The Clinical Utility of High Resolution Pharyngeal Manometry

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Disclosures

- Consultant, Medtronic Inc.
- Advisory Board Member, Carolina Speech Services
- Salary from MUSC
- No compensation for this presentation

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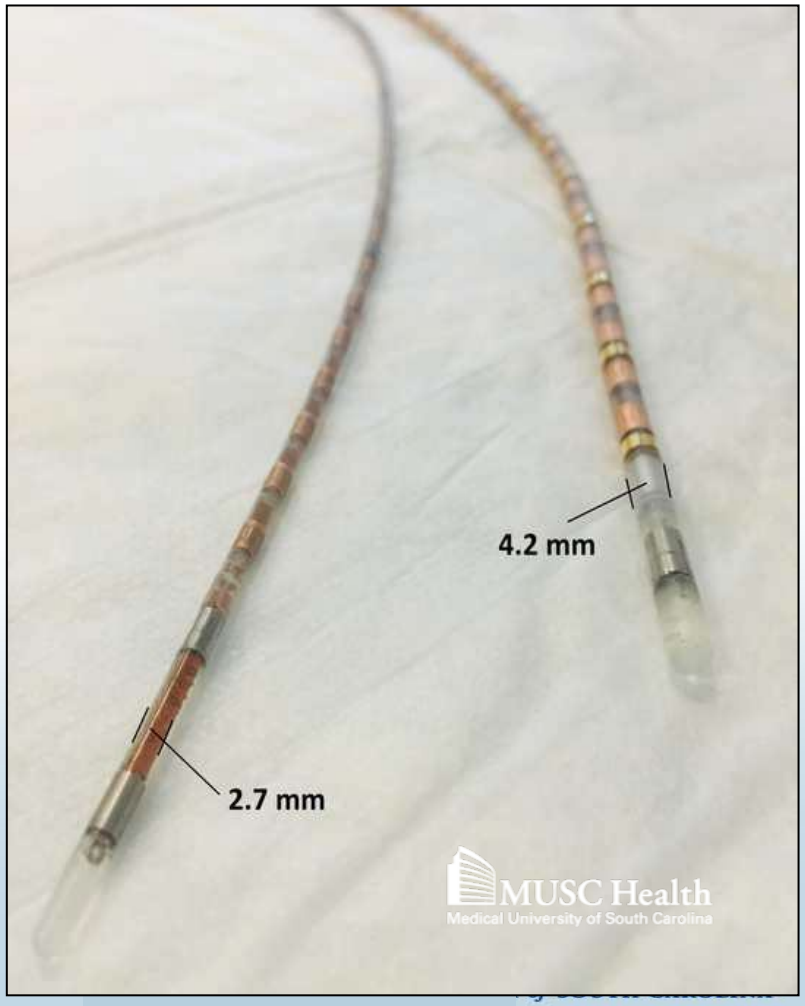
Outline

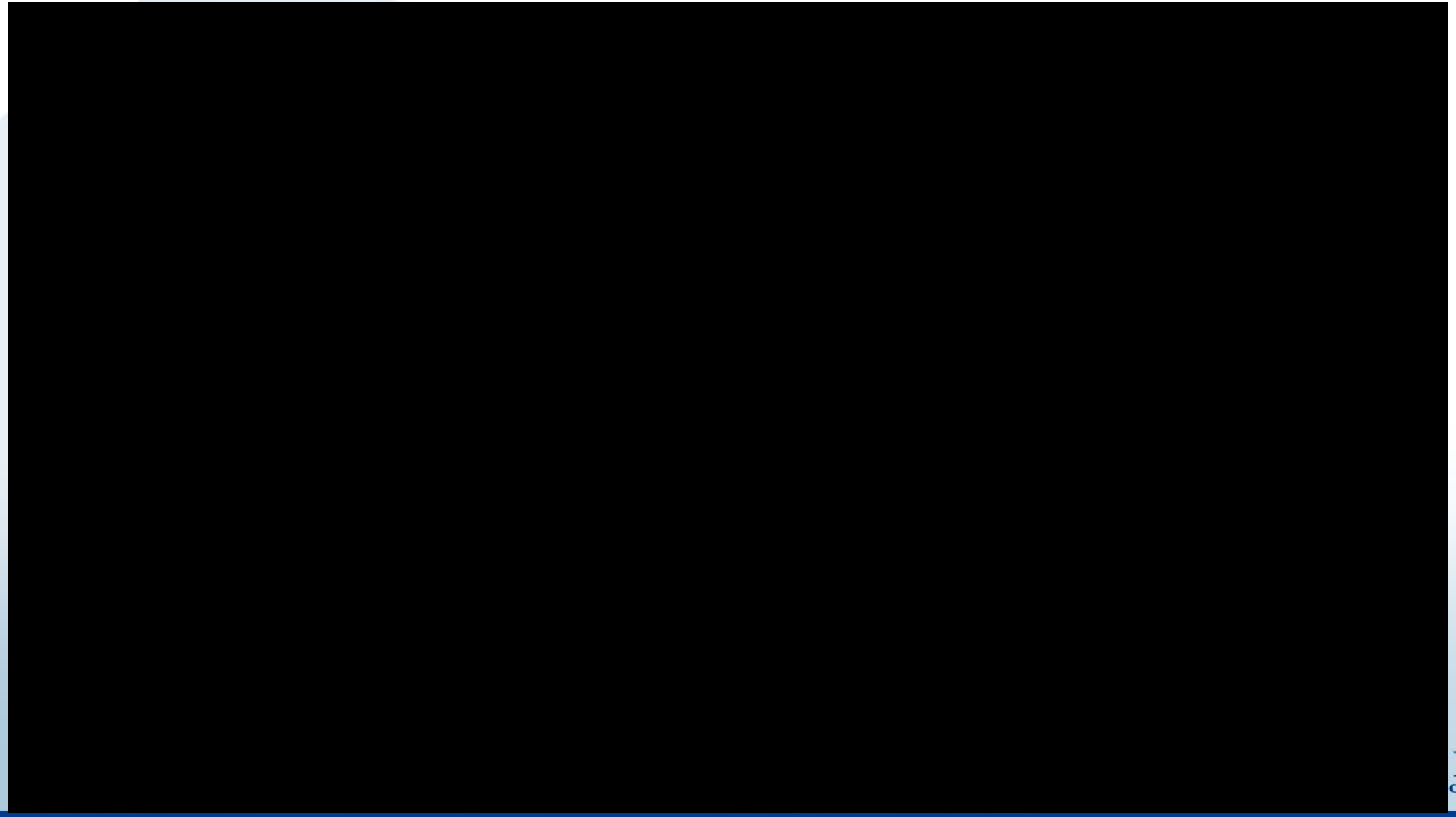
- Introduction to high resolution pharyngeal manometry (HRPM)
- Incorporation of HRPM into Clinical Practice
  - Adjuvant Diagnostic Tool
  - Therapeutically for Biofeedback
  - Assess Efficacy of Interventions

What is *High Resolution* Manometry?

- A catheter placed trans-nasally
- Sensors along catheter measure intraluminal pressures
- Solid state catheter
- At least 10 contiguous sensors, no more than 1 cm apart (pharynx)
  - Most catheters have 36 sensors
  - Sensors can be unidirectional or circumferential
- Can include impedance (but doesn't have to)

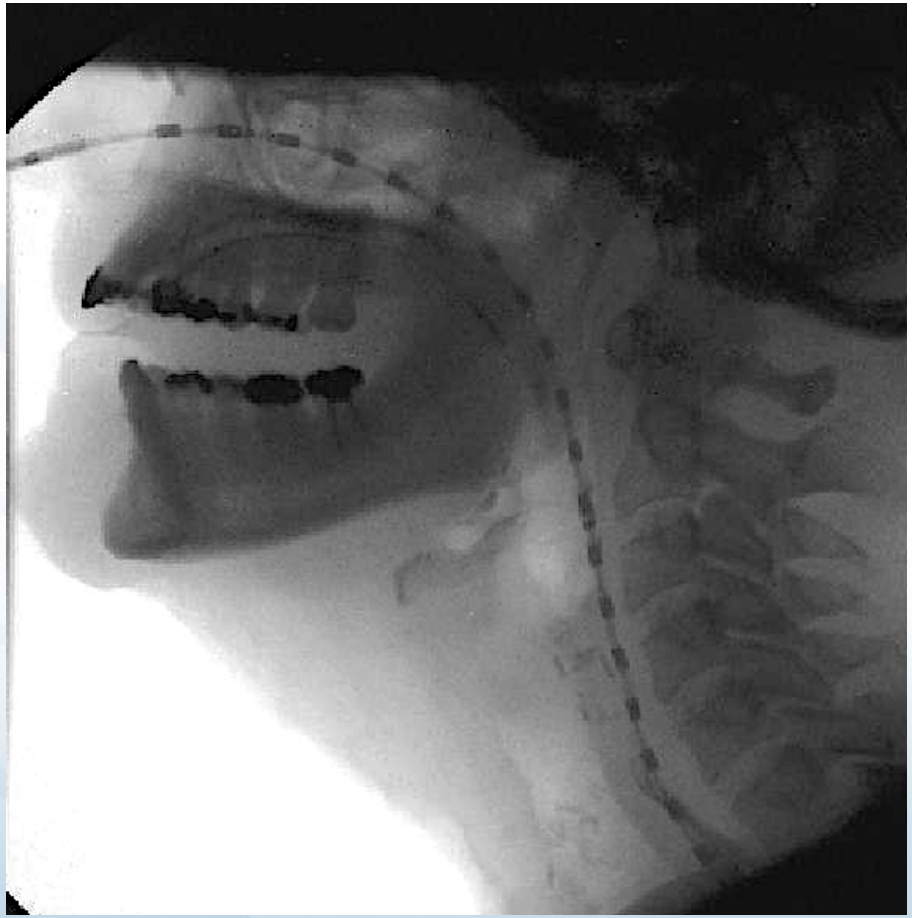


Overview of the Procedure



High Resolution Pharyngeal Manometry

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



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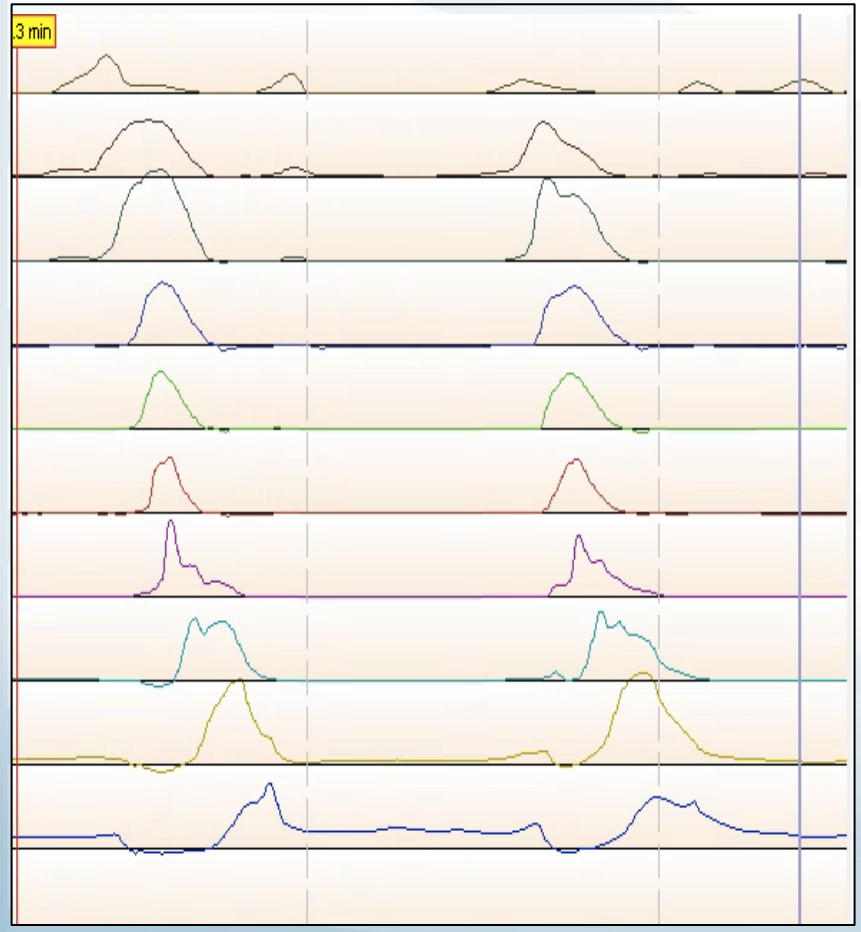
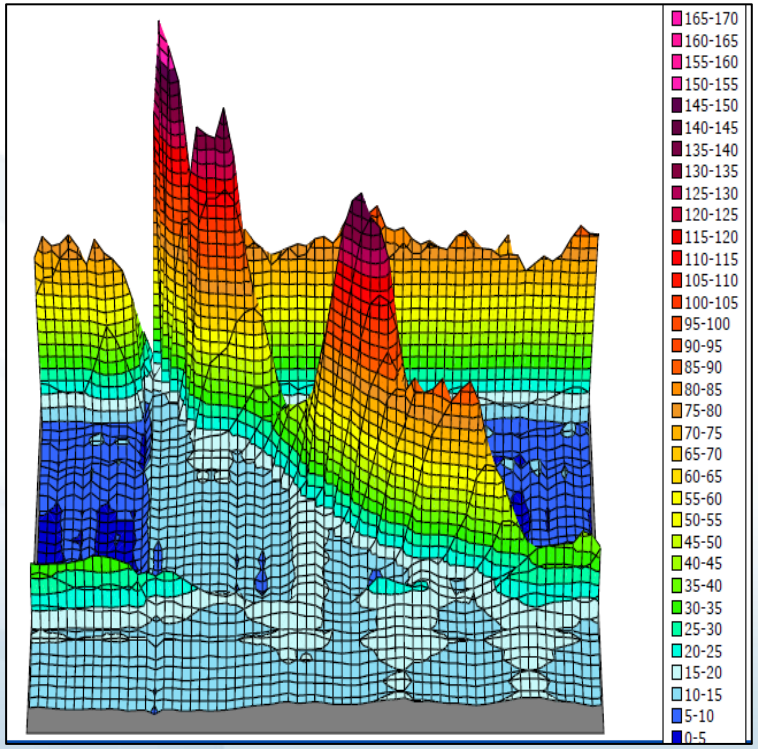
Topographical Pressure Plots
Clouse et al AJP 1996





