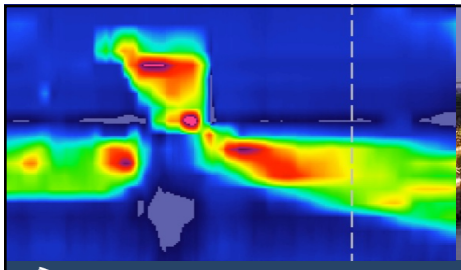


MUSC Health Medical University of South Carolina

The Charleston Pharyngoesophageal Manometry Program • April 7 – 8, 2023 • Charleston, SC

Abnormal Swallowing: Utilization of Pharyngeal Manometry

Ashli K. O'Rourke, M.S., M.D.

Associate Professor, Director of Laryngology
Mark & Evelyn Trammell Endowed Chair in Otolaryngology
Department of Otolaryngology – Head and Neck Surgery
Medical University of South Carolina

Outline

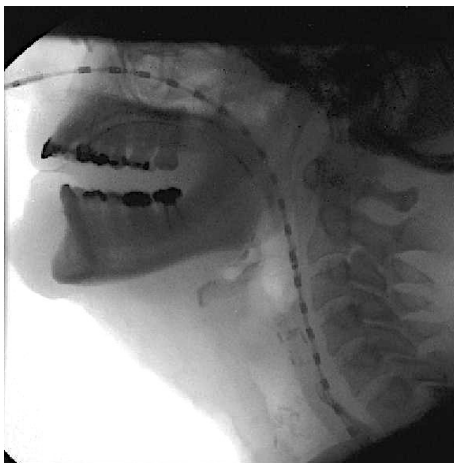
- Background
- Diagnostic Metrics

Outline

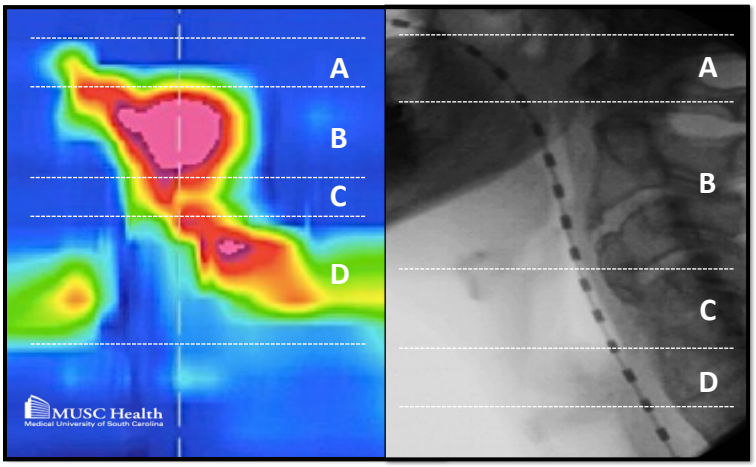
- **Background**
- Diagnostic Metrics

High Resolution Pharyngeal Manometry

- Pharyngeal muscle contraction
  - Quantitative assessment
  - Composite information
  - Intrabolus pressures
- Upper Esophageal Sphincter
  - Quantitative assessment
  - Coordination & Timing
  - Relaxation duration
  - Relaxation pressures



Manometric Regions



A) Velopharynx Region
- Soft palate
- Superior pharyngeal constrictors

B) Mesopharyngeal
- Tongue base
- Inferior pharyngeal constrictors
- Middle pharyngeal constrictors

C) Hypopharynx Region
- Inferior pharyngeal constrictors

D) UES Region
- Pharyngoesophageal segment

Outline

- Background
- **Diagnostic Metrics**

DIAGNOSTIC METRICS

Dysphagia
https://doi.org/10.1007/s00455-019-10023-y

ORIGINAL ARTICLE

High-Resolution Pharyngeal Manometry and Impedance: Protocols and Metrics—Recommendations of a High-Resolution Pharyngeal Manometry International Working Group

Taher I. Omari[1] · Michelle Ciucci[2] · Kristin Gozdzikowska[3] · Ester Hernández[3] · Katherine Hutcheson[4] · Corinne Jones[2] · Julia Maclean[5] · Nogah Nativ-Zeltzer[6] · Emily Plowman[7] · Nicole Rogus-Pulia[2] · Nathalie Rommel[8] · Ashli O'Rourke[9]

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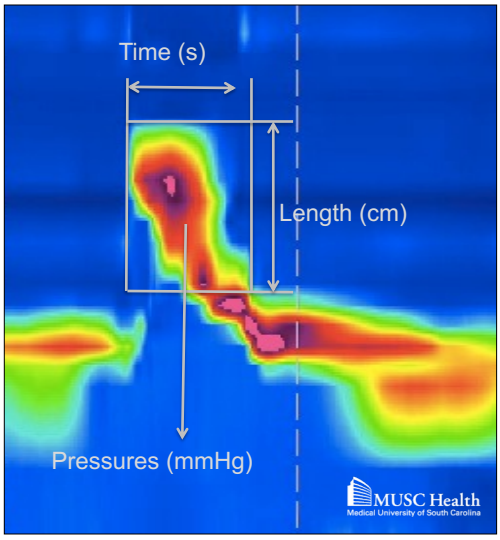
Pharyngeal Contractile Integral

An integral is a mathematical term that represents an area or a generalization of an area.



