

September 2021

Testing for GERD: Beyond pH Monitoring

C. Prakash Gyawali, M.D.
Professor of Medicine
Division of Gastroenterology



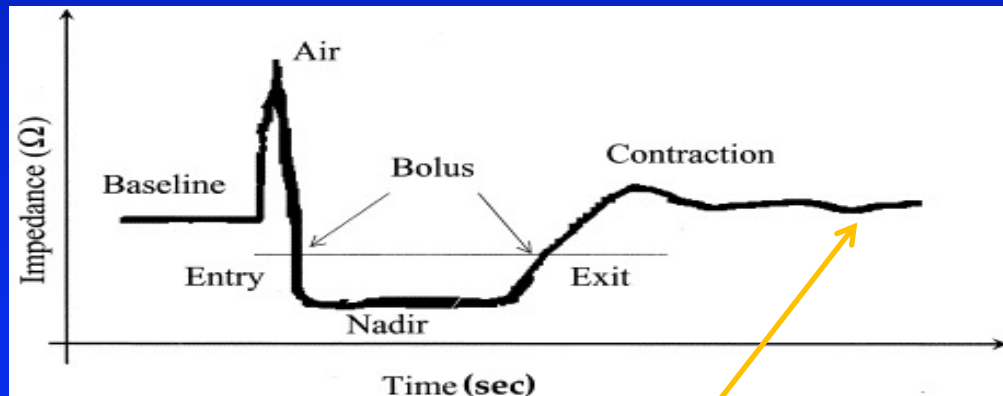
Washington University in St. Louis

Disclosures: Medtronic (consulting, speakers' bureau), Diversatek, Ironwood, Quintiles (consulting)

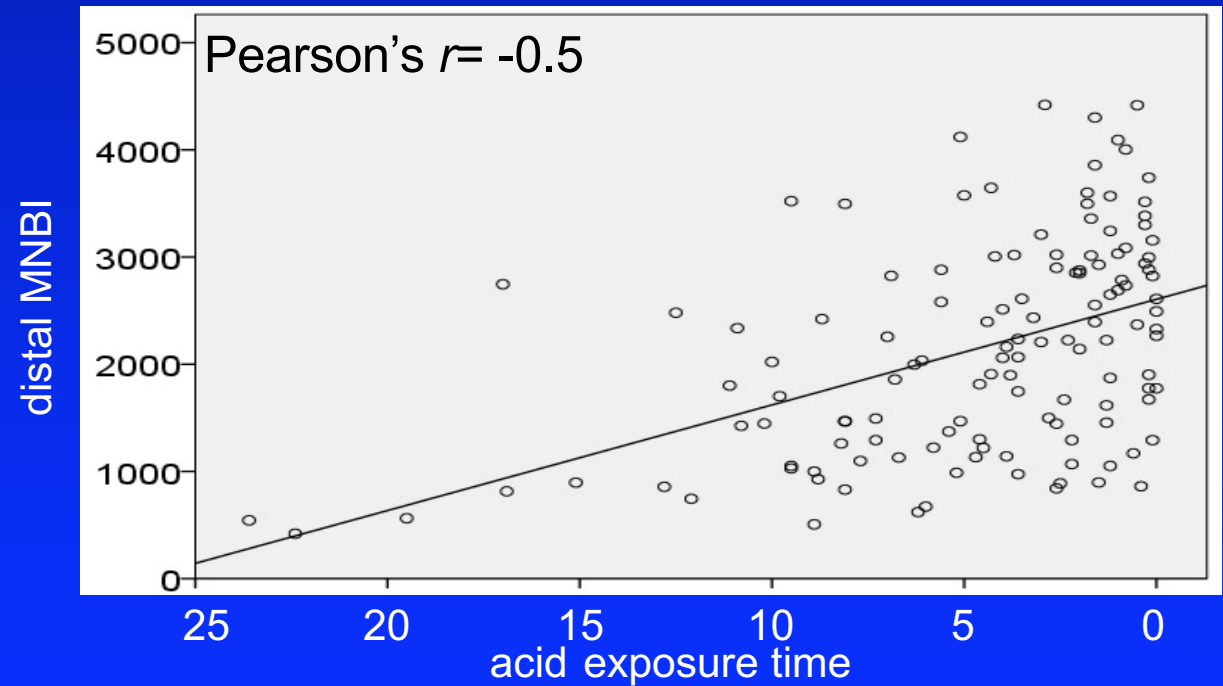
- Baseline impedance
- Esophageal clearance
- Motor patterns