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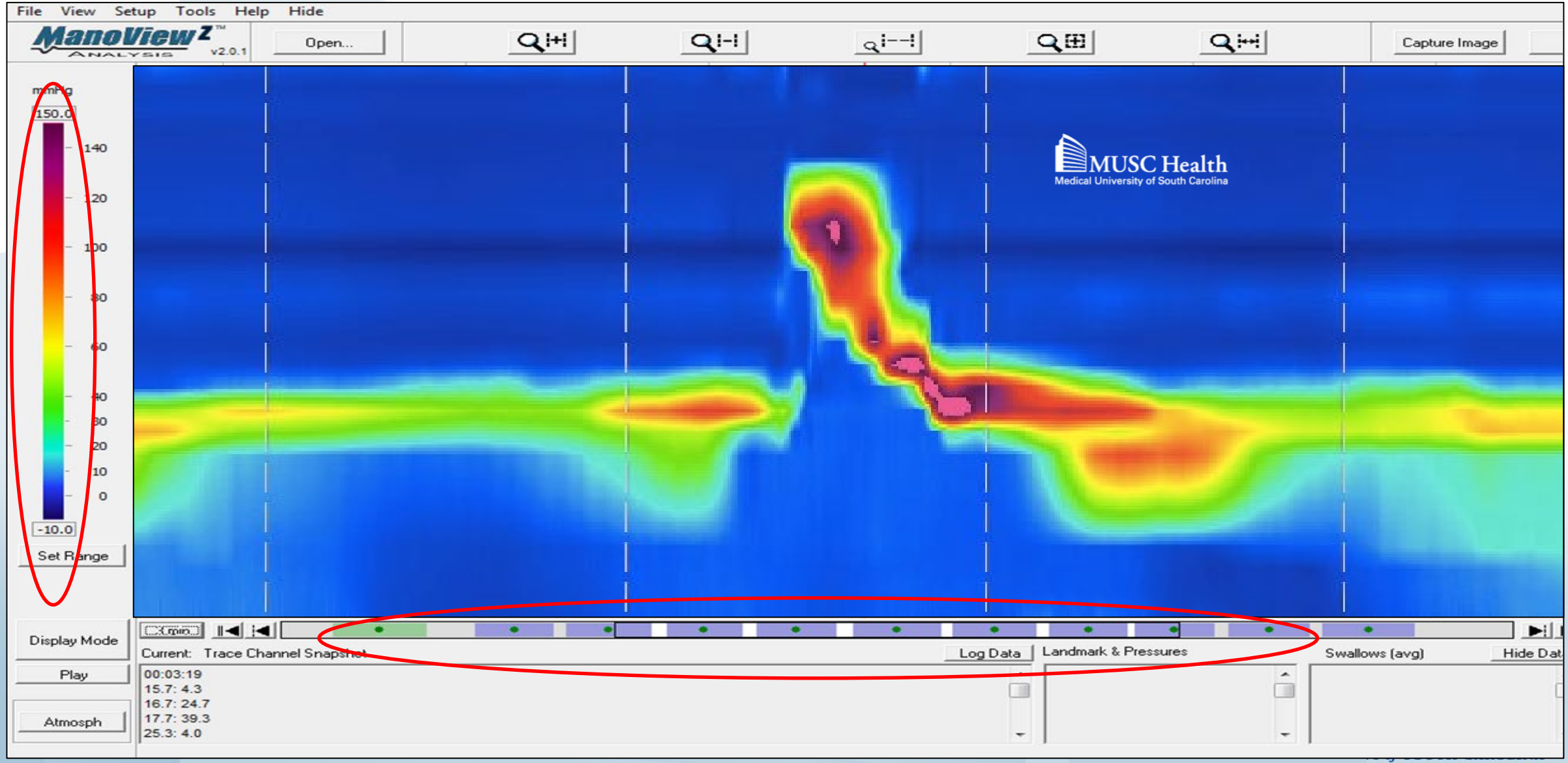
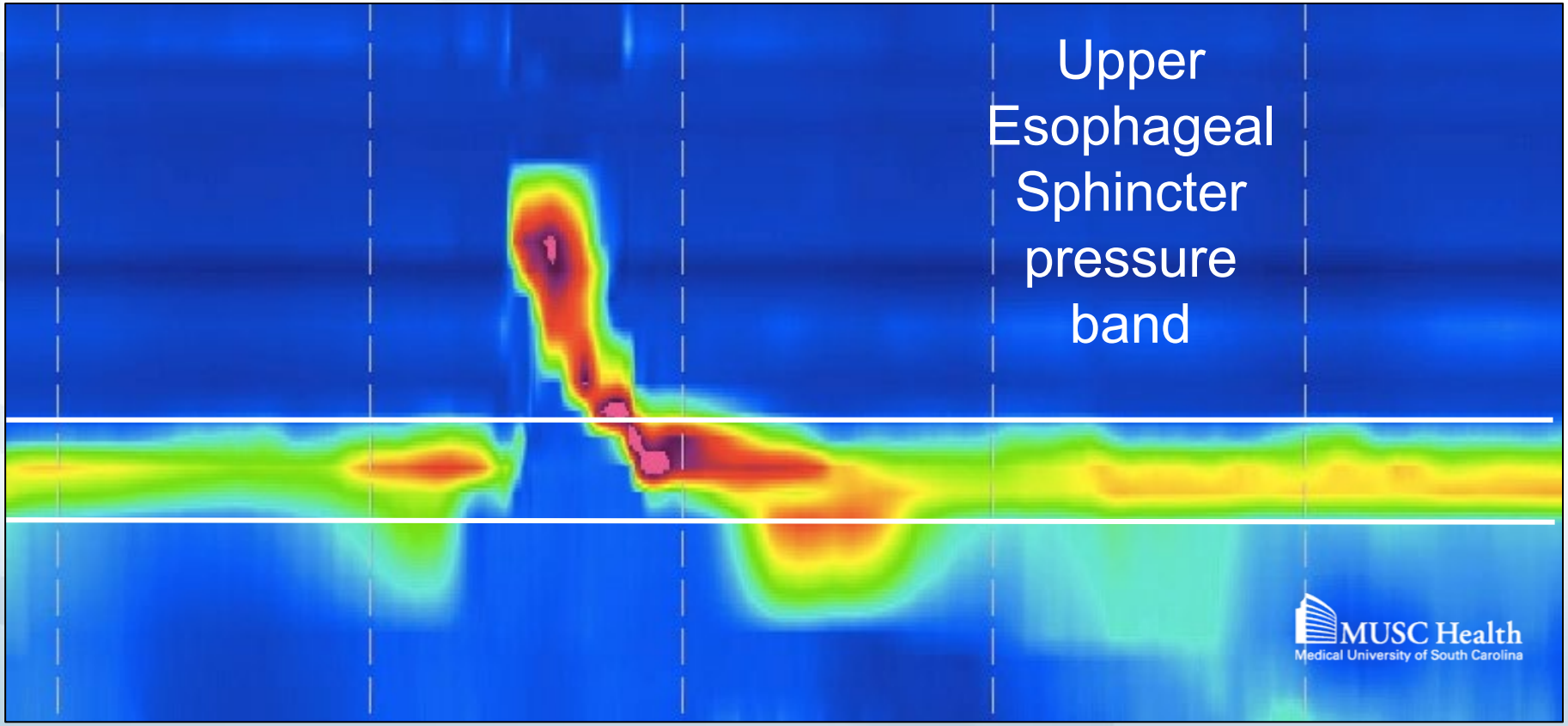
High Resolution Pharyngeal Manometry



High Resolution Pharyngeal Manometry

High Resolution Pharyngeal Manometry



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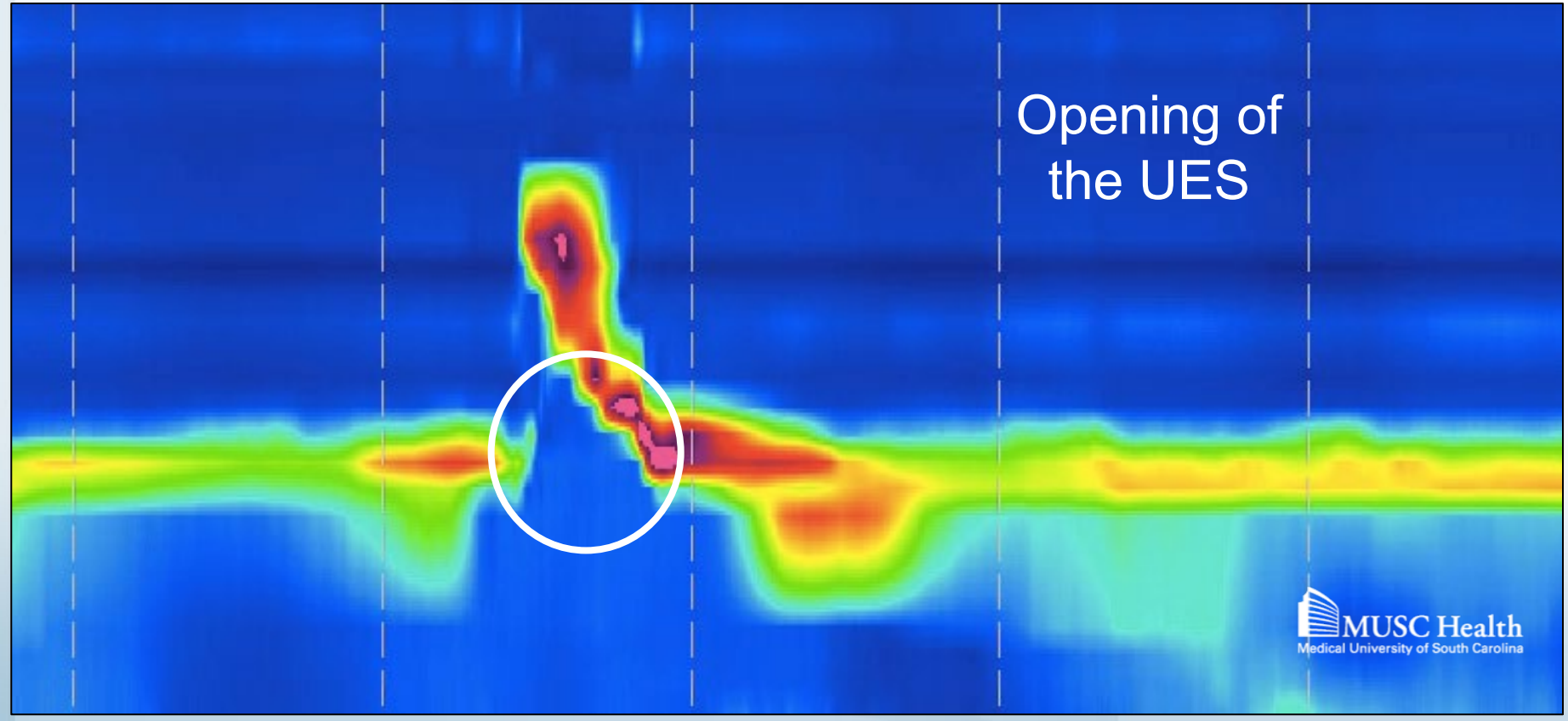
High Resolution Pharyngeal Manometry



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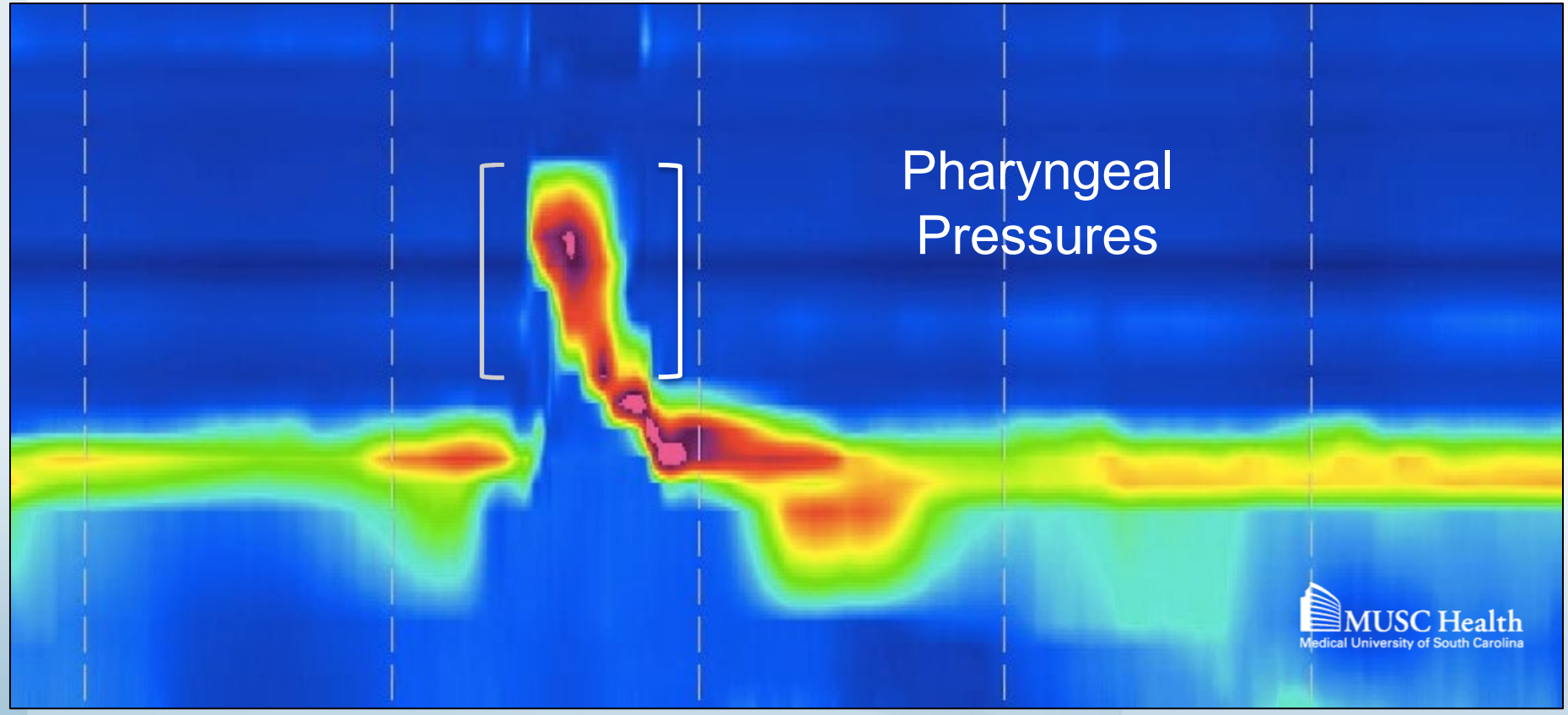
High Resolution Pharyngeal Manometry