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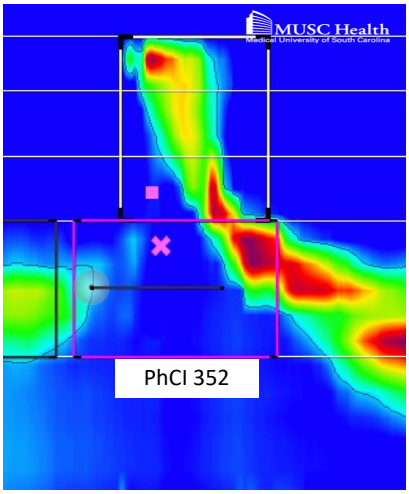
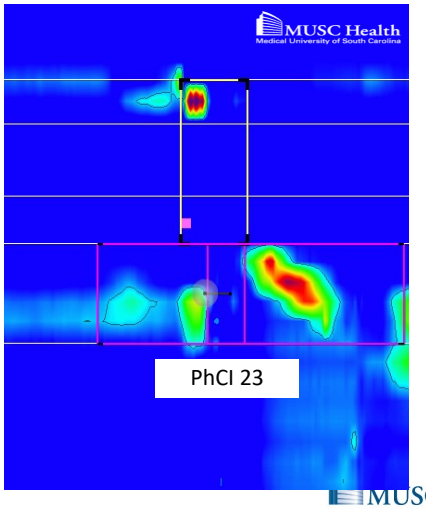
Illustrative Examples of Pharyngeal Contractile Integral (PhCI)





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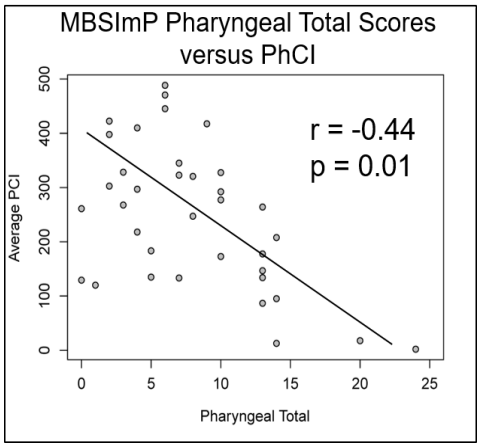
The Relationship Between PhCI & Findings on Videofluoroscopy



- Worsening MBS ImP Pharyngeal Total scores correlated with decreased pharyngeal contractility (PhCI).
- PAS scores for thin liquids were significantly different between low & High PhCI groups.

Table 2: Comparison of Penetration Aspiration Scale Results by Pharyngeal Contractile Integral Groups

	Overall	Thin	Nectar	Honey	Pudding	Solid
Higher PCI Group	1.21	1.44	1.28	1.11	1.11	1.11
Lower PCI Group	1.99	3.78	2.29	1.27	1.00	1.07
p value	0.03	0.01	0.06	0.05	0.80	0.97

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O'Rourke, Lazar, Humphries, Martin-Harris 2017 Neurogastroenterology & Motility

The Relationship Between PhCI & Findings on Videofluoroscopy

- 47 records from 25 females and 22 males with a mean age of 62 (range 28-86)
- Overall mean PhCI = **172.2 mmHg·s·cm** (range 5.5-1050.9)

Table 1. Differences in Pharyngeal Contractile Integral based on Residue Presence

	Residue Median [IQR] Mean ± SD	No Residue Median [IQR] Mean ± SD	p-value
Thin			
Valleculae	80.4 [57.3-176.8] 102.7 ± 65.1	159 [104.2-236.4] 192.7 ± 167.6	**0.013**
Pyriforms	159 [111.0-224.8] 97.6 ± 73.5	78.7 [54.5-137.4] 189.0 ± 163.4	**0.013**
Nectar			
Valleculae	137.2 [85.0-184.2] 132.1 ± 62.7	183.3 [129.7-219.9] 172.2 ± 79.9	**0.007**
Pyriforms	87.3 [66.0-121.2] 96.1 ± 46.1	164.9 [119.8-217.7] 185.3 ± 132.6	0.052
Pudding			
Valleculae	195.8 [132.0-258.3] 126.9 ± 82.2	118.4 [68.8-181.6] 195.3 ± 89.7	**0.016**
Pyriforms	85.6 [62.4-196.6] 123.3 ± 34.2	185.2 [141.5-236.5] 70.3 ± 12.4	**0.012**

