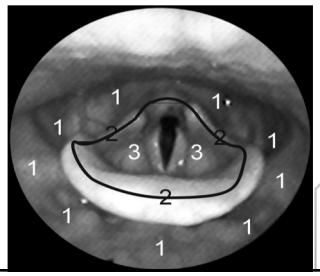
Dua (1997): How Far Did the Bolus Fall?

	Valleculae	Pyriforms	Laryngeal Rim	Total
Liquids	37%	11%	12%	60%
Food	40%	2%	34%	76%

*Dua
eating. Gastroenterology. 1997,112(1):73-83.

THE LARYNGEAL RIM IS THE BORDER BETWEEN 'SAFE' SPILLAGE OUTSIDE THE LARYNX, AND PENETRATION

- What happens when a bolus crosses the laryngeal rim?
- Cough?
- Swallow?
- Clear throat?
- Nothing?



MOVIES SHOWING BOLUS CROSSING LARYNGEAL RIM

Anatomy.Normal → Airway closure to water

- Healthy normal trying to inhibit swallow

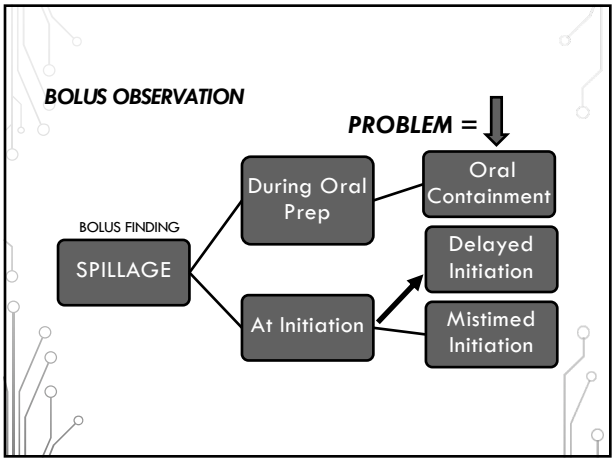
Optional videos (in Scoring.Abnormal findings - →

- *Spill Leak small amt 3062*
- *Aspir bef Milk 16 sec*

PATTERNS OF SPILLAGE ALSO TIED TO WHEN IT OCCURS

1 Spillage **during oral preparation** of the bolus

2 Spillage at the time of initiation of the swallow



FIRST PATTERN: SPILLAGE DURING ORAL PREPARATION

Jeff Palmer's work: Transition from oral prep to the initiation of the swallow

Palmer and Hiiemae, Matsuo, Haishima, Hiraoka,Palmer, multiple publications *Read everything he writes!!*

FOOD AND LIQUID ARE HANDLED DIFFERENTLY DURING ORAL PREP

- Oral preparation of food
- Food that is chewed is moved to the back of the tongue and into the valleculae gradually, as the food in the front of the mouth continues to be processed and mixed with saliva.
- **Normal time for a masticated bolus to be seen in the HP may be as long as 10 seconds**

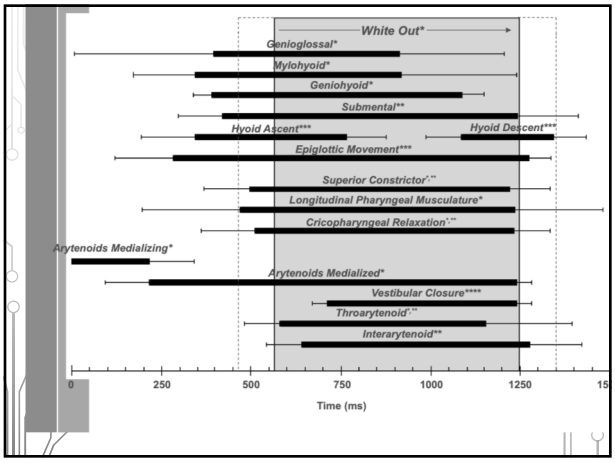
WHAT ABOUT LIQUIDS?

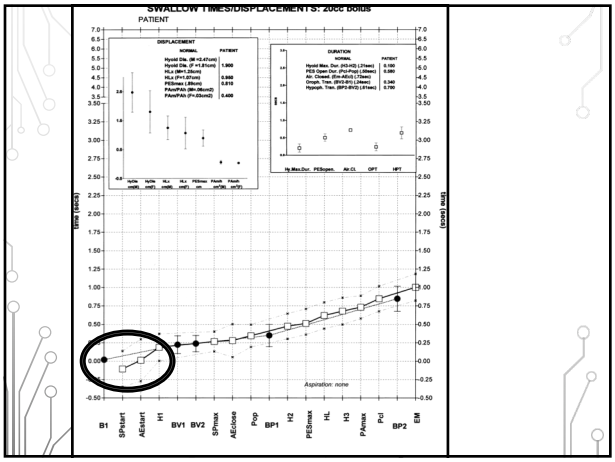
- **The entire liquid bolus moves from the oral cavity; moves directly into the esophagus; Any leakage is abnormal;**
- **but you might see the leading edge of the entire liquid bolus as it is swallowed**