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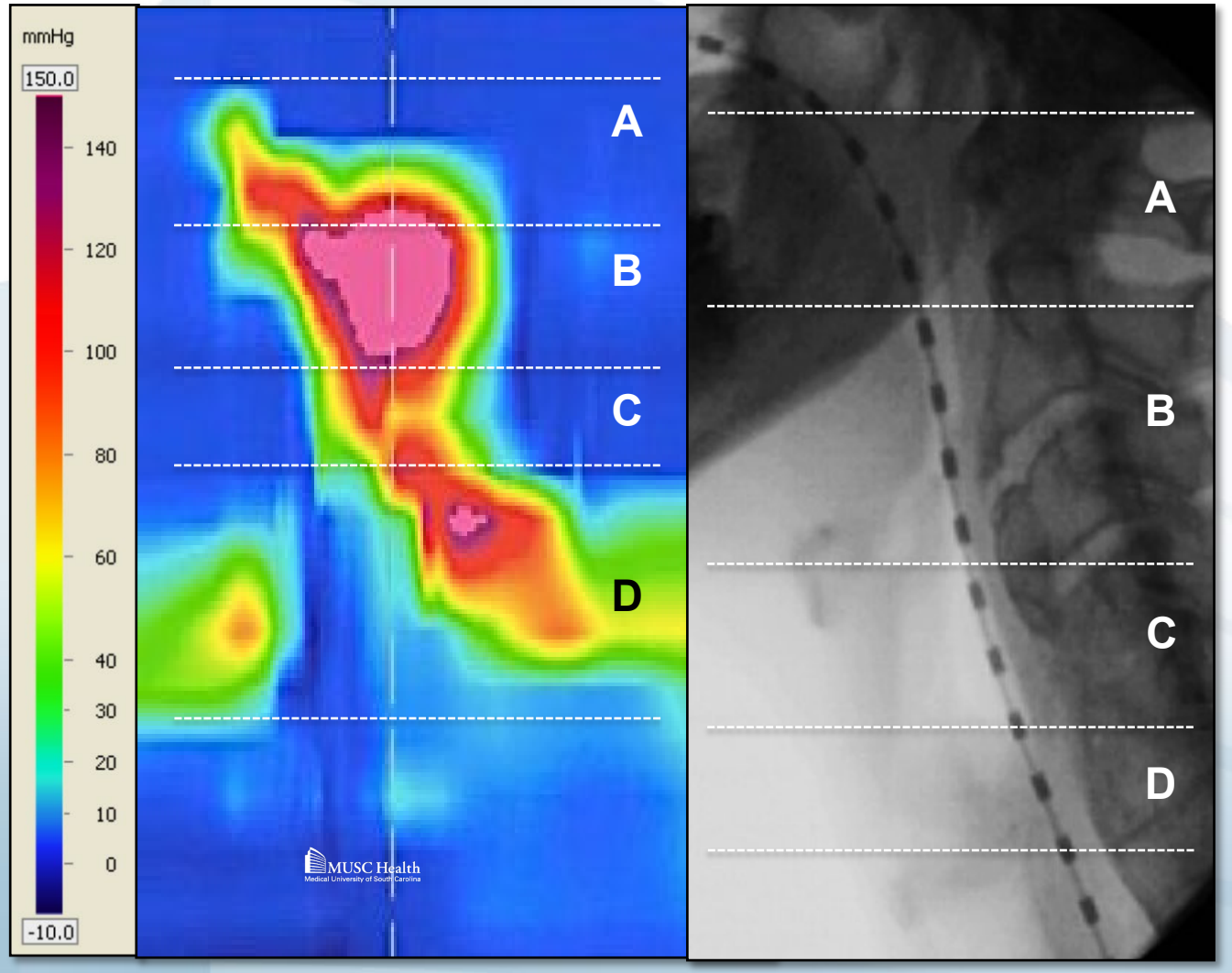
Landmarks



A) Velopharynx Region

- Soft palate
- Superior pharyngeal constrictors

B) Mesopharynx Region

- Tongue base
- Inferior pharyngeal constrictors
- Middle pharyngeal constrictors

C) Hypopharynx Region

- Inferior pharyngeal constrictors

D) UES Region

- Pharyngoesophageal segment

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International HRPM Working Group

Vision

"To improve the quality of dysphagia care through the clinical implementation of high resolution pharyngeal manometry."

Mission

"To create a standardization of high resolution pharyngeal manometry acquisition, measurement, reporting, education and training as well as advocate with payers and healthcare systems."

Recommended HRPM Protocol	
System to use	• Any solid state HRM system including a catheter configured with at least 10 pressure sensors at 1cm spacing. • If impedance included then electrodes at 2 cm spacing.
Catheter placement	• Requires education and training • Apply lubricant gel to catheter • May apply topical anesthesia to nasal passage • Liquid sips via straw during placement • Wait 5 minutes for catheter accommodation
Test boluses	• Position - seated with head neural • Delivery - syringe preferred • Volumes - 5 ml, 10 ml & sometimes 20 ml (case by case) • Minimum 3 repeats (case by case)

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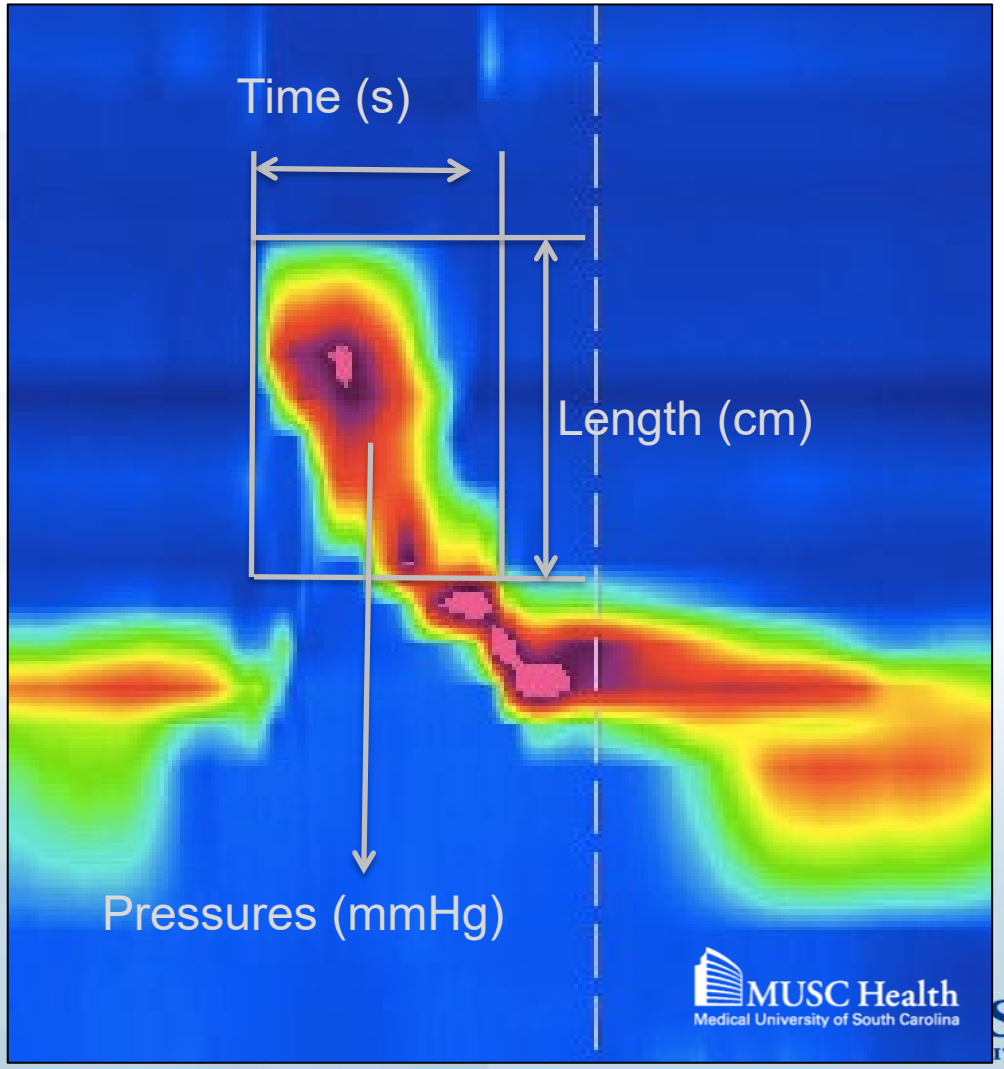
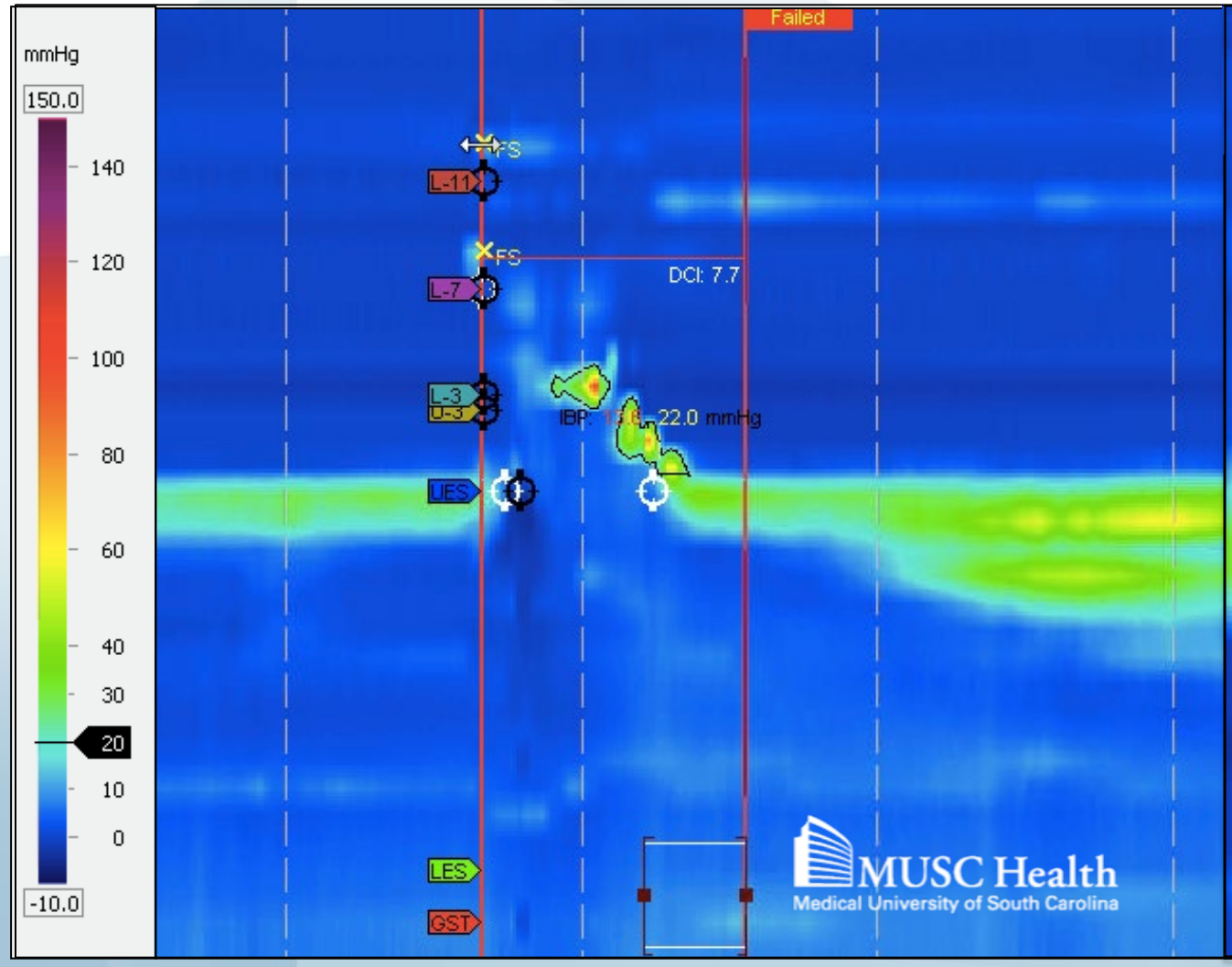
Omari et al...O'Rourke AK. Dysphagia 2019