Table 2. Threshold Pharyngeal Contractile Integral (PhCI) for residue clearance

	Threshold PhCI (mmHg·s·cm)	R^2	p-value
Thin			
Valleculae	173.3	0.0020	<0.0001
Pyriforms	177.9	0.0224	<0.0001
Nectar			
Valleculae	162.0	0.0279	<0.0001
Pyriforms	175.9	0.0466	<0.0001
Pudding			
Valleculae	186.6	0.1023	<0.0001
Pyriforms	185.9	0.0751	<0.0001

Hamberis, Davidson, Zhao, Nguyen, O'Rourke
Presented Am. Academy Otolaryngology 2019
Unpublished data.
2.7 mm Medtronic catheter; Manoscan software

Accuracy of High-Resolution Pharyngeal Manometry Metrics for Predicting Aspiration and Residue in Oropharyngeal Dysphagia Patients with Poor Pharyngeal Contractility

Howell Henrian G. Bayona, Nicole Pizzorni, Jan Tack, Ann Goeleven, Taher Omari & Nathalie Rommel

Aspiration

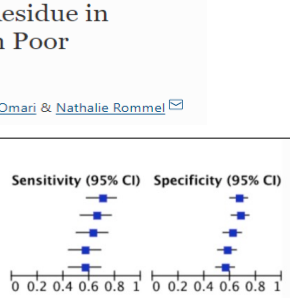
HRPM Metric	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
HypoPeakP < 42	47	65	20	131	0.70 [0.58, 0.81]	0.67 [0.60, 0.73]
SRI > 8.7	44	63	23	133	0.66 [0.53, 0.77]	0.68 [0.61, 0.74]
PCI < 63	42	75	25	121	0.63 [0.50, 0.74]	0.62 [0.55, 0.69]
MCI < 36	38	83	29	113	0.57 [0.44, 0.69]	0.58 [0.50, 0.65]
VCI < 44	38	86	29	110	0.57 [0.44, 0.69]	0.56 [0.49, 0.63]

Residue – Pyriform Sinuses

HRPM Metric	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
HypoPeak < 46	79	48	37	99	0.68 [0.59, 0.76]	0.67 [0.59, 0.75]
SRI > 7.5	77	45	39	102	0.66 [0.57, 0.75]	0.69 [0.61, 0.77]
UES–IRP > 3	69	57	47	90	0.59 [0.50, 0.68]	0.61 [0.53, 0.69]
VCI < 46	68	60	48	87	0.59 [0.49, 0.68]	0.59 [0.51, 0.67]
PCI < 77	65	61	51	86	0.56 [0.47, 0.65]	0.59 [0.50, 0.67]

Residue – Valleculae

HRPM Metric	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
MCI < 43	88	47	56	72	0.61 [0.53, 0.69]	0.61 [0.51, 0.69]
HypoPeak < 49	87	47	57	72	0.60 [0.52, 0.68]	0.61 [0.51, 0.69]
SRI > 6.5	86	49	58	70	0.60 [0.51, 0.68]	0.59 [0.49, 0.68]
PhCI < 168	85	49	59	70	0.59 [0.51, 0.67]	0.59 [0.49, 0.68]
VCI < 49	84	49	60	70	0.58 [0.50, 0.66]	0.59 [0.49, 0.68]



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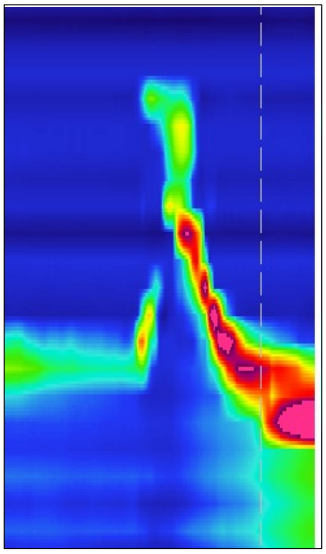
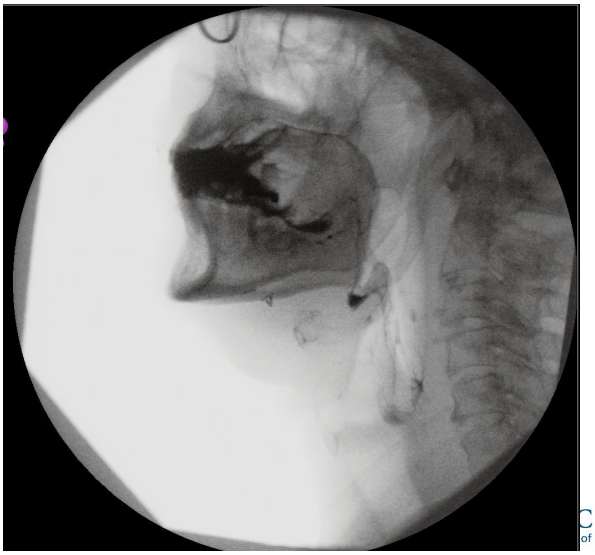
Bayona et al. Dysphagia. 2022 Feb 19. Epub ahead of print.
3.2 mm Unisensor catheter, MMS/Laborie Solar GI System Acquisition software, SwallowGateway Analysis Software)