More common upward time limit = 1.5 - 2 seconds

ORAL PREPARATION TRANSITIONS TO INITIATION OF THE SWALLOW

- Oral preparation ends, followed by lingual propulsion, and multiple laryngeal/pharyngeal movements that occur nearly simultaneously.
- **Timing/ coordination of tongue and laryngeal movements is critical**





ONSET OF THE SWALLOW

Onset of the swallow triggered by:

1 Soft palate rises

#2 Tongue propulsion (bolus moves posteriorly)

Arytenoids move medially and anterior

ABNORMAL PATTERNS OF SPILLAGE AT INITIATION OF THE SWALLOW

FIRST PATTERN:

Mistiming of tongue propulsion with pharyngeal response.

Entire bolus is propelled into the pharynx before the pharynx is 'ready'

You see the bolus - and after a short pause, the pharyngeal response kicks in

SECOND PATTERN AT INITIATION OF SWALLOW

Delayed, slow; 'difficulty' initiating the swallow…..***bolus may or may not spill/ leak*** as the person attempts to initiate the swallow

THIRD PATTERN

Occasional, Unintentional leakage of a small amount of liquid before the person has initiated the swallow

No lingual propulsion seen

- person is distracted?
- head turns/ positional change?
- incomplete palatal/lingual seal?

SUMMARY OF SPILLAGE NORMS (STILL NEED MORE RESEARCH!)

WHEN	CONDITION	LIQUID	FOOD
During oral prep	Natural eating/ drinking	no spillage	1 – 10 sec
At Initiation of the swallow if……	Command to Swallow given	less than ½ sec	Not studied
At initiation of the swallow if……	One bolus at a time	1 to 2 sec	1 to 3 sec (if spill during oral prep not seen)
At initiation of the swallow if…….	Natural eating/ drinking	1 to 3 sec	1 to 10 sec (including accumulation during oral prep)

VIDEOS

1 Spill during oral pre (bread/cheese)

<u>During Oral Prep</u>: Patient unaware of oral spillage

2. Spill early DanielsExam 1.28sec

<u>Initiation of swallow:</u>

2. "Early/ premature appearance of the bolus; mistiming bolus propulsion and pharyngeal response

3 Spill Delay during oral and at initiation (MS)

3. Delayed initiation – bolus leaks while patient tries to initiate the swallow

4 Spill leak small amt 3062.

4. Small amount leaks prior to initiation

INTERPRETING SPILLAGE

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What is the aberrant swallowing pattern?

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What medical/functional problem causes the anatomic or physiologic impairment?

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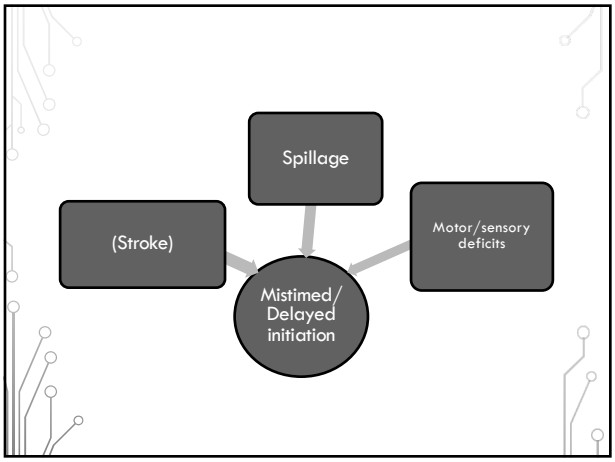
What underlying anatomic or physiologic parameter is impaired?



MOTOR CHARACTERISTICS OF **CORTICAL STROKE** (UMN) **UNDERLYING SPILLAGE**

⇩⇩ **SPEED** –slow; slow to start; long latency of response

⇩⇩ **ACCURACY –**mistimed, incoordinated

⇩⇩ **SENSATION –** reduced central processing

==========

⇩ **STRENGTH –** reduced/weak

⇩ **RANGE -** decreased amplitude;
secondary to increased tone and weakness

⇧ **TONE -** excessive – spastic

These are the focus of treatment!

SECOND PROBLEM = RESIDUE

SCORING RESIDUE

RATING RESIDUE IN THE CLINICAL WORLD OR IN RESEARCH

- No standard, validated measure used widely for FEES
- Usually reported as mild, mod, severe
  - or present/absent
- Never used in research as primary outcome **even though it is sometimes the biggest problem**
- HNC – usually the most prevalent problem
- Neuro – a problem if weak

PISEGNA. (DYSPHAGIA, 2018)

How should we Rate severity of Residue on a FEES?

Is a categorical or visual analog scale more reliable among raters?