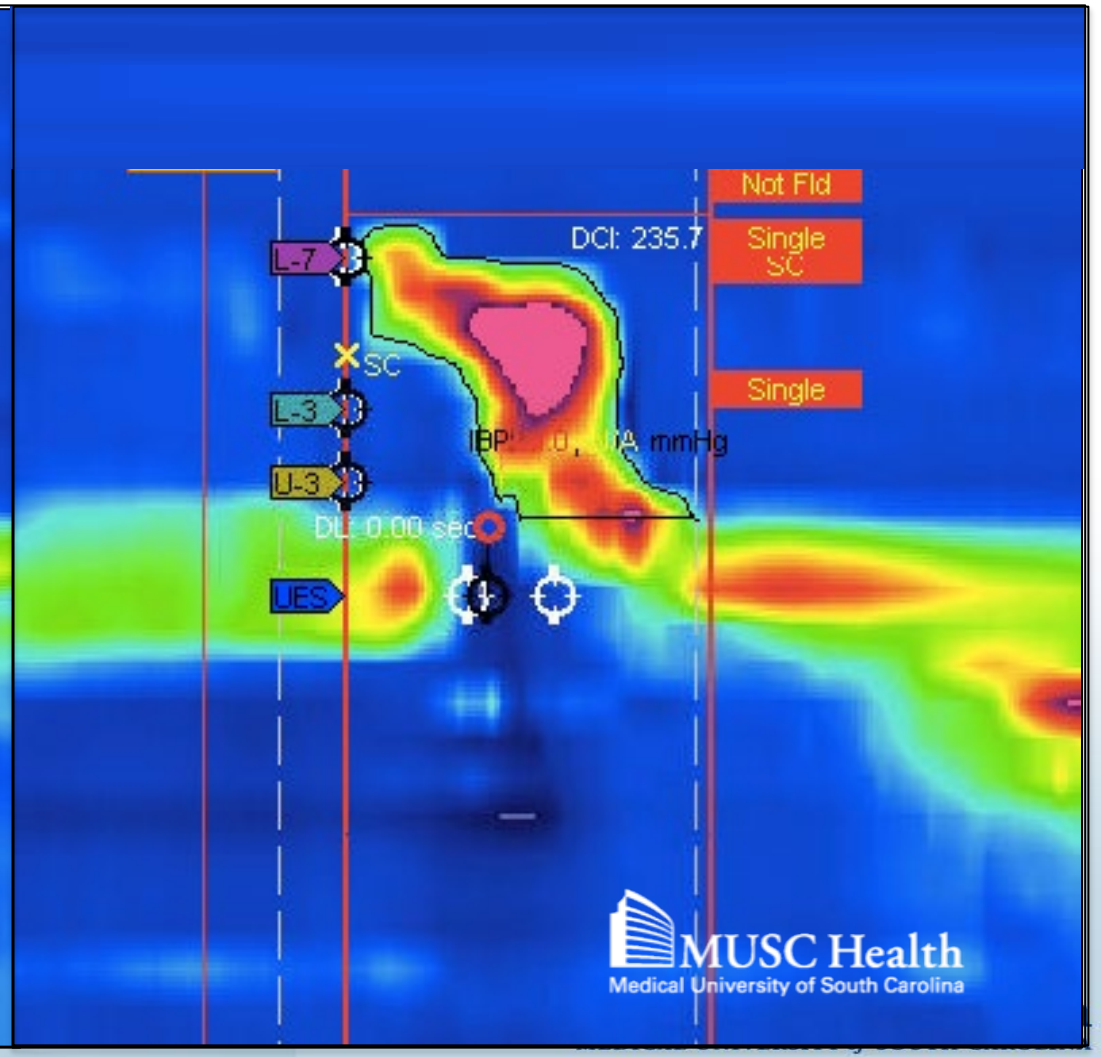
Pharyngeal Contractile Integral

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

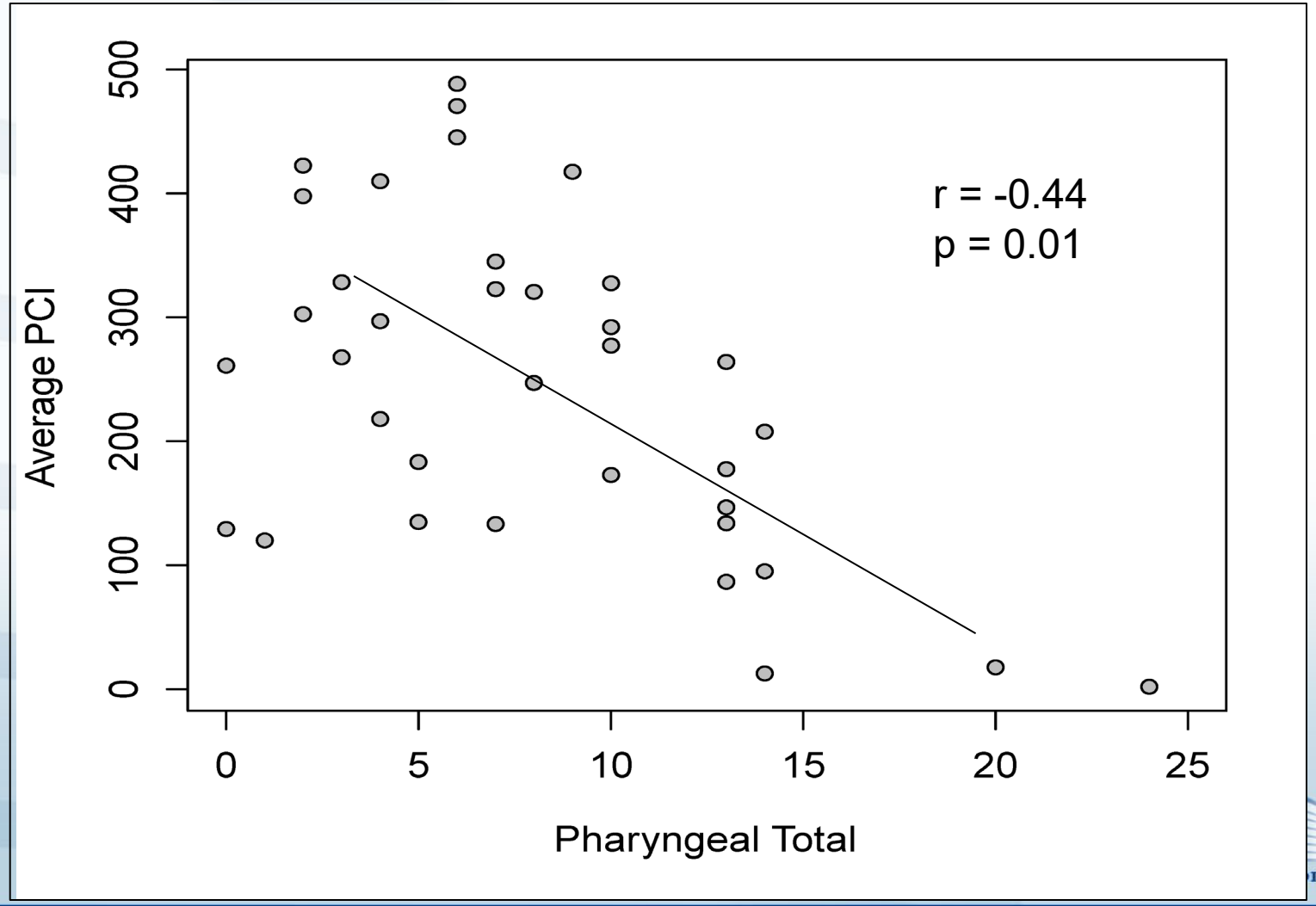


Illustrative Examples of PhCI





The Relationship Between Pharyngeal Contractile Integral and Pharyngeal Total Scores on Videofluoroscopy



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O'Rourke, Humphries et al 2017 Neurogastroenterology & Motility

PhCI and PAS

- PAS scores for thin liquids were significantly different between groups (1.44 versus 3.78; p = 0.01)

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, Humphries et al 2017 Neurogastroenterology & Motility

How much pressure is needed to clear bolus?

- 47 dysphagic patients; 25 females, 22 males; mean age of 62 (range 28-86)

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

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Hamberis A, Davidson K, Zhao E, O'Rourke, unpublished data, presented at AAO 2019

Outline

- Introduction to high resolution pharyngeal manometry (HRPM)
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  - Adjuvant Diagnostic Tool
  - Therapeutically for Biofeedback - tomorrow
  - Assess Efficacy of Interventions - tomorrow

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Diagnostic Applications of HRPM

- Characterize PES/UES function
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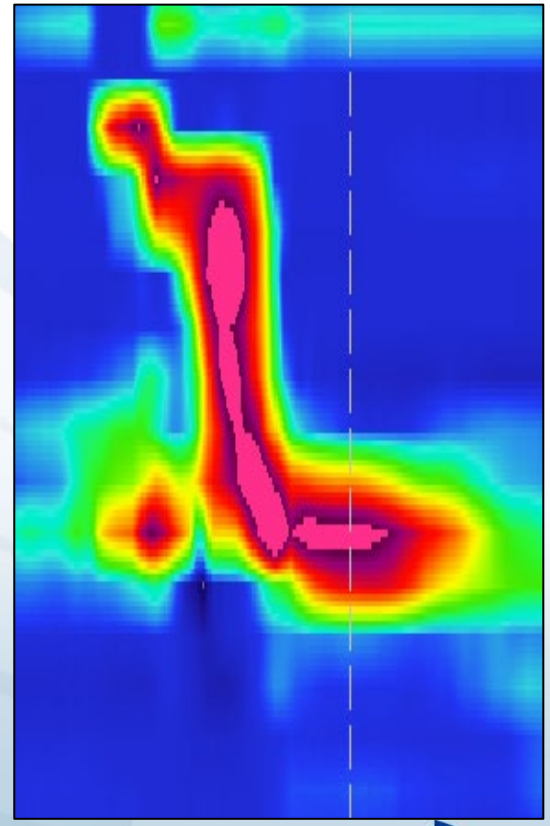
Cricopharyngeal Dysfunction

Esophagram

HRM



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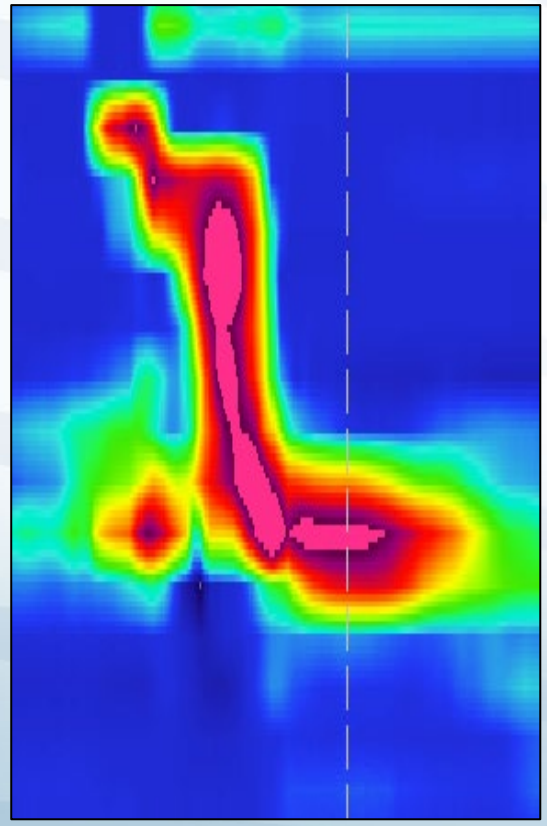
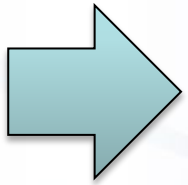
Cricopharyngeal Dysfunction

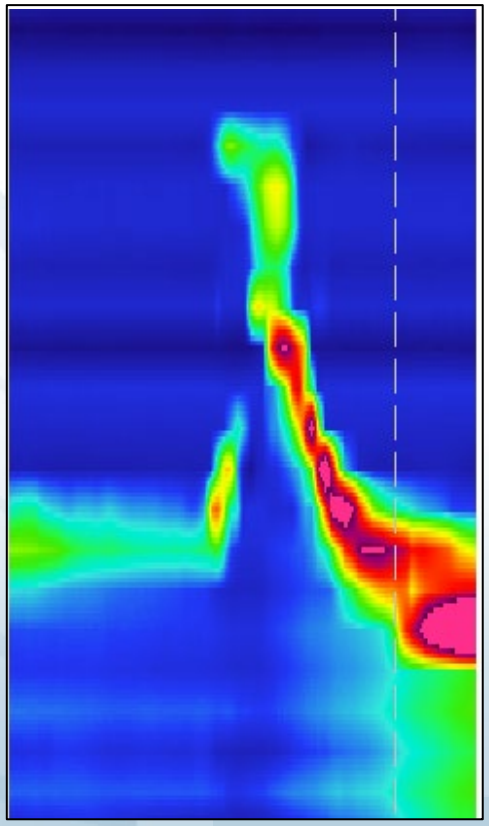
Before





CP Myotomy

After



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.

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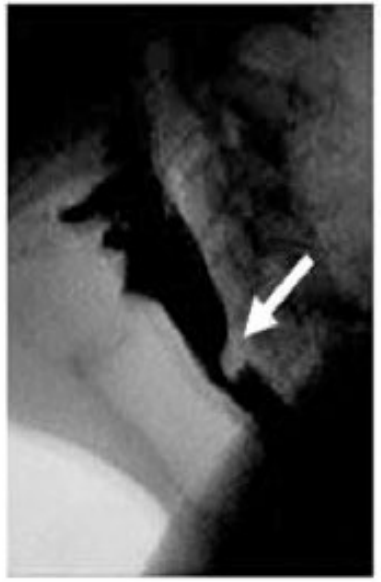

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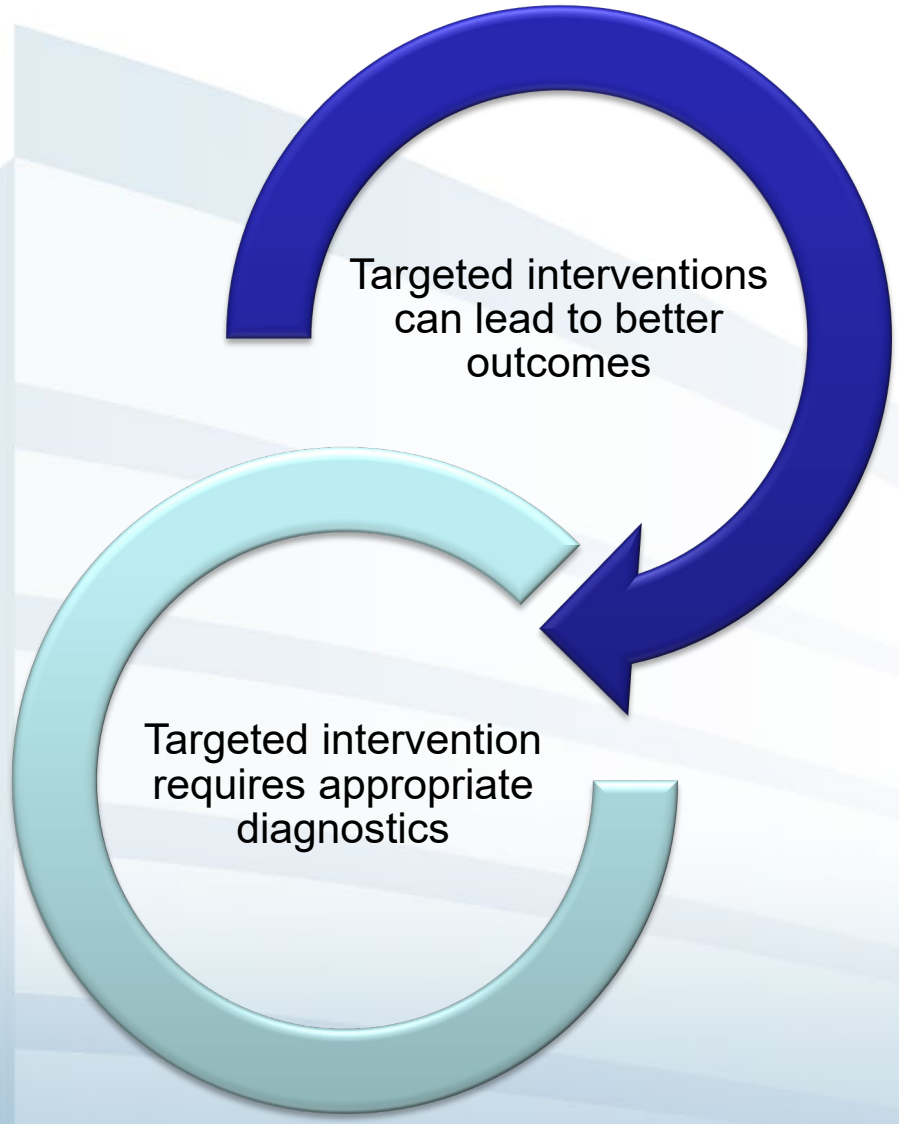