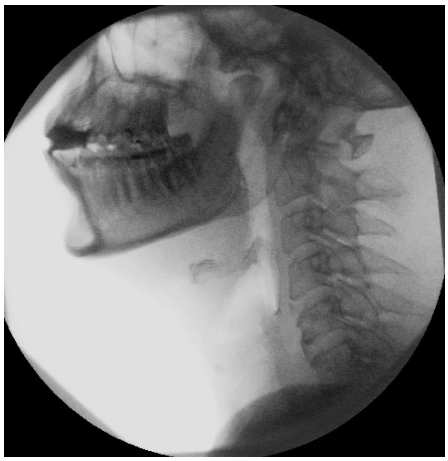
VPI/MCI Deficits



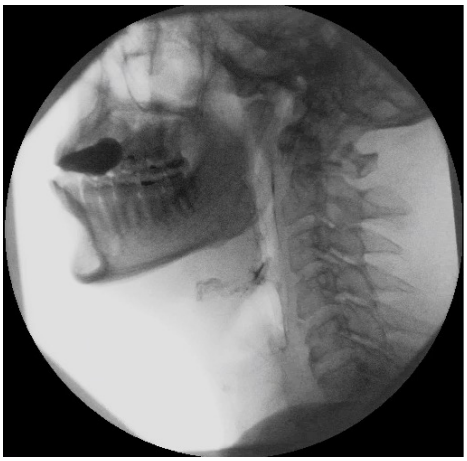


C Health
of South Carolina

Feeling of an Effortful Swallow
Status Post UPPP



Thin Liquid



Puree

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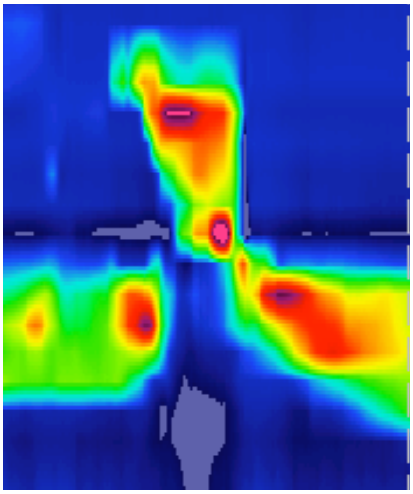
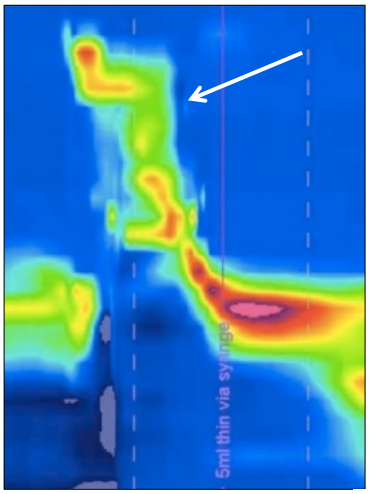
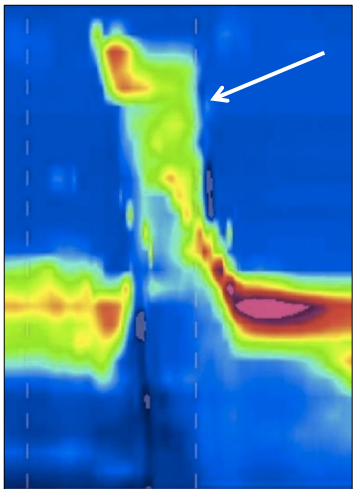
Oropharyngeal Dysphagia
Mesopharyngeal Contractile Deficits