Newer Metrics: Markers of Longitudinal Injury

Impedance signature of a bolus passing across a pair of sensors



baseline impedance



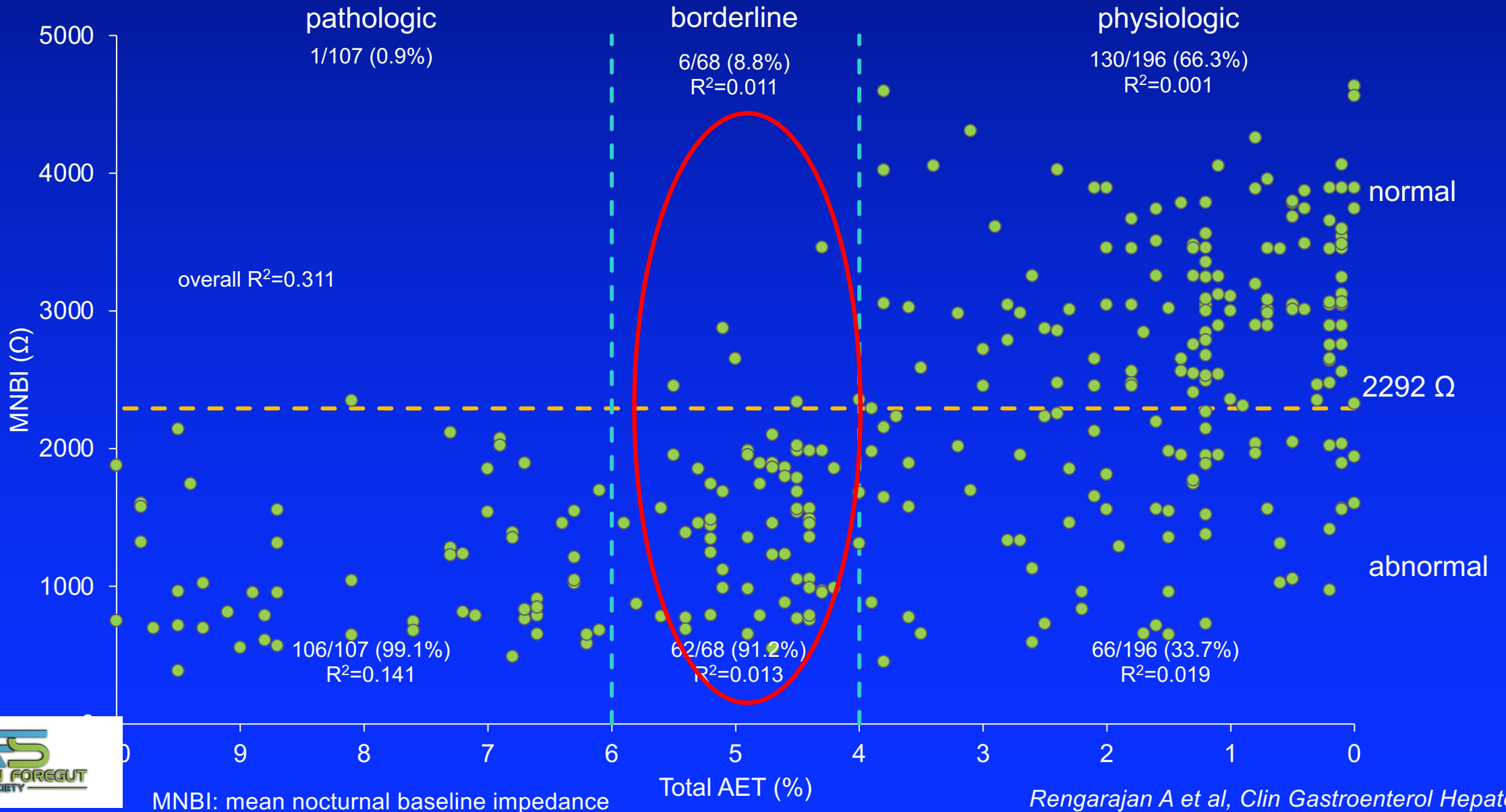
Patel A, Gyawali CP et al, APT 2016