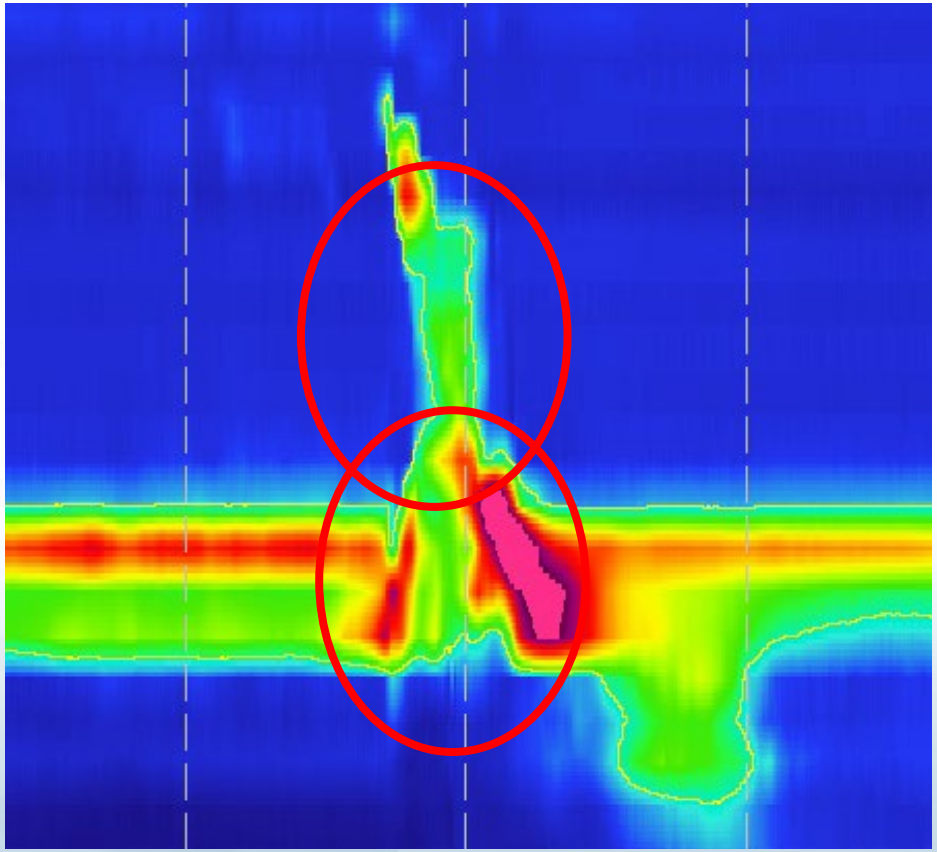

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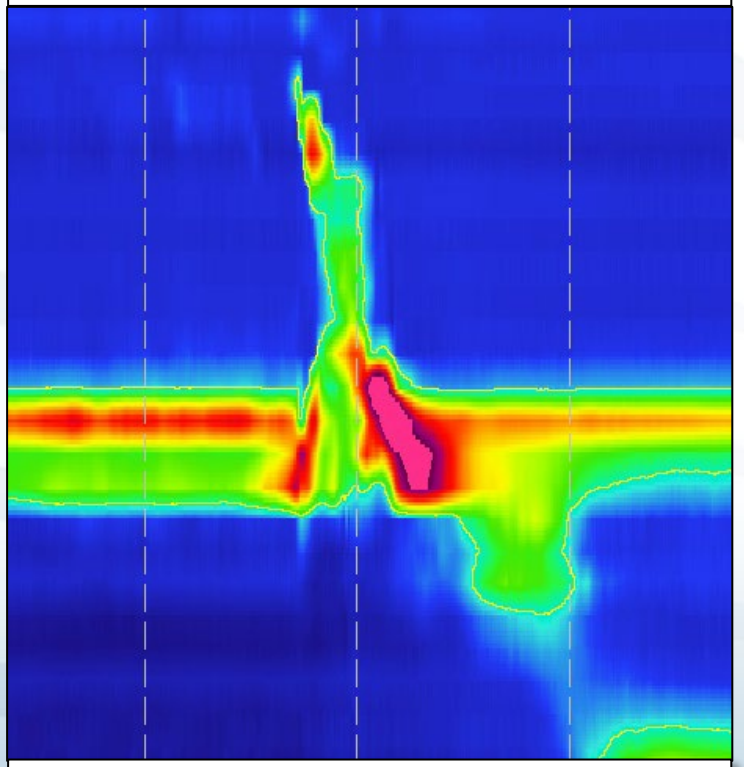
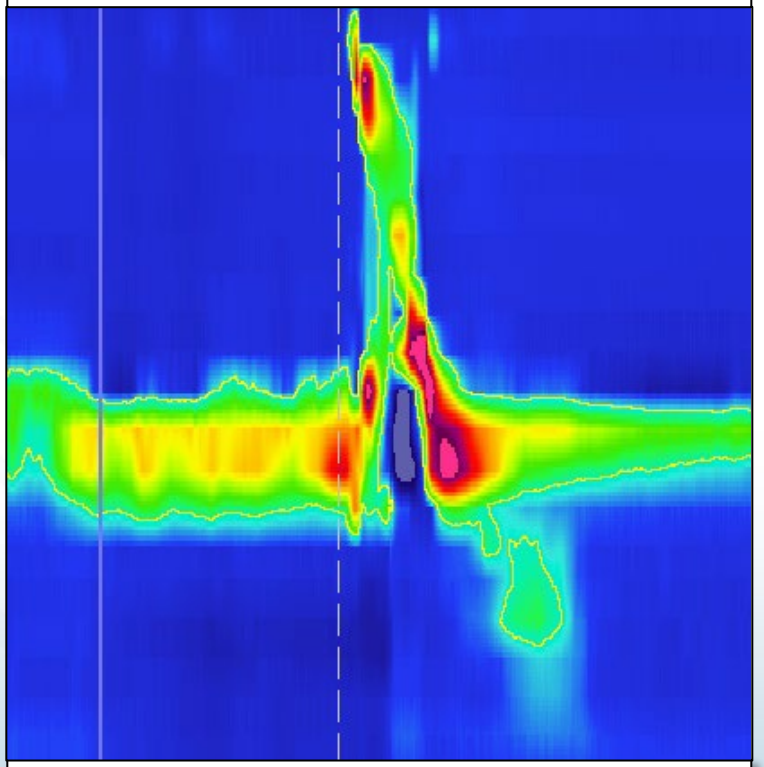
After 6 Weeks HRPM Biofeedback Assisted Therapy

Pre-Therapy



PhCI: 154 mmHg-cm-s
UES Opening Duration: 140 ms
UES Nadir Relaxation Pressure: 27

Post-Therapy



PhCI: 334 mmHg-cm-s
UES Opening Duration: 350 ms
UES Nadir Relaxation Pressure: -3

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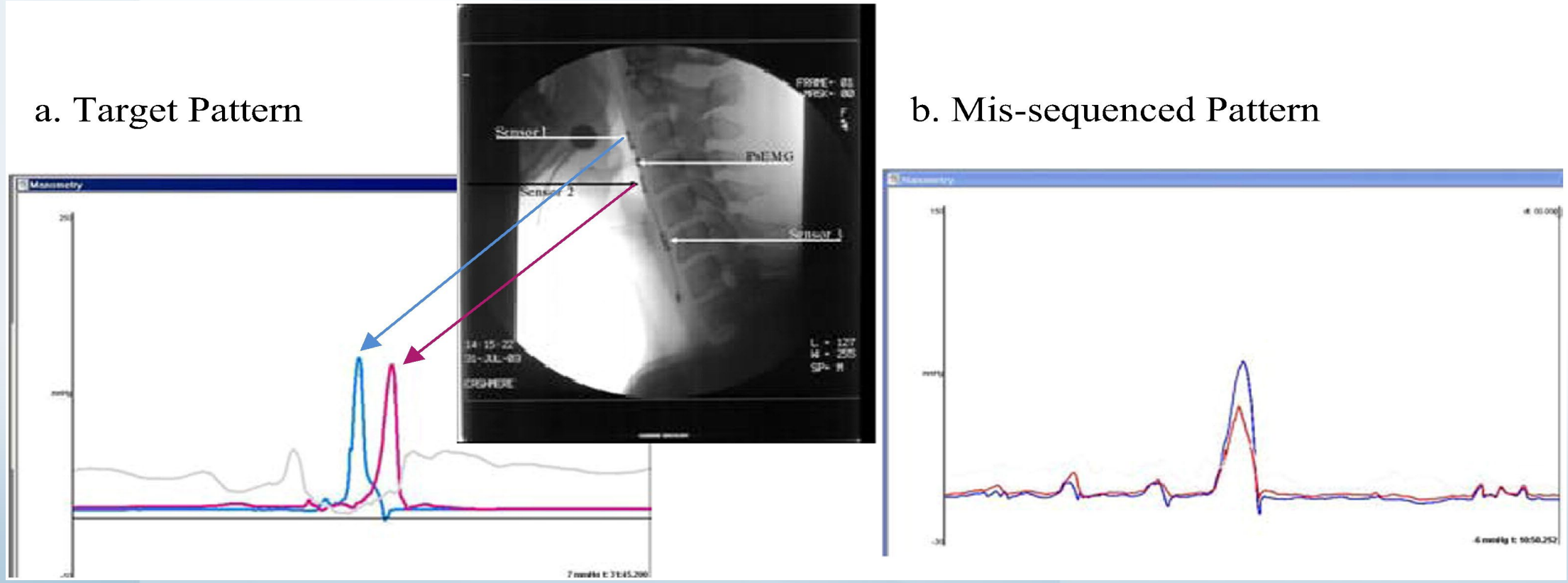
Temporal Coordination
Pharyngeal Mis-sequencing



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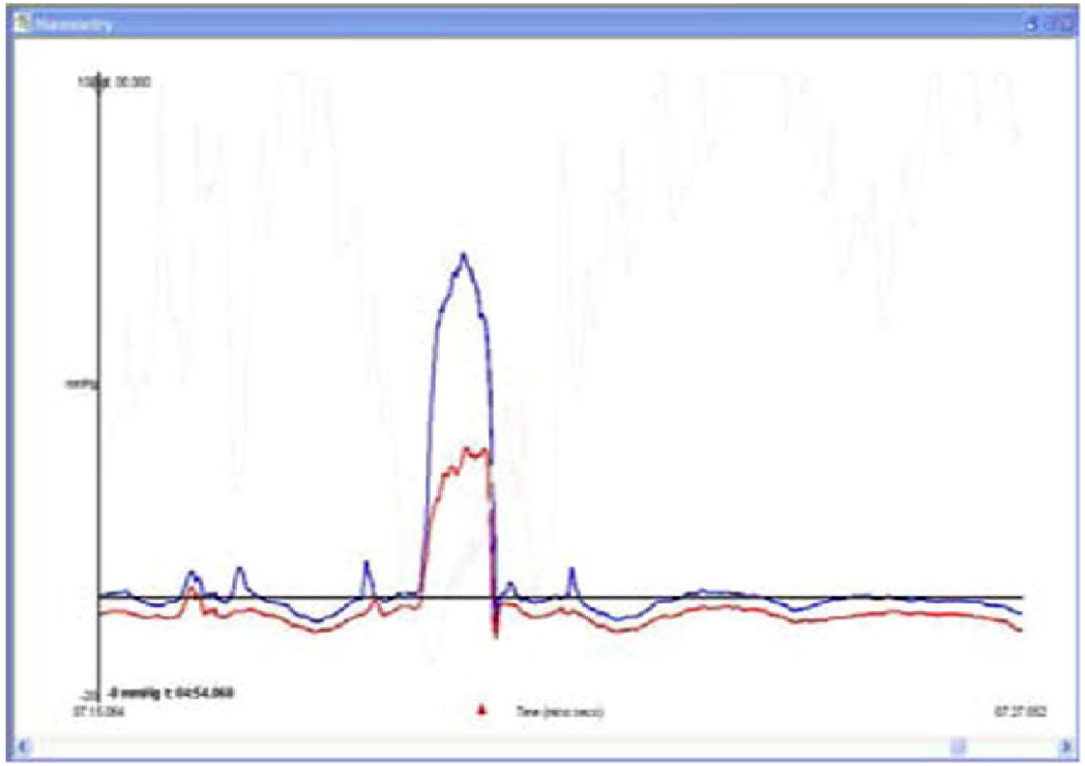
Huckabee et al., 2014