- **Ordinal ratings** (none, trace, mild, mod, severe)
- **Continuous scale** (VAS) 0 to 100

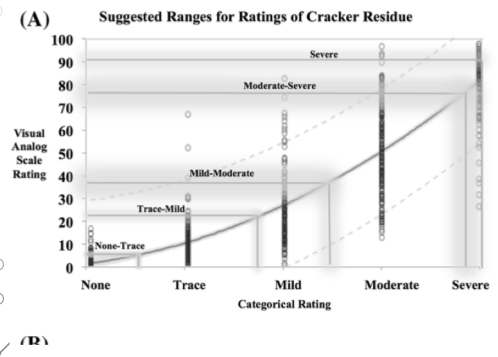
SHE COMPARED TWO TYPES OF RATINGS

- 33 raters rated 25 cracker, 25 applesauce, 25 thin liquid FEES videos
- They were asked "How much residue overall do you see?"

COMPARING VAS AND ORDINAL SCALES

- Boundaries between the zones (mild, mod, sev) were uneven For cracker, most of the ratings were in this range:
  - "Mild" = 5-40% on VAS
  - "Moderate" = 30–75% on VAS
  - "Severe" = 50– 90% on VAS

RELATIONSHIP BETWEEN VAS AND ORDINAL RATINGS



PUBLISHED RESIDUE SCALES USING FEES

ALL PERCEPTUAL IN NATURE

PERCEPTUAL SCALES FOR RATING RESIDUE

MBS – Perceptual Rating Scales

- Martin, MBSImp (2008) – rate adequacy of pharyngeal wall movement and 3 ratings of amt of residue
- Dejaeger (1997) 4 point rating scalle
- Eisenhuber: (2002) 3 point scale
- MBS DIGEST, OPSE – estimate the % of the entire bolus that is left in the HP

FEES –Perceptual Rating Scales

- Langmore, 2001 (text) amount, location, awareness, clearing swallows
- Kelly, 2006, 2008
- Farneti – 2008, 2014 - Pooling Score
- Kaneoka - 2014
- Neubauer 2015 – Yale Residue Severity Rating Scale

KELLY'S RESIDUE SCALE 2006, CLIN OTOLARYNGOLOGY

- 5 point scale: (for liquid, yoghurt)
  - Coating: coating of the pharyngeal mucosa; no pooling
  - Mild = mild pooling/residue
  - Moderate = moderate polling/residue
  - Severe = Severe pooling/residue

KELLY, 2006 COMPARING RESIDUE ON FEES VS FLUORO

- Simultaneous studies
- 15 patients with dysphagia;
- FEES scores were consistently higher than MBS
  - **Mean residue score was 1.0 point higher than the mean score on MBS (p <0.001)**

KELLY – 2008: NORMAL AMOUNT OF RESIDUE

- 11 diff anatomic sites rated - none, mild, mod, severe
- Normal healthy persons
  - 21 young; 11 elderly (over 65)
- Reliability testing: 95% agreement kappa = .6 (good)

KELLY (2008) RESULTS (NORMS)

- **92% of the young subjects and 96% of the elderly subjects scored None (or occasionally Coating)** for residue
- 1.3% occurrences of penetration (mild or coating)

FARNETI'S "POOLING SCORE" (P-SCORE)

(ACTA OTORHIN LARYN ITALICA, 2008)

1. **Site** – 5 sites – score the worst
   Vallecula = 1; rim=1; piriforms=2; vestibule = 3; beneath VCs= 4
2. **Amount** – 3 grades:
   Coating = 1; minimum = 2; maximum = 3
3. Management – **how many swallows to clear**
   <2 = 2; 2-5 = 3; >5 = 4
4. Add these up to get Total Pooling score = 4-11points

THE YALE PHARYNGEAL RESIDUE SEVERITY RATING SCALE NEUBAUER, 2015

- 5 point ordinal scale – location and amount
- 20 raters rated 13 images for each of 2 locations - rated severity 2 weeks apart

RESULTS

- Intra rater and inter-rater reliability – good
- Construct validity (compared to 2 expert raters) – good
  0.848 for valleculae and 1.000 for piriforms

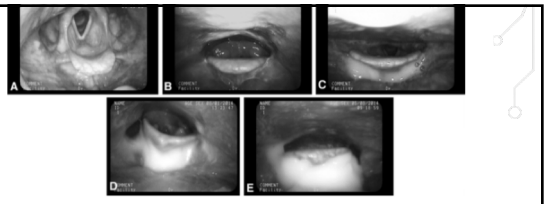
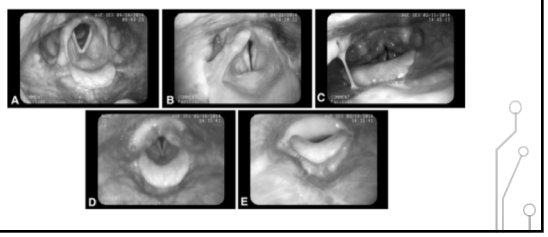


Fig. 1 The vallecula images with the greatest inter-rater agreement for each residue level: **a** none; **b** trace; **c** mild; **d** moderate; and **e** severe