Normal Comparison
Thin Liquid

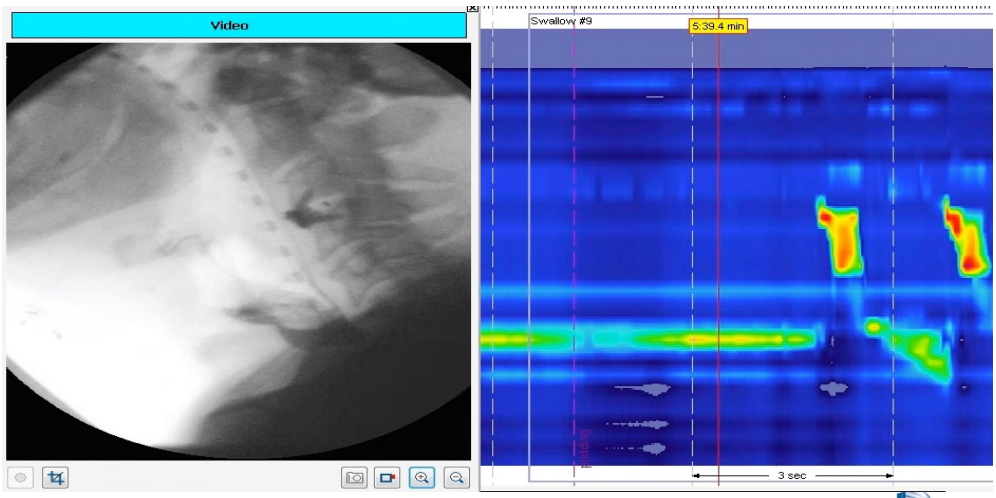


Patient
Thin Liquid



Patient
Puree

Hypopharyngeal Deficits



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METRICS

Dysphagia
https://doi.org/10.1007/s00455-019-10023-y

ORIGINAL ARTICLE

High-Resolution Pharyngeal Manometry and Impedance: Protocols and Metrics—Recommendations of a High-Resolution Pharyngeal Manometry International Working Group

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Metric	Acronym
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UES maximum admittance	UES MaxAd
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UES integrated relaxation pressure (UES IRP):
The lowest non-consecutive 0.20–0.25 s of UES pressure during relaxation.

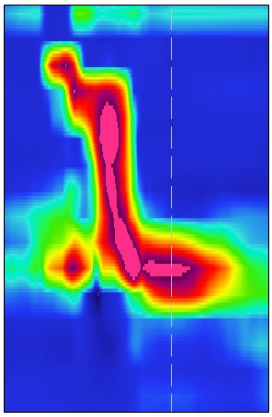
UES Relaxation Time (UES RT):
The duration of UES relaxation the pressure interval below 50% of baseline or 35 mmHg, whichever is lower, measured in units of seconds.

Metric	Acronym
UES integrated relaxation pressure	**UES IRP**
UES relaxation time	**UES RT**
UES maximum admittance	UES MaxAd
Hypopharyngeal intrabolus pressure	IBP

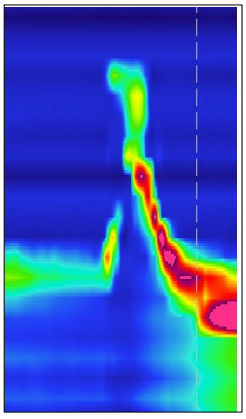
UES Dysfunction

Esophagram

HRM



After CP Myotomy



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Are our interventions improving swallowing?

Head Neck. 2018 Jan;40(1):203-212. doi: 10.1002/hed.24977. Epub 2017 Oct 30.

Swallowing outcomes after cricopharyngeal myotomy: A systematic review.

Knigge MA[1], Thibeault SL[2].

⊕ **Author information**

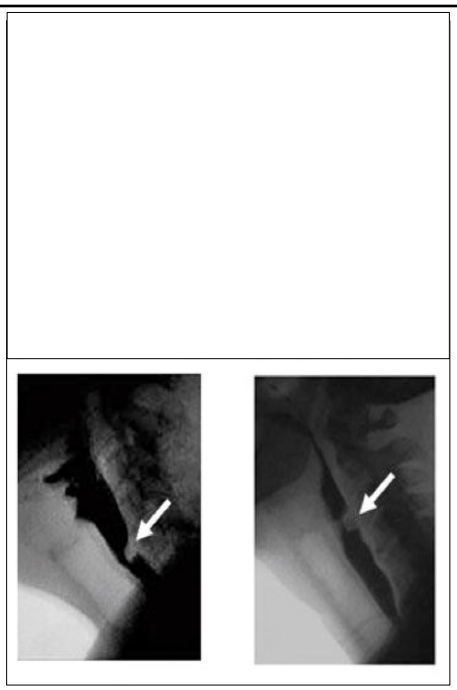
Abstract

BACKGROUND: No practice guidelines have been established for swallowing outcomes after cricopharyngeal myotomy (CPM). The purpose of this systematic review was to summarize evidence for swallowing outcomes in patients undergoing CPM to treat symptomatic cricopharyngeal dysfunction, in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) protocol.

METHODS: Swallowing outcomes examined included penetration/aspiration ratings, manometric measures, patient-rated dysphagia scales, clinician-rated dysphagia scales, diet level, and weight.