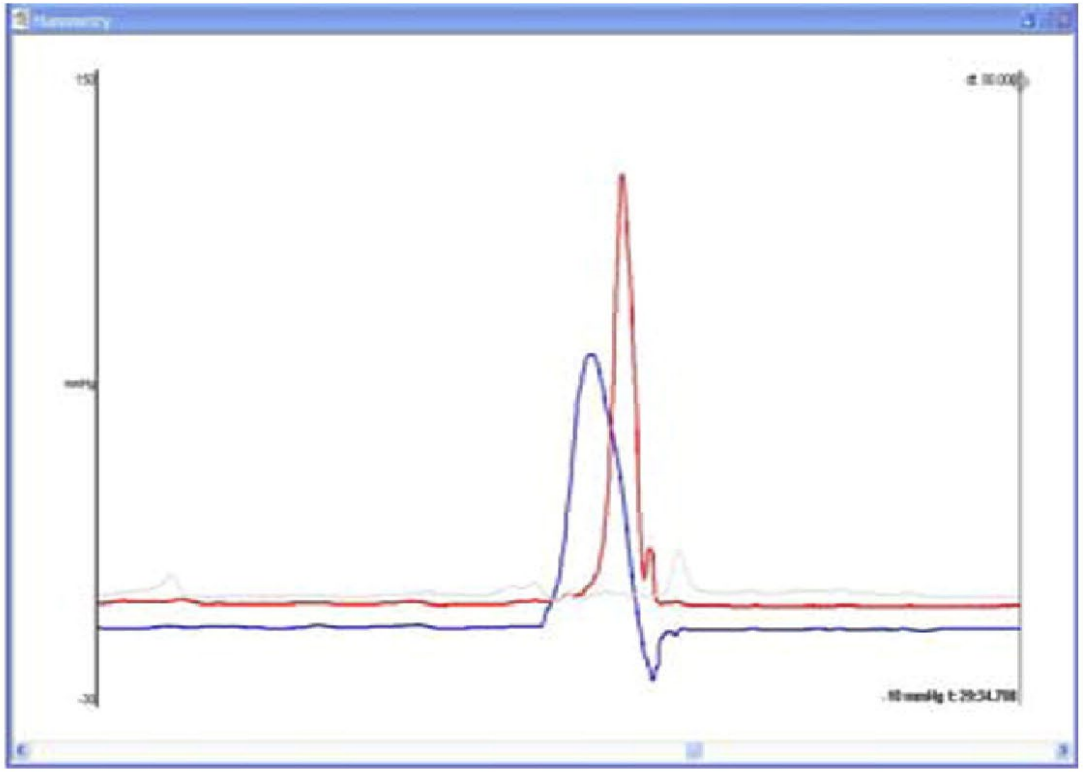
Temporal Coordination

Pharyngeal Mis-sequencing

a. Pre-treatment



b. Post-treatment



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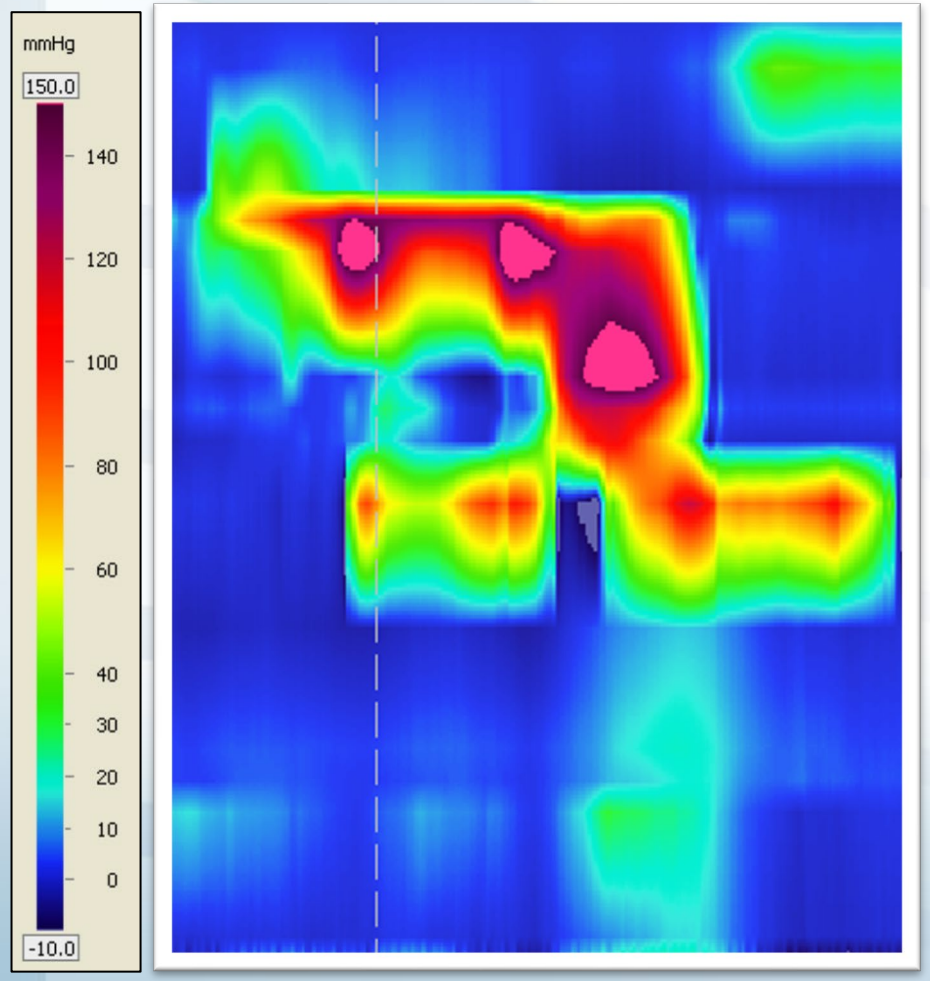
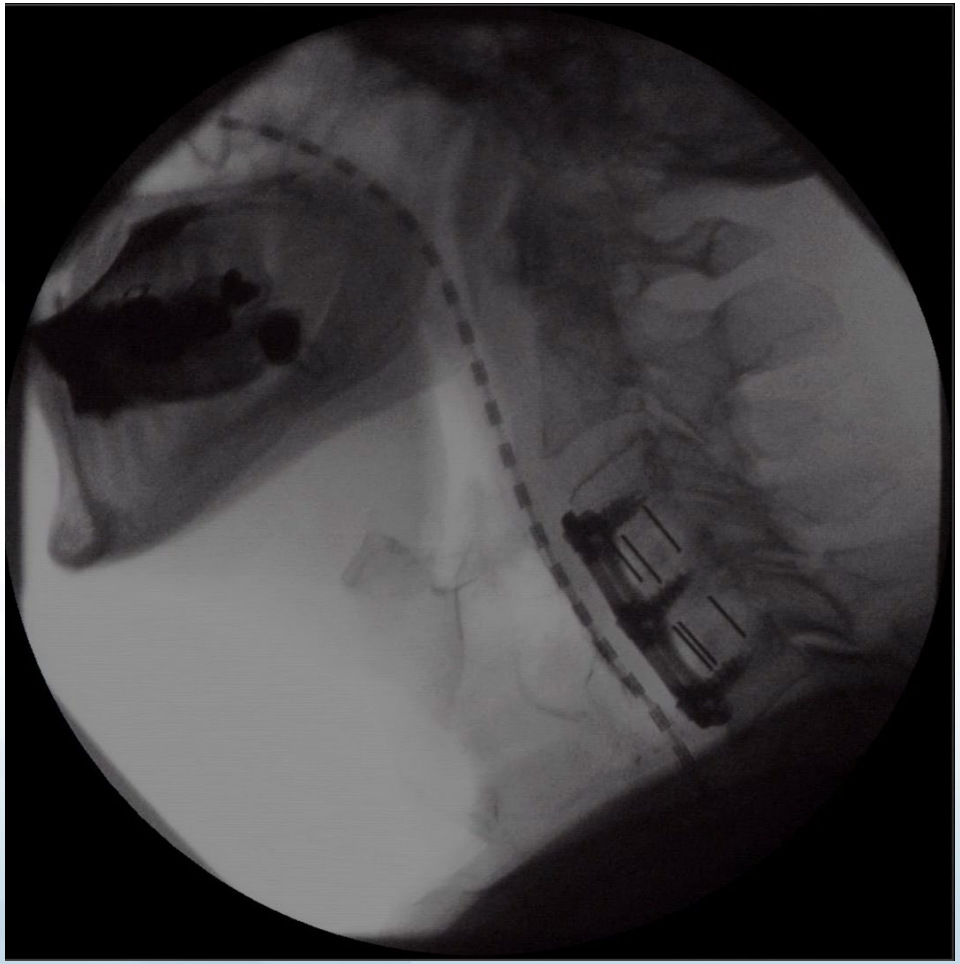
Huckabee et al., 2014

Temporal Coordination

Simultaneous Contraction





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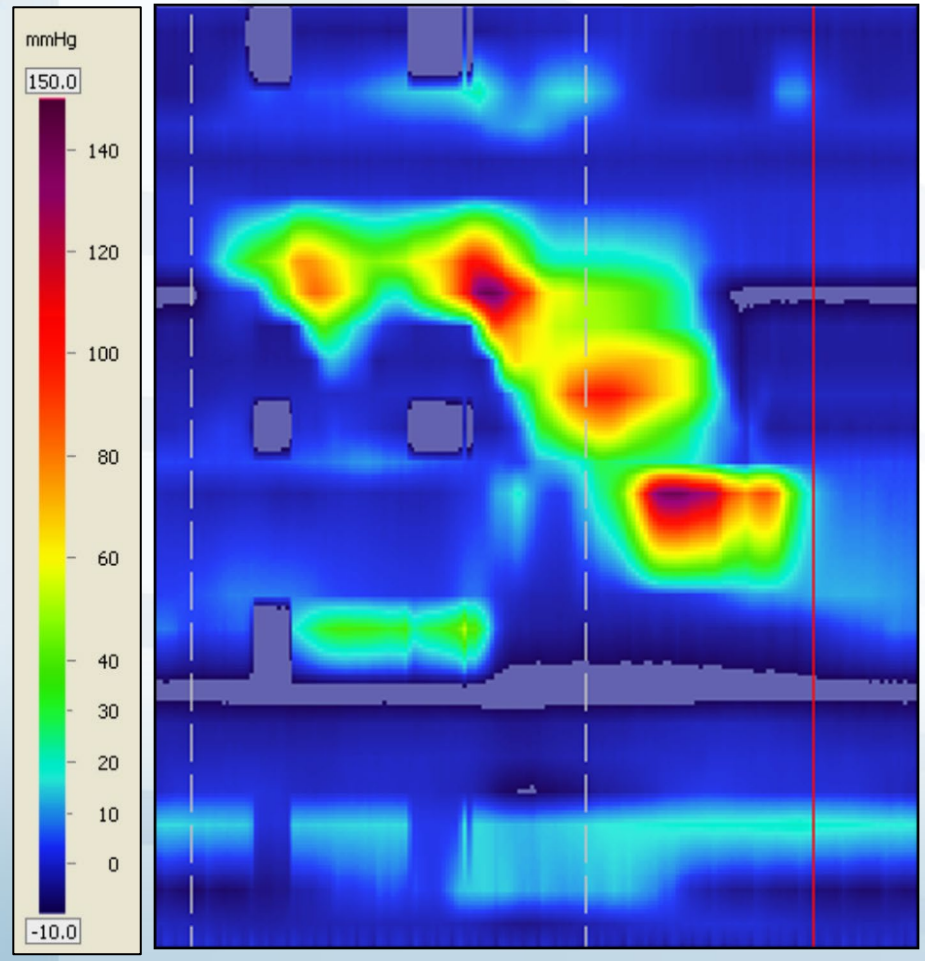
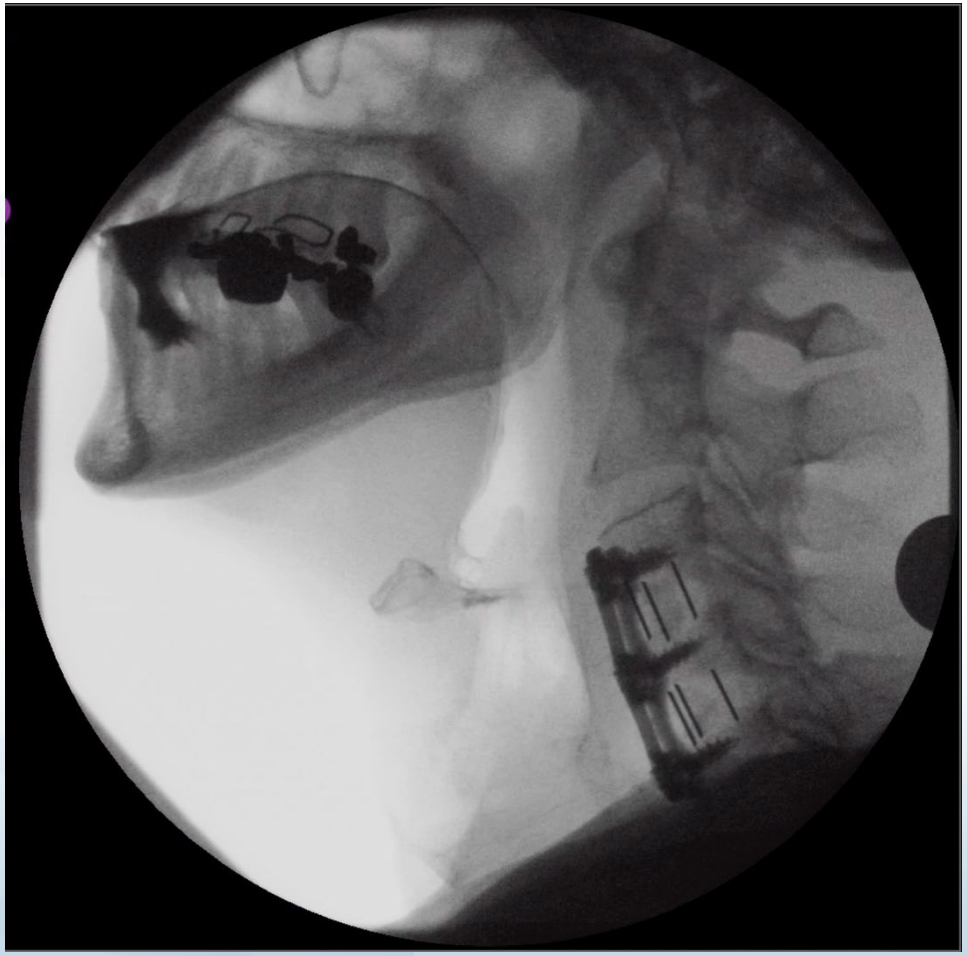
Temporal Coordination

Simultaneous Contraction





Post-HPRM Assisted Therapy

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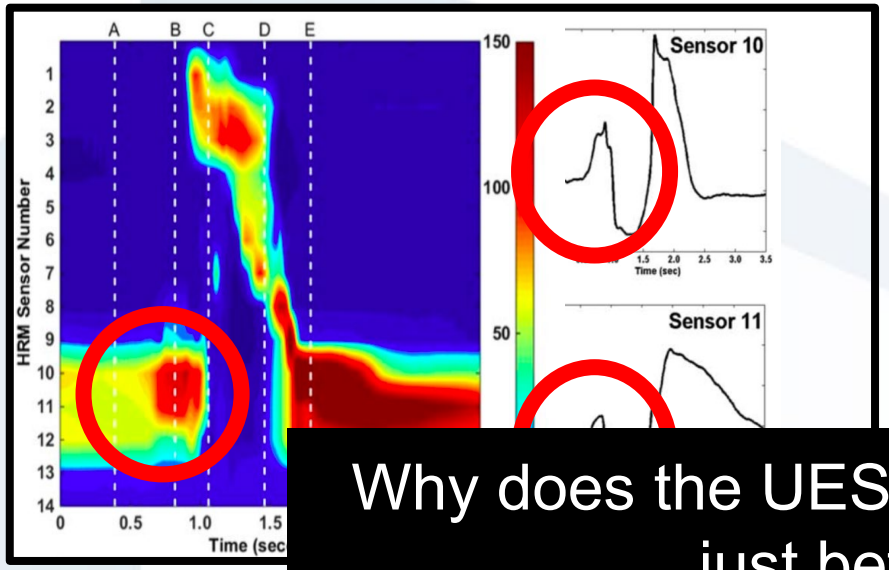
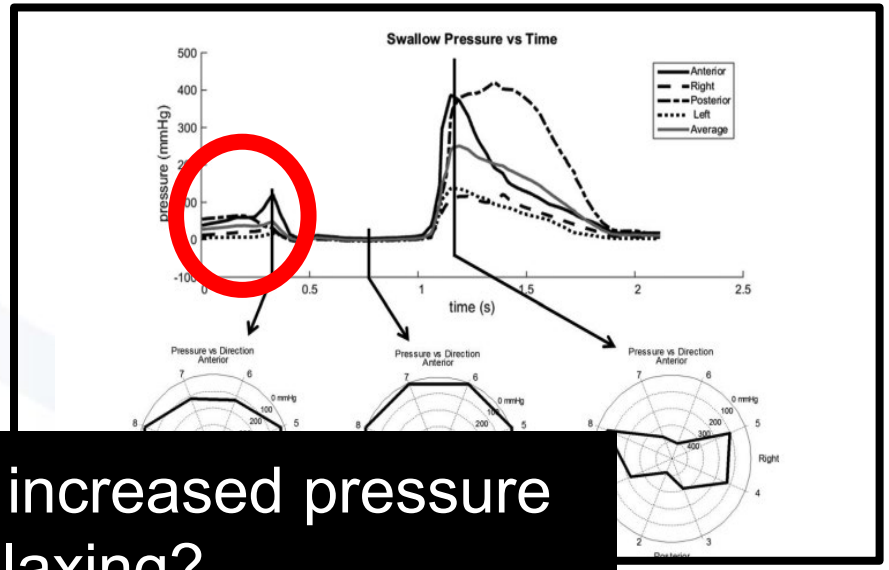
Pharyngeal Chamber Formation