SCORE 3 VIDEOS USING NEUBAUER'S SCALE

RESIDUE SCORING PRACTICE

- #5 cracker
- #42 liquid
- #47 applesauce

BRACS: BOSTON RESIDUE AND CLEARING SCALE

KANEOKA, ET AL 2014

- Takes 4 factors into account:
  - Location
  - Amount – Mild(<1/3) Mod(1/3 to 2/3) Severe (>2/3)
  - Any spontaneous swallows to clear?
  - Effectiveness of clearing swallows (no, partly cleared, mostly or all cleared)

LIMITATIONS OF BRACS

- Takes about 2 minutes to score a swallow
- Future Plans
  - Develop shorter version that is valid, reliable

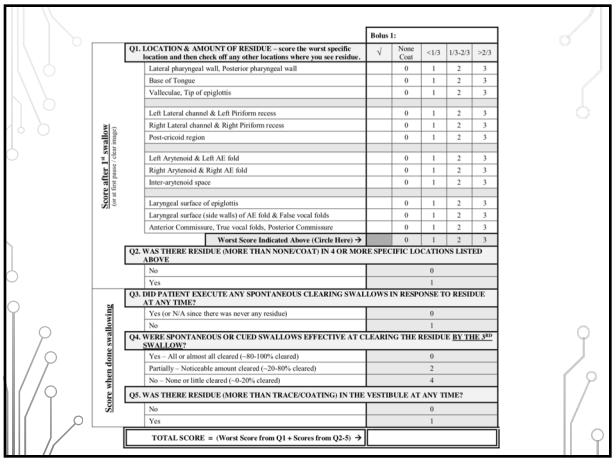
STATS ON THE BRACS SCALE

- Factor analysis identified 3 factors that were highly correlated from the 12 locations

12 locations → 3 regions

- Upper pharynx
- Lower pharynx
- Larynx

A future version of BRACS could be simplified by only identifying 3 regions



		Bolus 1:				
	Q1. LOCATION & AMOUNT OF RESIDUE – score the worst specific location and then check off any other locations where you see residue.	√	None Coat	<1/3	1/3-2/3	>2/3
Score after 1st swallow (use all four pieces - chew enough)	Lateral pharyngeal wall, Posterior pharyngeal wall		0	1	2	3
	Base of Tongue		0	1	2	3
	Valleculae, Tip of epiglottis		0	1	2	3
	Left Lateral channel & Left Piriform recess		0	1	2	3
	Right Lateral channel & Right Piriform recess		0	1	2	3
	Post-cricoid region		0	1	2	3
	Left Arytenoid & Left AE fold		0	1	2	3
	Right Arytenoid & Right AE fold		0	1	2	3
	Inter-arytenoid space		0	1	2	3
	Laryngeal surface of epiglottis		0	1	2	3
	Laryngeal surface (side walls) of AE fold & False vocal folds		0	1	2	3
	Anterior Commissure, True vocal folds, Posterior Commissure		0	1	2	3
	Worst Score Indicated Above (Circle Here) →		0	1	2	3
	Q2. WAS THERE RESIDUE (MORE THAN NONE/COAT) IN 4 OR MORE SPECIFIC LOCATIONS LISTED ABOVE					
	No		0			
	Yes		1			
Score when done swallowing	**Q3. DID PATIENT EXECUTE ANY SPONTANEOUS CLEARING SWALLOWS IN RESPONSE TO RESIDUE AT ANY TIME?**					
	Yes (or N/A since there was never any residue)		0			
	No		1			
	Q4. WERE SPONTANEOUS OR CUED SWALLOWS EFFECTIVE AT CLEARING THE RESIDUE BY THE 3RD SWALLOW?					
	Yes – All or almost all cleared (~80-100% cleared)		0			
	Partially – Noticeable amount cleared (~20-80% cleared)		2			
	No – None or little cleared (~0-20% cleared)		4			
	Q5. WAS THERE RESIDUE (MORE THAN TRACE/COATING) IN THE VESTIBULE AT ANY TIME?					
	No		0			
	Yes		1			
	TOTAL SCORE = (Worst Score from Q1 + Scores from Q2-5) →					

(SCORE) 3 VIDEOS USING BRACS SCALE - DISCUSS

- #5 cracker
- #42 liquid
- #47 applesauce

"MEASURING" RESIDUE WITH FEES?