RESULTS: Three databases were queried for studies published between January 1995 and July 2015, resulting in a total of 122 full-text eligible records. Studies were screened and reviewed, culminating in 10 studies meeting inclusion criteria. Critical appraisal of study design, swallowing outcomes measures, and statistical analysis were summarized.

CONCLUSION: This systematic review revealed insufficient evidence for guiding clinical practice. Future investigations should use validated patient-rated and clinician-rated instruments as well as detailed high-resolution manometry measures to optimally capture postoperative swallowing outcomes.

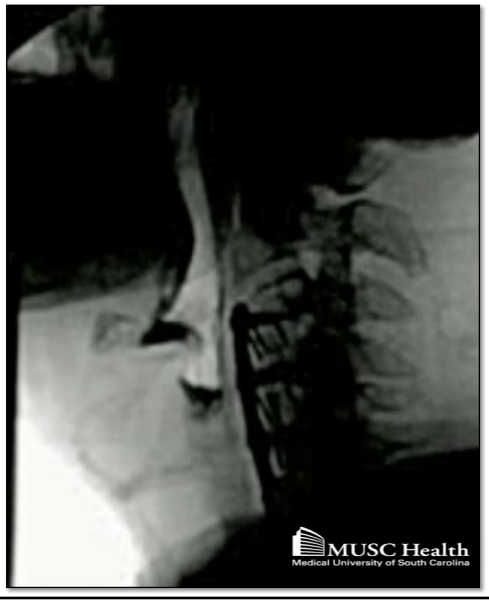


Corinne Jones, PhD

MUSC Health
Medical University of South Carolina

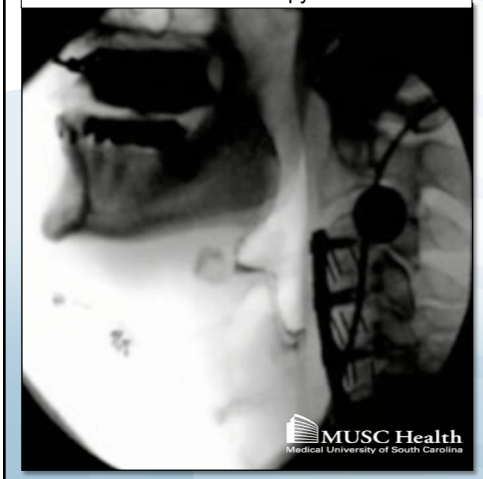
Case Example: Patient referred for cricopharyngeal myotomy.

- Dysphagia following cervical spine fusion > 3 months prior.
- Coughing while eating and effortful swallowing.
- 15 lb. weight loss, two recent episodes of pneumonia.
- Soft diet, nectar liquids.
- We performed HRM-FEES
  - Patient had 3 previous MBSS
  - Determine safety of swallow (evaluate for airway protection)

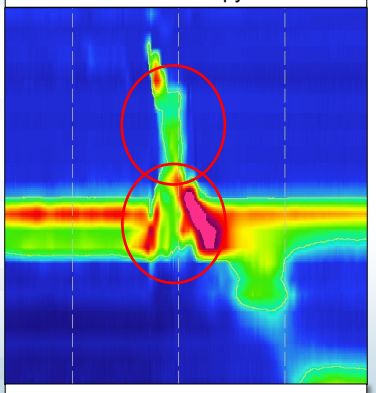


Targeted Swallowing Therapy

Post-Therapy

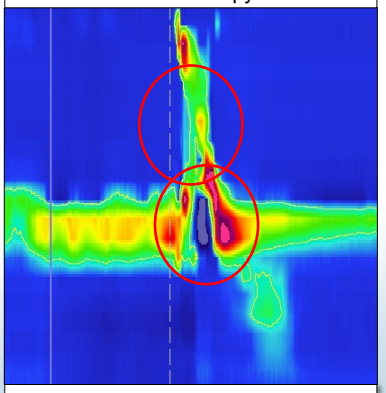


Pre-Therapy



PhCI: 154 mmHg-cm-s
UES Opening Duration: 140 ms
UES IRP: 27

Post-Therapy



PhCI: 334 mmHg-cm-s
UES Opening Duration: 350 ms
UES IRP: 3

METRICS

Dysphagia
https://doi.org/10.1007/s00455-019-10023-y

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UES maximum admittance	**UES MaxAd**
Hypopharyngeal intrabolus pressure	**IBP**

High Resolution Manometry with Impedance

Manometry

- Measures intraluminal pressure changes caused by muscular contraction and relaxation
- Measured in mmHg