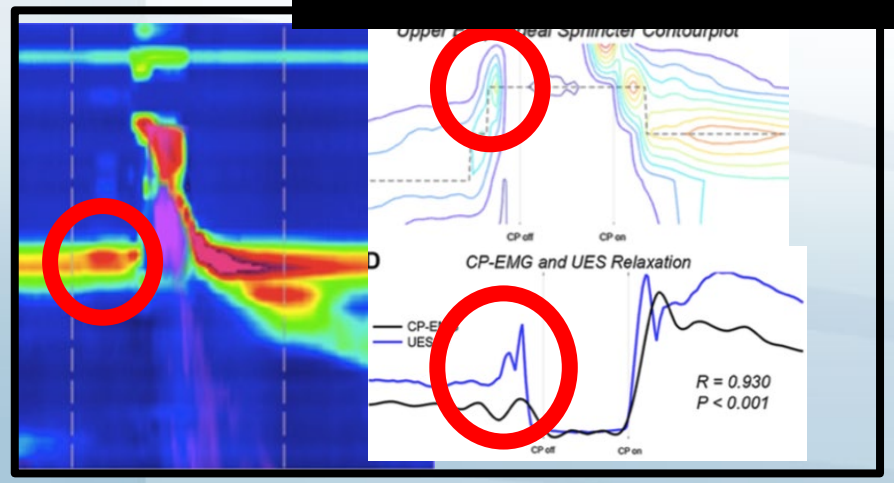


Jones et al 20

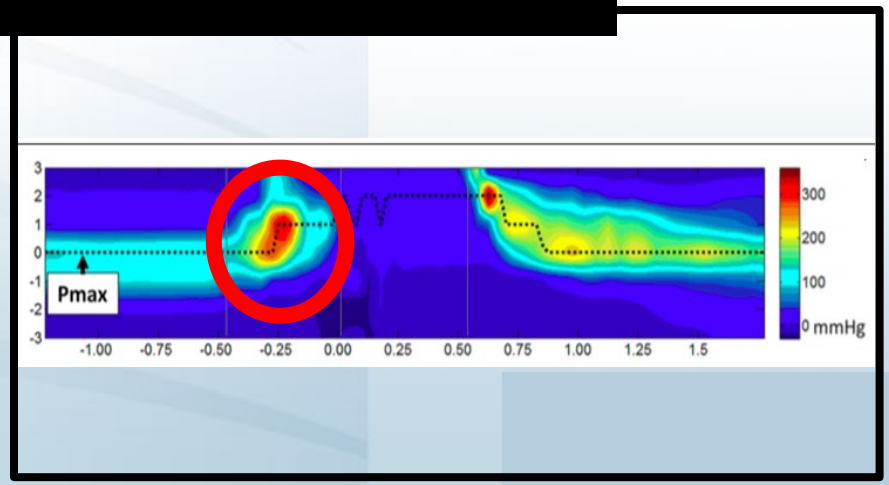


er et al 2016

Why does the UES show increased pressure just before relaxing?

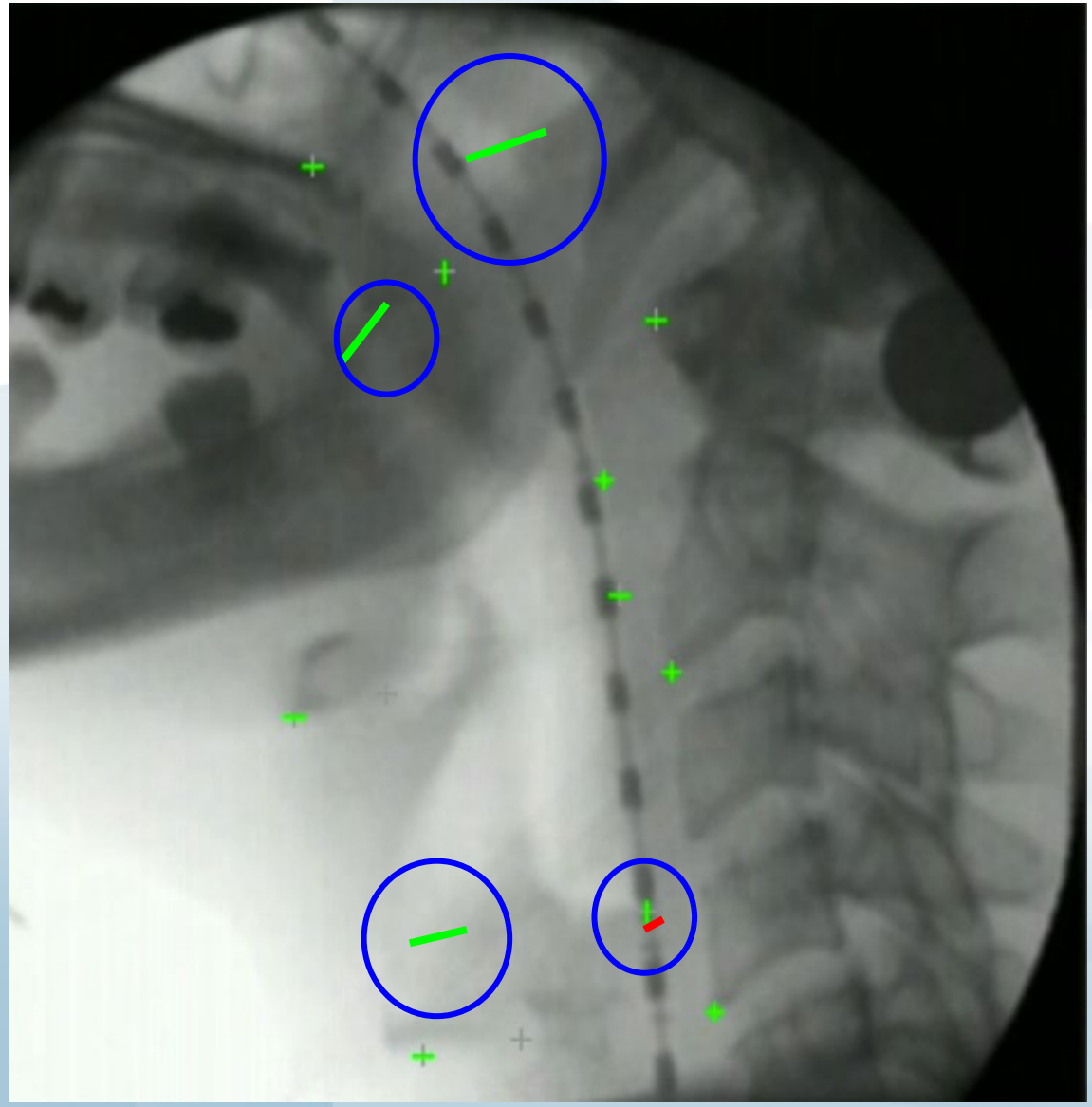


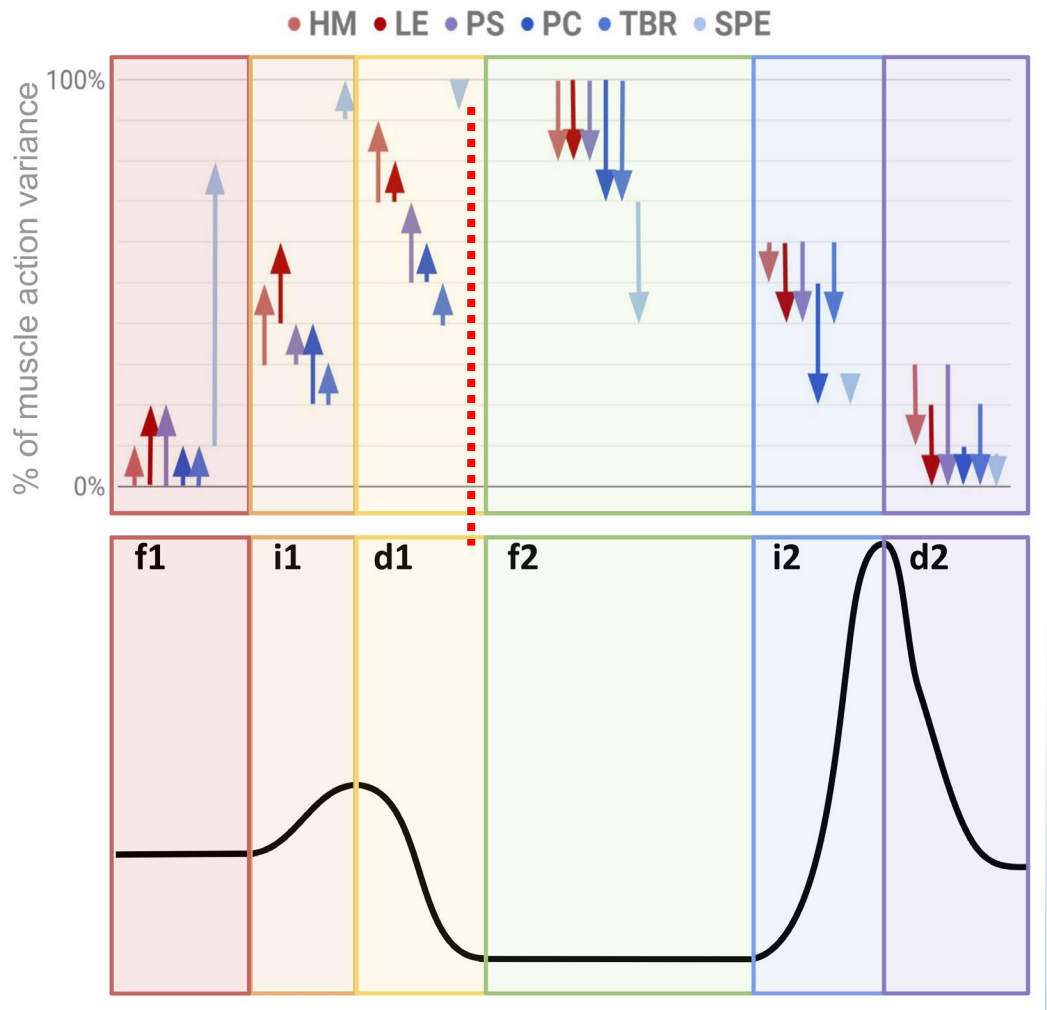
Cock et al 2017



Omari et al 2015

Pressure Chamber Formation





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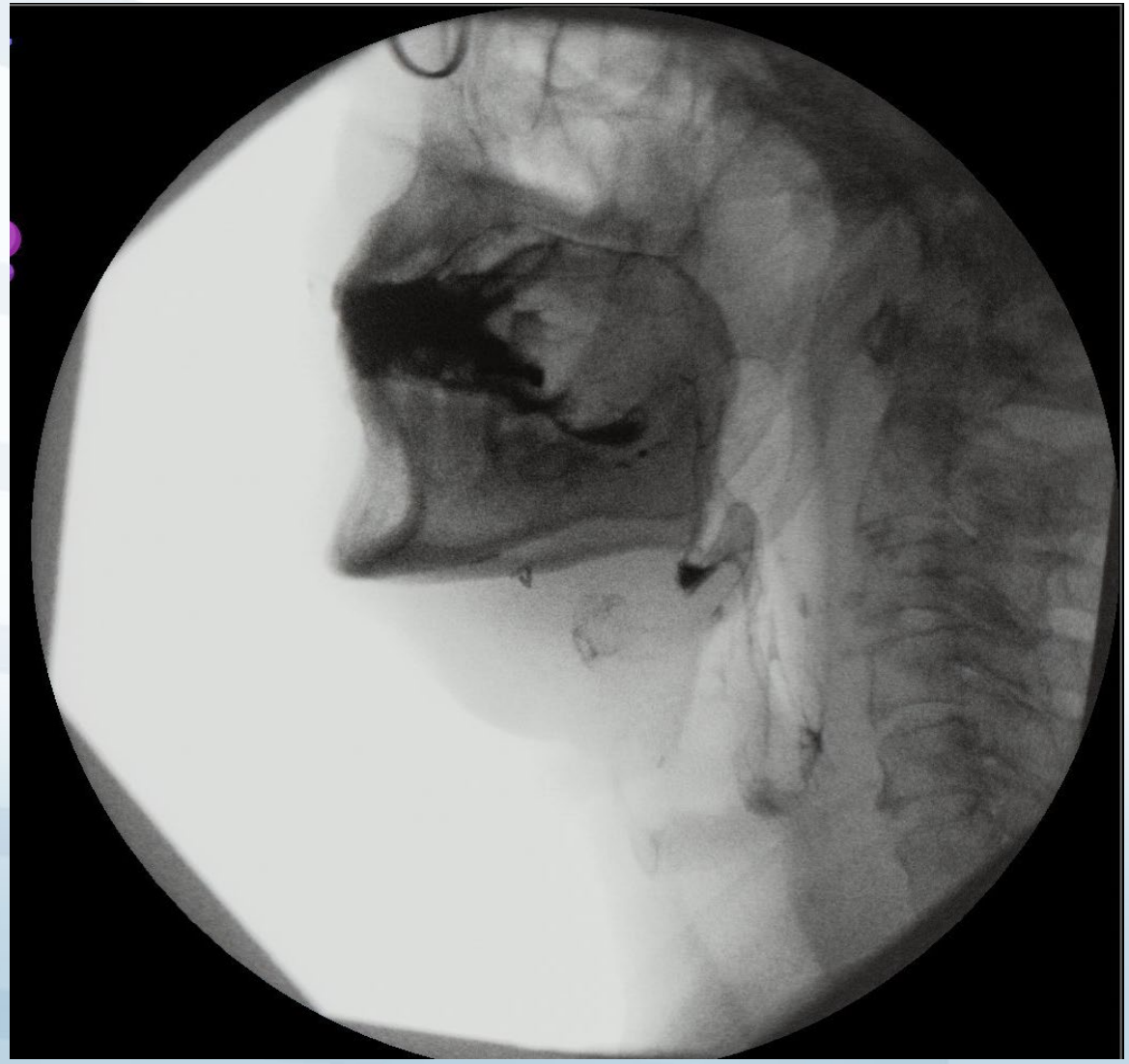
May N, Humphries K, Pearson W, O'Rourke A. 2019. Head & Neck in Press.