One study: Pisegna, 2017

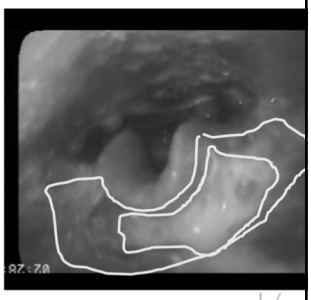
Computed area of vallecular residue and compared it to vallecular residue on MBS

PISEGNA, 2017 (PRESENTATION)

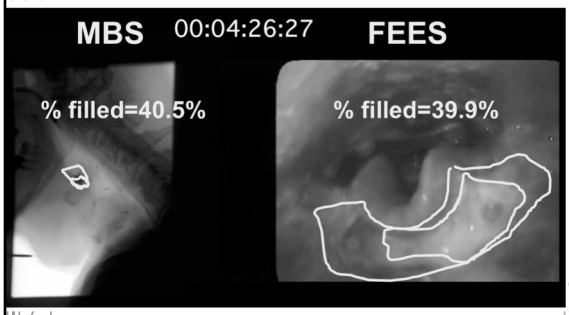
Residue Area: 51411 pixels

Cavity Area: 128868 pixels

FEES valleculae
% filled: 51411 / 128868 = 39.9%



PISEGNA: QUANTIFYING RESIDUE



WHAT DO WE NEED TO BE ABLE TO MEASURE EXACT RESIDUE WITH FEES?

- If measuring the % of the cavity filled……
  - Need a 3 dimensional endoscope that measures distance in order to be accurate
- If measuring the exact volume left in a cavity……
  - Need to know the capacity of a cavity
  - Or *the average* capacity of the piriforms, lat channels, valleculae

EXPERIMENT AT BOSTON MED CENTER: HOW MUCH DID HIS CHANNELS HOLD?

- Mike Walsh SLP volunteered
- Infused liquid into HP with syringe = into the vallecula, piriforms
- He suppressed a swallow.
- Measured volume that had been delivered

Volume in 1 piriform – about 2.5 – 3 ml

in both piriforms (& lateral channels)= 5-6 ml

in his valleculae = 1.5 ml

One subject!!

SHORT VIDEO OF BMC EXPERIMENT

- Folder = Mike Filling up channels
  - → 4 Mike HP Vall LC Pir Thick

SUMMARY: SCORING RESIDUE

Scoring residue:

- What bolus consistency?
- Where?
- How much?
- Spontaneously cleared?
- Cleared when prompted?

→ Overall Severity

INTERPRETING RESIDUE

BOLUS FINDING

RESIDUE ⇒

THE PROBLEM

Incomplete Bolus Clearance

INTERPRETING REDUCED BOLUS CLEARANCE

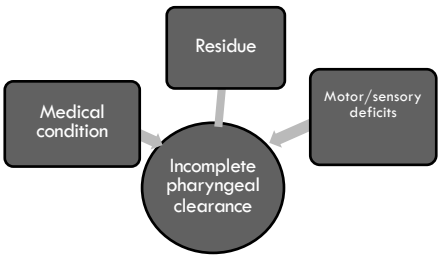
- **Why is there residue?**

  Reduced pressure on the bolus from……

  - Anatomical barrier?
  - Weakness?
  - Stiffness?

- **Where is residue?** → locus of region with reduced pressures

PUT IT ALL TOGETHER



RESULTING MOTOR DEFICITS

STRENGTH – reduced/weak

SPEED – too fast, slow; slow to start or stop

RANGE - decreased or variable (stiff; weak; tone)

STEADINESS – unsteady; rhythmic or arhythmic - tremor, myoclonus, tic, spasm, dystonia, fasciculations

TONE – reduced/flaccid; excessive – spastic/ rigid

ACCURACY/TIMING – consistently inaccurate (eg., if weak) or mistimed, incoordinated

EXAMPLES: REDUCED BOLUS CLEARANCE

BOLUS FINDING	PATTERN OF DYSPHAGIA	MEDICAL ETIOLOGY	MOTOR, SENSORY, ANATOMIC IMPAIRMENT
Residue	Reduced Bolus Clearance	**HNC; POST SX;** STRUCTURES ALTERED ⟹	INACCURATE (BOLUS PATH ALTERED) WEAK IF NERVE DAMAGE
		HNC; POST CRT ⟹ FIBROSIS	STIFFNESS, REDUCED AMPLITUDE, WEAK; REDUCED SENSATION
Residue	Reduced Bolus Clearance	**STROKE, NEURO DISEASE, MYOPATHY** ⟹	WEAK, REDUCED AMPLITUDE; REDUCED AWARENESS
Residue	Reduced Bolus Clearance	**OTHER STRUCTURAL** (FOREIGN BODY OR SURGERY) ⟹	INACCURATE,(AT LEVEL OF OBSTRUCTION)

MAJOR FORCES FOR PHARYNGEAL CLEARANCE:

- **Base of Tongue** squeezes against the **pharyngeal walls**
- as **Pharyngeal muscles** contract to clear the tail of the bolus
- **Hyolaryngeal excursion** provides counter force to assist pharyngeal constrictors and pharyngeal longitudinal muscles

- **If pharyngeal clearance is reduced, residue remains behind**

HOW TO VIEW/ RATE PHARYNGEAL CLEARANCE ON FEES

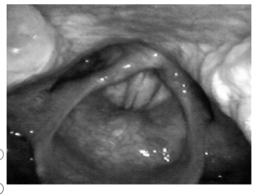
Pharyngeal squeeze – Part 1 or during swallowing