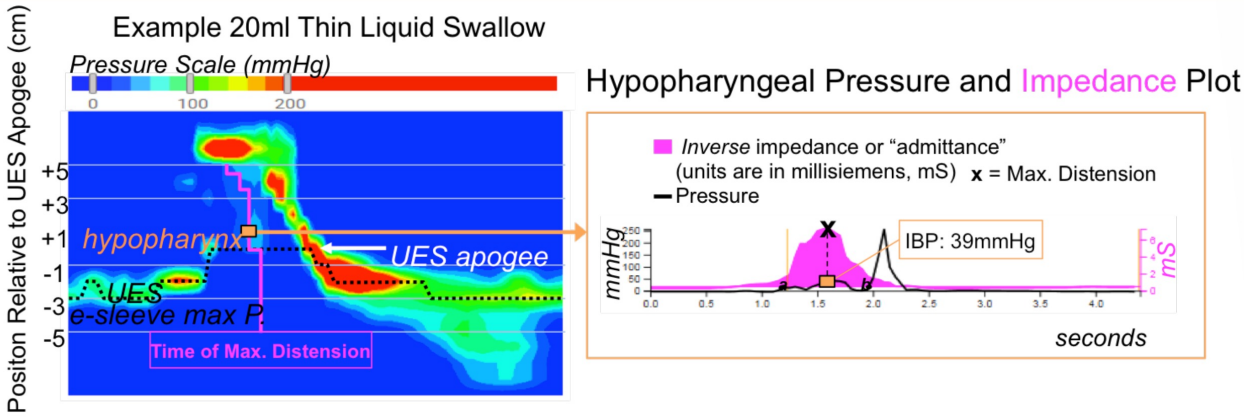
Impedance

- Measures the resistance to electrical current flow in the GI tract
- Impedance changes due to the electric conductivity of digestive contents
- Measured in ohms

Admittance

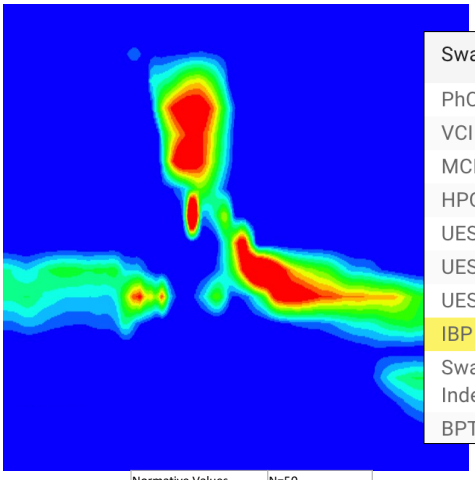
- It is the inverse of impedance and thus, how easily flow is allowed
- Surrogate for distention
- Measured in milliSiemens

Hypopharyngeal Intrabolus Pressure

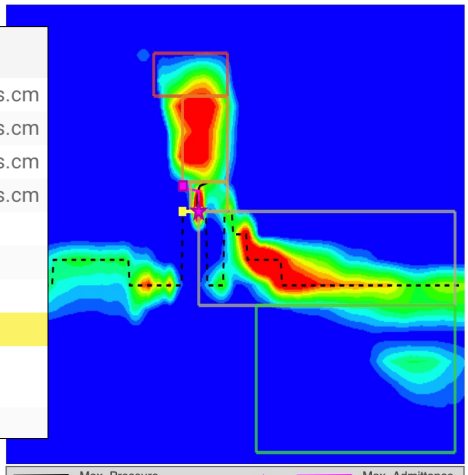


hIBP is pressure 1cm superior of UES apogee position at the time of maximum hypopharyngeal distension deduced from impedance topography.

Increased Hypopharyngeal Intrabolus Pressure



Swallow Properties		
PhCI	349.00	mmHg.s.cm
VCI	74.24	mmHg.s.cm
MCI	236.76	mmHg.s.cm
HPCI	38.00	mmHg.s.cm
UES IRP	148.67	mmHg
UES RT	0.11	s
UES Max Adm	0.71	mS
IBP	38.74	mmHg
Swallow Risk Index	3.77	
BPT	0.25	s