Pressure Formation Issue - VPI



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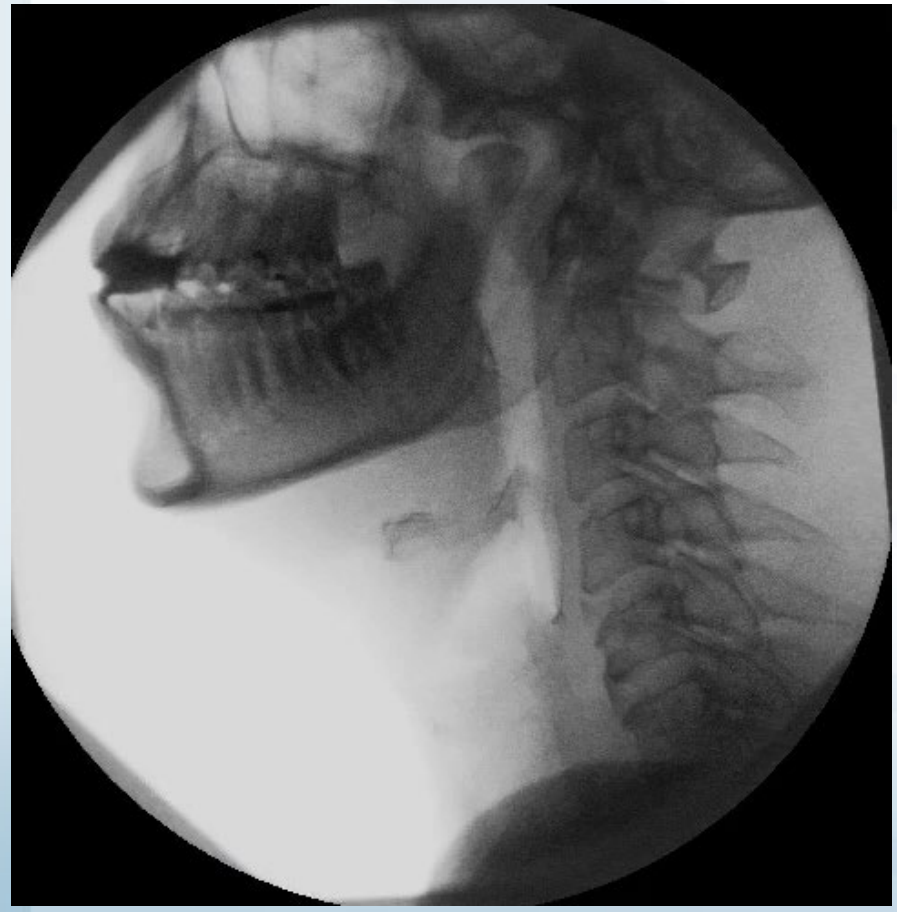
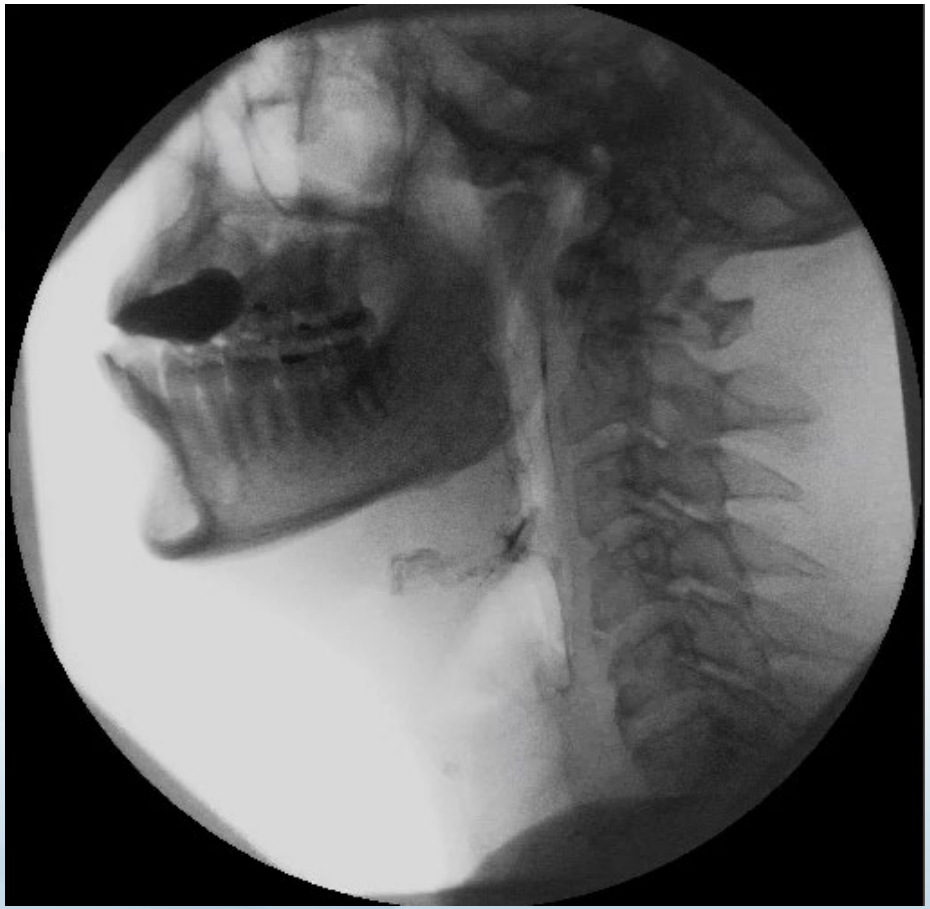
Quantifying Subtle Changes
Status Post UPPP

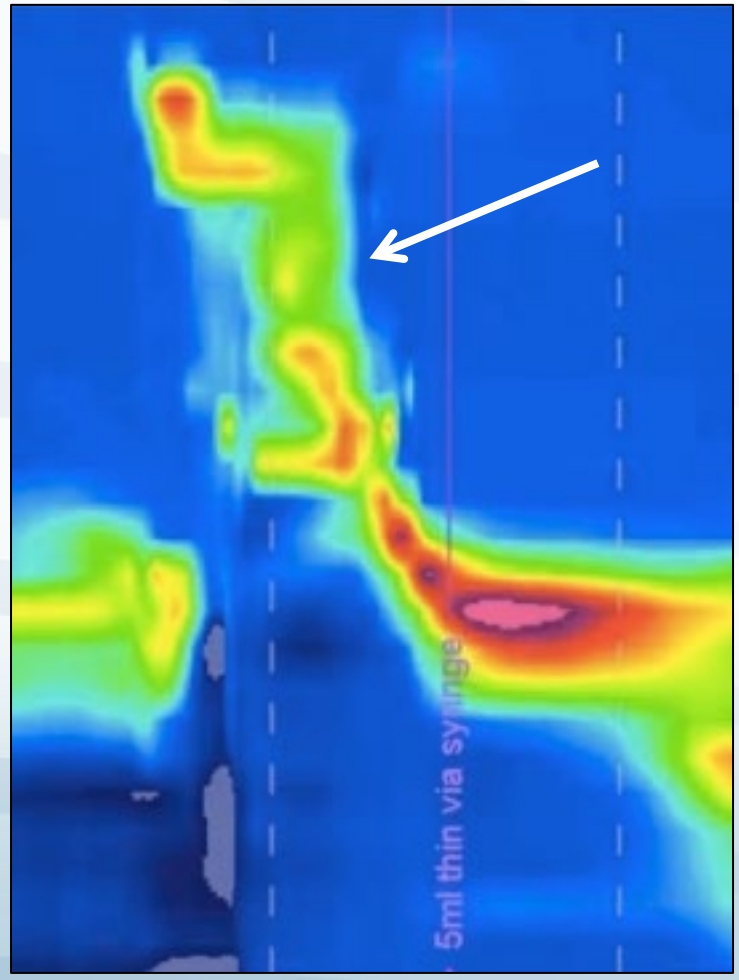


Thin Liquid

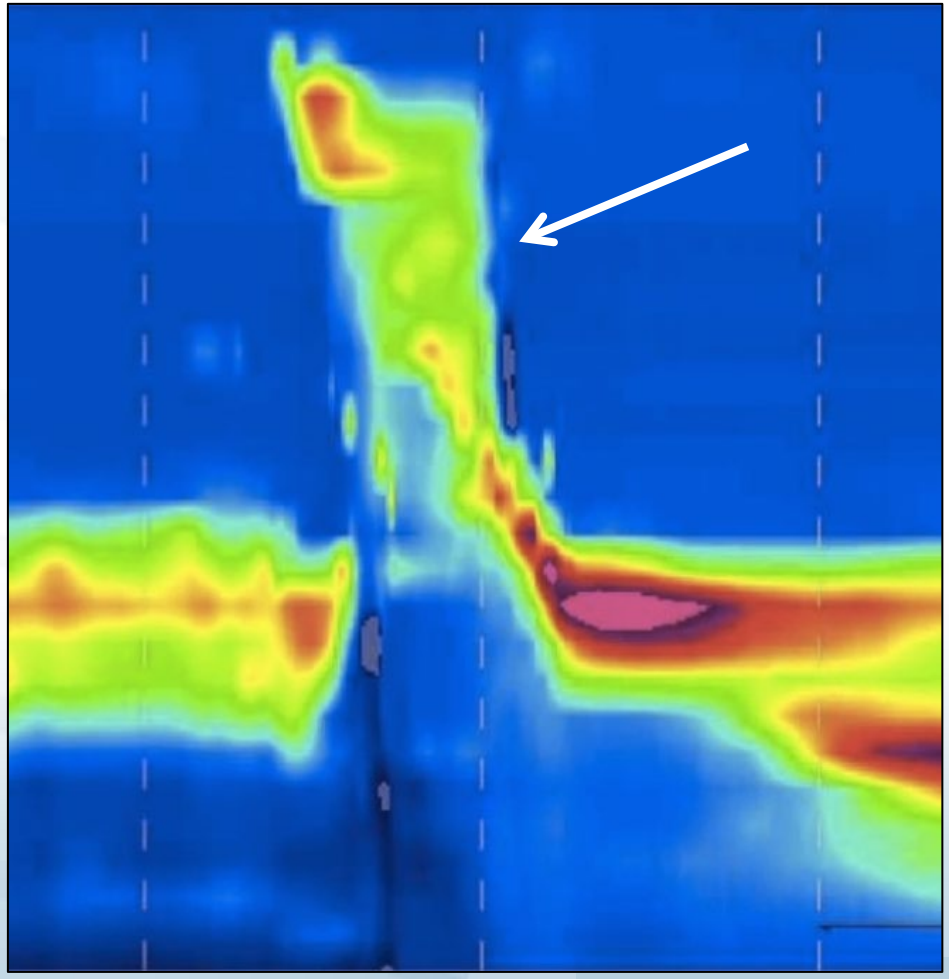


Puree

Oropharyngeal Dysphagia
Mesopharyngeal Deficits



Thin Liquid



Puree

Diagnostic Applications of HRPM

- Characterize PES/UES function
- Timing & Coordination
- Pressure chamber formation – fluid dynamics
- Addition to VFSS in evaluation of subtle contractility deficits
- Evaluation of the entire swallowing process

Why is our understanding of esophageal dysphagia important?

- Swallowing involves bolus transfer from the lips to the stomach.
- Swallowing mechanism is interrelated in timing and function.
- Dysfunction in one area can affect the other.
- We need to understand, evaluate, and treat the *swallowing mechanism as a whole*

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Outline

- Introduction to high resolution pharyngeal manometry (HRPM)

- Incorporation of HRPM into Clinical Practice
  - Adjuvant Diagnostic Tool
  - Therapeutically for Biofeedback – tomorrow!
  - Assess Efficacy of Interventions – tomorrow!

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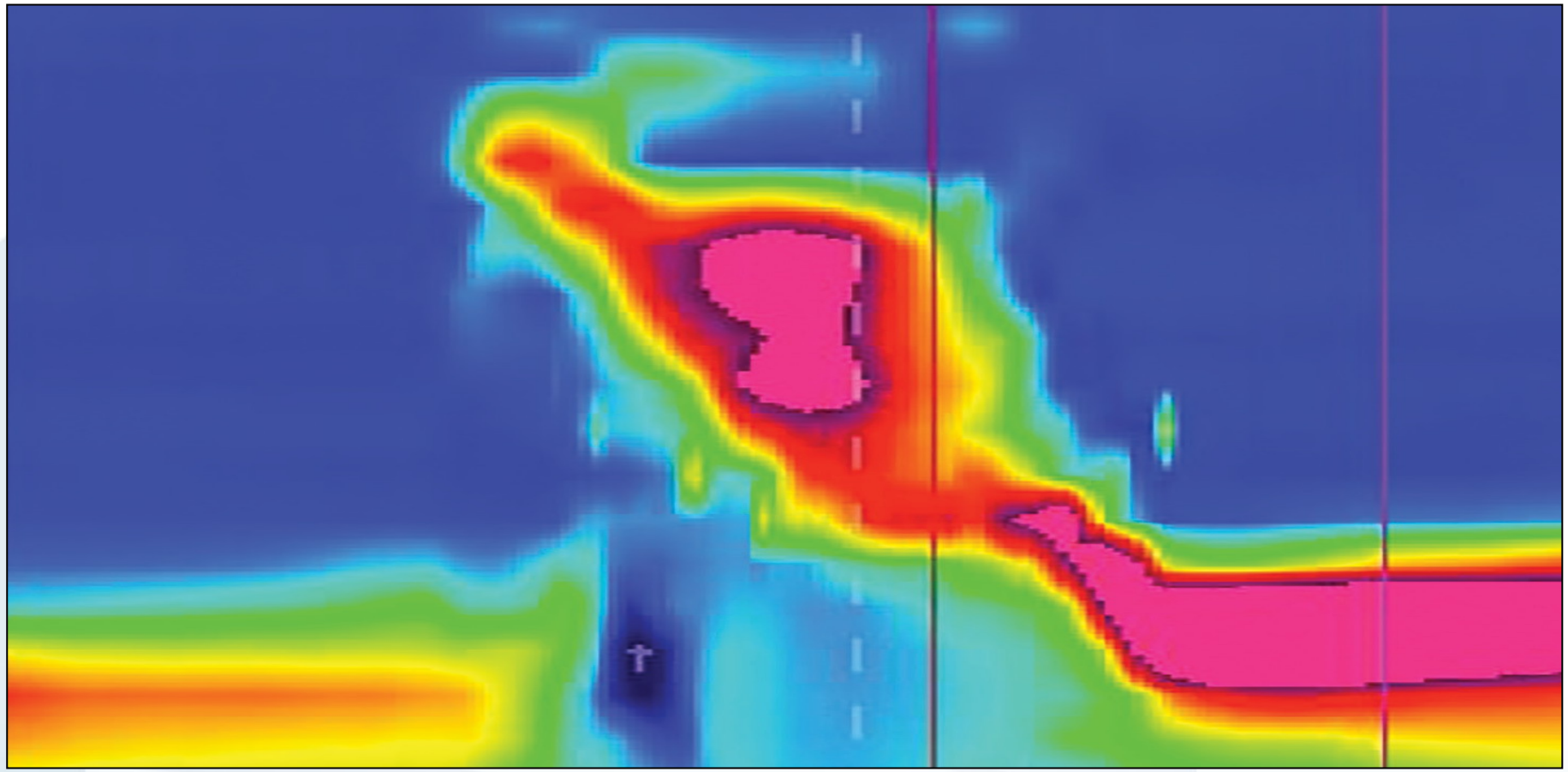

The Charleston Pharyngoesophageal Manometry Training Program

January 10 - 11, 2020

Hyatt House Mount Pleasant - Midtown

www.musc.edu/ent/cme

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