White out duration

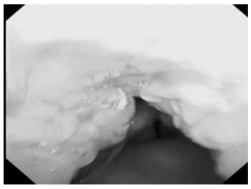
Residue – amount and location

VIEWING PHARYNGEAL CONTRACTION/ SQUEEZE ON FEES

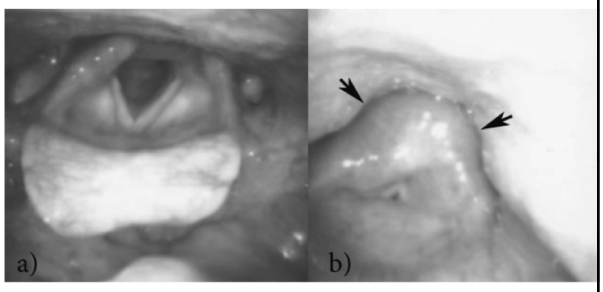
PART 1 OF PROTOCOL



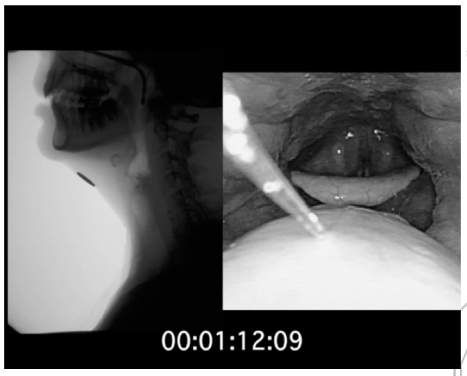
PART 1 OF PROTOCOL



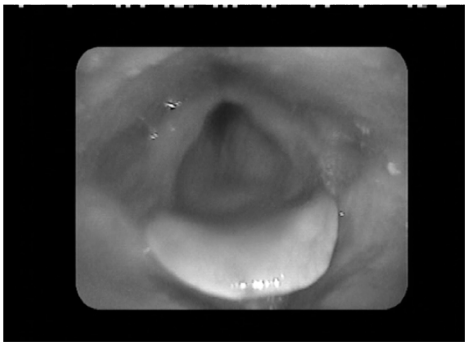
PSM FROM FULLER ARTICLE



VIEWING SUPERIOR PHARYNGEAL CONSTRICTORS DURING THE SWALLOW



INCOMPLETE PHARYNGEAL AND EPIGLOTTIC MOVEMENT (POST CRT)



WHITE OUT CORRESPONDS TO AIRSPACE CLOSURE

COMPLETE WHITE OUT

INCOMPLETE WHITE OUT

DURATION OF WHITE OUT = DURATION OF COMPLETE AIR SPACE CLOSURE

(PHARYNGEAL) RESIDUE IS A SURROGATE MEASURE FOR PHARYNGEAL CLEARANCE

- Residue helps you localize the problem and reflects the severity of the problem

THE LOCATION OF THE RESIDUE MARKS THE ORIGIN OF REDUCED FORCE

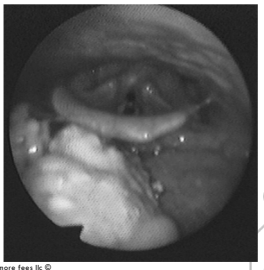
- **Upper pharynx/ Nasopharynx** = Levator; Superior constrictor – inserts into lateral tongue and palate
- **Base of tongue** – intrinsic and extrinsic tongue muscles; suprahyoids; middle pharyngeal constrictors
- **Mid pharynx/ valleculae** = Middle pharyngeal constrictor inserts into hyoid at level of valleculae; hyolaryngeal excursion
- **Lower pharynx/ piriforms;** Inferior constrictor inserts into thyroid and cricoid cartilages at level of piriforms

MANOMETRY AND RESIDUE

- Manometry is the 'gold standard' – identifying where the pharyngeal pressures are higher, lower
- **The location of the residue indicates where the pressures were reduced/ incomplete**
  - Verified by several research studies
  - **So rating impairment from amount and location of residue is valid!**

WHAT DOES RESIDUE ON BASE OF TONGUE MEAN?

- What has not moved adequately / generated enough force?



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RESIDUE IN VALLECULA

Why is there residue in the vallecula?

- What has not moved adequately / generated enough force?
  - Epiglottis
  - Hyolaryngeal excursion
  - Base of tongue
  - Middle pharyngeal constricgor
  - Long pharyngeal muscles

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RESIDUE IN PIRIFORMS

- Why is there residue in the piriforms?
- What has not moved adequately / generated enough force?
  - Inferior pharyngeal constrictor and pharyngeal elevators (longitudinal muscles)
- FEES can also specify residue in the lateral channels (superior portion of the piriforms)

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RESIDUE IN PIRIFORMS COULD BE DUE TO TIGHT UES:

WHAT OPENS THE UES?