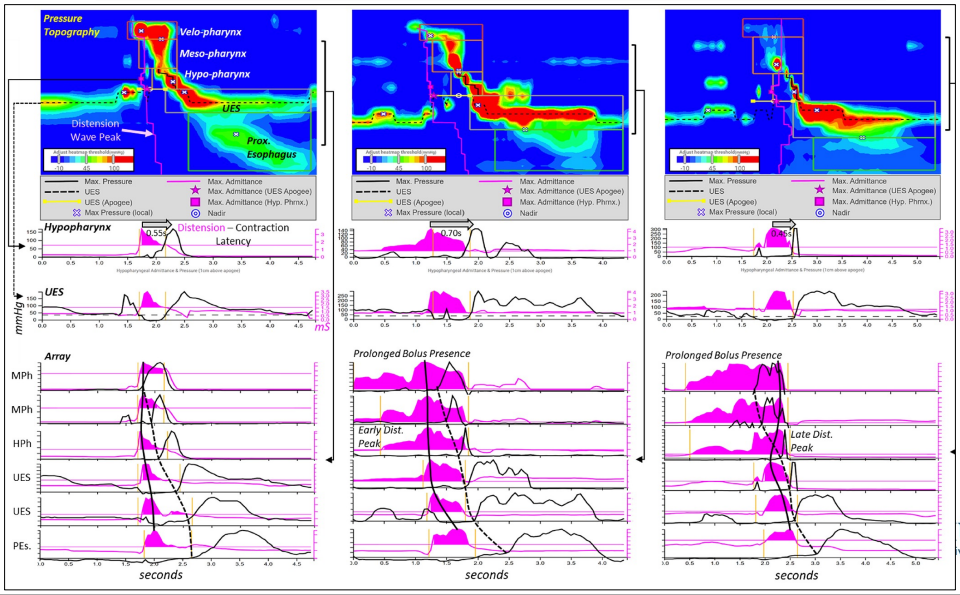
Normative Values	N=50
5 ml L	–1–22
10 ml L	–1–28
5 ml V	–2–23
10 ml V	–2–21

www.swallowgateway.com

Distension contraction plots of pharyngeal/esophageal peristalsis: next frontier in the assessment of esophageal motor function

Am J Physiol Gastrointest Liver Physiol 323: G145–G156, 2022.

Taher I. Omari,[1] Ali Zifan,[2] Charles Cock,[3] and Ravinder K. Mittal[2]



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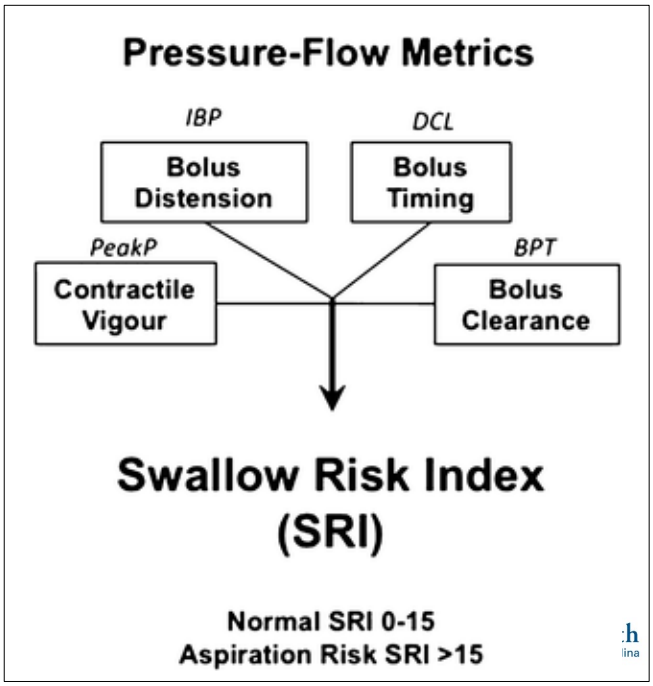
Swallow Risk Index

SRI=(FI × PNadImp)/(PeakP × (TNadImp-PeakP+1)) × 100

Higher SRI = greater aspiration risk

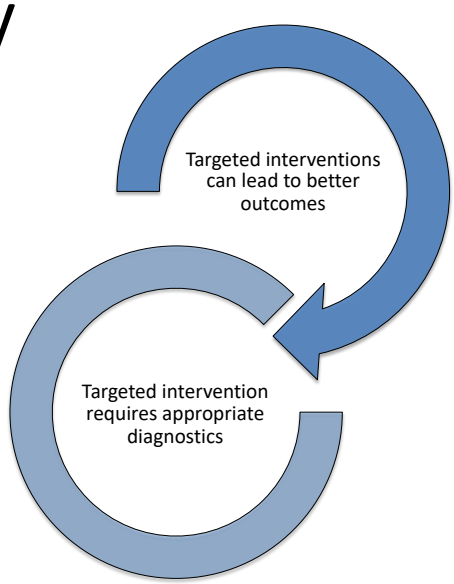
Cock, C., Omari, T. Diagnosis of Swallowing Disorders: How We Interpret Pharyngeal Manometry. *Curr Gastroenterol Rep* **19,** 11 (2017).

Omari TI,, et al. A method to objectively assess swallow function in adults with suspected aspiration. Gastroenterology. 2011;140:1454–63.



Summary

- HRPM can be a helpful adjuvant tool in the evaluation of dysphagia.
- Currently not a stand alone assessment.
  - Risk assessments
  - Impedance measurements give promising information
- Has diagnostic and therapeutic benefits.



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