- HYOLARYNGEAL EXCURSION AND PHARYNGEAL ELEVATORS
  - SUPRAHYOID MUSCLES
  - THYROHYOID
  - LONG PHARYNGEAL MUSCLES

PROBLEM #3: VP VALVING,, LARYNGEAL VALVING

- Valving
  - VP Valving, VPI
    - **BOLUS regurgitates up to the nasal cavity**

TODAY: Laryngeal Valving (airway closure)

- **BOLUS seen in the laryngeal vestibule and/or beneath the glottis**

SCORING PENETRATION & ASPIRATION

- Before, during, or after the swallow?
- How deep? What was the patient's response?
  - Rosenbek's 8-Point Penetration/Aspiration Scale (1996)[1] applied to endoscopy by Colodny (2002)[2]

[1] Rosenbek JC, Robbins JA, Roecker EB, Coyle JL, Wood JL. A penetration-aspiration scale. Dysphagia. 1996;11(2):93-98.

[2] Colodny N. Interjudge and Intrajudge Reliabilities in Fiberoptic Endoscopic Evaluation of Swallowing (Fees) Using the Penetration-Aspiration Scale: A Replication Study. Dysphagia. 2002;17(4):308-315.

PENETRATION-ASPIRATION SCALE

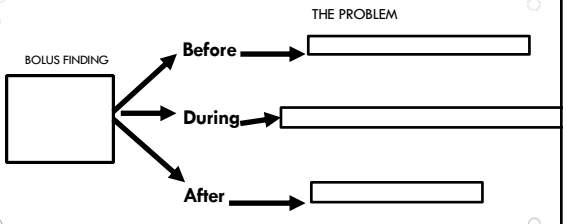
- Colodny **2002 -Interrater reliability of PAS with FEES –** equivalent to MBS findings of Rosenbek (1996)
- Butler – **excellent IRR** for 35 swallows with FEES (older)
- Kelly – 2007 – compared PAS with FEES compared to MBS
  FEES gave higher (worse) scores than MBS; all scores except PAS of 3

Conclusions: FEES ratings are just as reliable as MBS - but scores may be different! (tend to be worse)

INTERPRETING ASPIRATION

- "*When does the Airway Fail to close*"?
- *"When did the aspiration occur?"*

INTERPRETING PENETRATION & ASPIRATION



DID PENETRATION /ASPIRATION OCCUR **BEFORE** THE SWALLOW?

If before the swallow begins - or just at the initiation of the swallow then ***due to mistiming***

- **The BOLUS spilled into the vestibule (penetration) and possibly into the airway (aspiration) before the airway closed off**

ASPIRATION *DURING* THE SWALLOW

- **IS *due to reduced/ incomplete/ slow laryngeal valving during the swallow***
- By the time whiteout occurs, the laryngeal valve should be closed;
- The bolus has leaked into the laryngeal vestibule because it was not closed tightly
- You see evidence of penetration/aspiration after the swallow

IF YOU SUSPECT ASPIRATION DURING THE SWALLOW…….

1. Look for evidence: coating or residue left behind in the laryngeal vestibule or on the subglottic shelf
2. Ask the patient to cough if aspiration suspected

   Is Green material coughed up?

   Was the thin liquid bolus bright white + green?

SORTING OUT INCOMPLETE LARYNGEAL CLOSURE VS DELAYED LARYNGEAL CLOSURE?

1. IF **NO** PENETRATION IS seen before the swallow begins, but penetration and/or aspiration occur during the swallow

   → laryngeal valving *is incomplete/reduced*

2. IF PENETRATION is seen before white out,

   →laryngeal valving is *delayed (and, of course, could also be incomplete)*

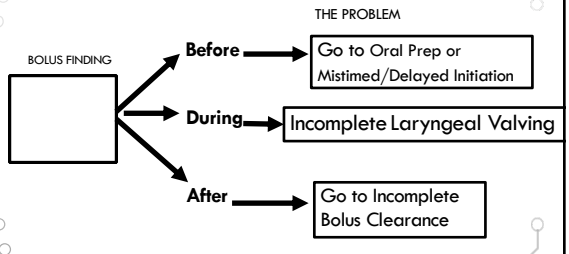
DID PENETRATION/ ASPIRATION OCCUR **AFTER** THE SWALLOW?

- **Penetration and aspiration can occur after the swallow** (when the airspace re-opens)
  - *from* residue in the pharynx that overflows into the laryngeal vestibule and/or below the vocal folds as the airway opens up

Another scenario:

- Penetration may occur during the swallow due to incomplete laryngeal valving – but no aspiration occurs until after the swallow
  - IF the VCs were tightly closed during the swallow – and then open up after the swallow

INTERPRETING PENETRATION & ASPIRATION



AIRWAY CLOSURE OCCURS IN THIS ORDER (OVERLAPPING)

- Arytenoids tilt forward to contact petiole of epiglottis and cover glottis
- The epiglottis retroflexes and covers the arytenoids
- True vocal folds adduct to seal the glottis
- Different from breath hold

LARYNGEAL AIRWAY VALVE CLOSURE

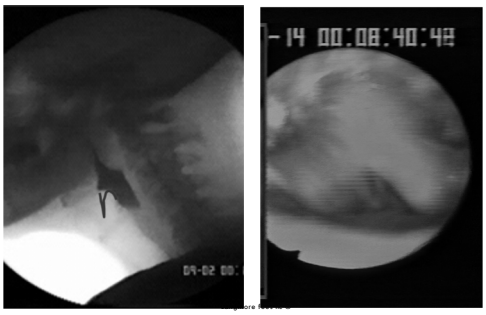
Fluoroscopy: look for…

1. Arytenoids tilt forward to touch base of the epiglottis
2. Epiglottis retroflexion
3. (TVC adduction – partial from AP view)

FEES: look for…

1. Arytenoids tilt forward to touch base of epiglottis
2. Epiglottis retroflexion – view return to rest
3. Airway/glottic closure - from Part 1

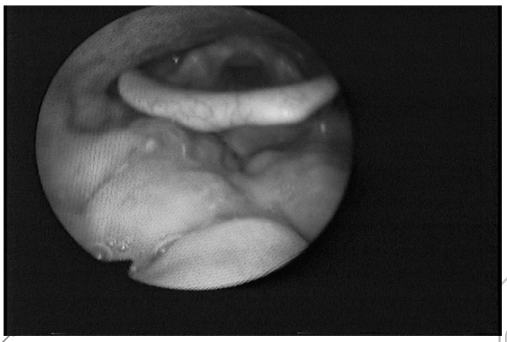
ARYTENOID TO BASE OF EPIGLOTTIS - NOT ALWAYS SEEN ENDOSCOPICALLY



EPIGLOTTIC RETROFLEXION IS TIED TO HYOLARYNGEAL EXCURSION

- *It causes it to retroflex*
- Van Daele study
  - Van Daele DJ, Intrinsic fibre architecture and attachments of the human epiglottis and their contributions to the mechanism of deglutition. J Anat, 1995

EPIGLOTTIC INVERSION –WITH MANUAL LIGHT SETTING



GLOTTIC CLOSURE

- True vocal cords adduct
- Judge glottic closure from from breath tasks

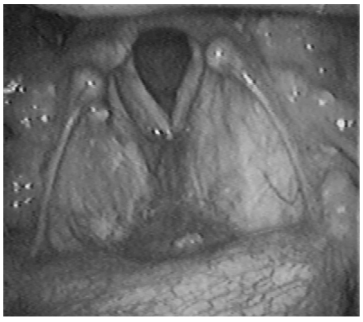
WHICH COMPONENT OF LARYNGEAL VALVING WAS INCOMPLETE?

- Hyolaryngeal excursion (arytenoids and/or epiglottis)

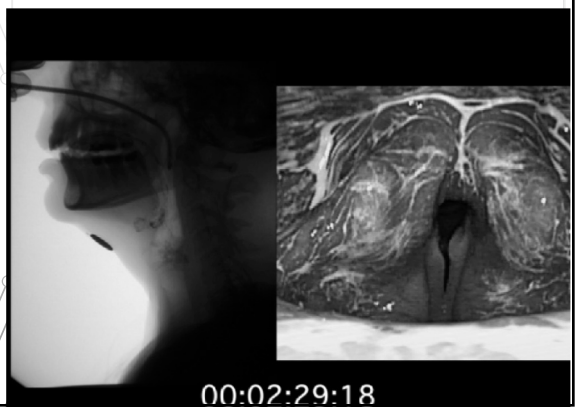
or

- Reduced VC adduction

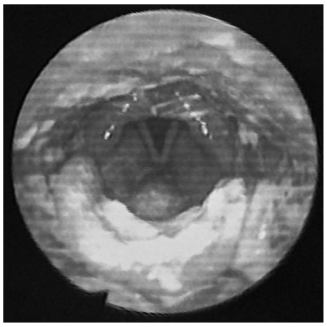
WHAT DIDN'T CLOSE?



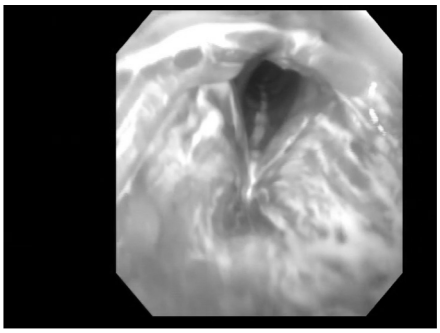
WHAT DIDN'T CLOSE?



WHAT DIDN'T CLOSE?



WHAT DID NOT CLOSE?



VIDEOS:

Aspir Bef 15ml thin

ICU patient

Aspir Dur thin 1010

ICU patient

Aspir Bef Dur Delay WeakSw CVA BrStemVirg.

Brain stem CVA

Aspir Dur XRT+ VC sx 27 sec

- *Surgery on vocal cords and RT to entire larynx*

Aspir after 2049

ICU patient

- *Aspir Bef dur After food residue 40 sec*
  - *HNC RT*