Kessing et al, Am J Gastroenterol 2011;106:2093-7

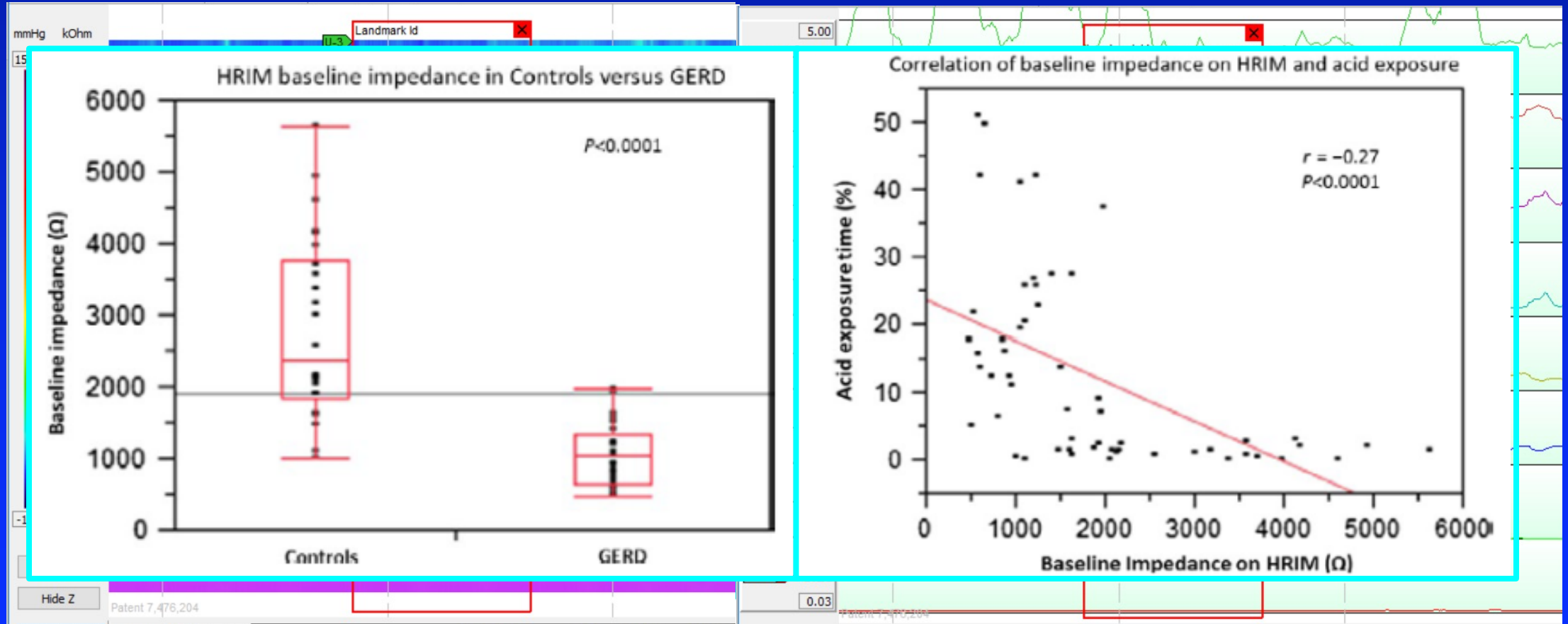
Mean Nocturnal Baseline Impedance

MNBI
Recumbent
Nocturnal
Around 1 AM - 3 AM
10 min periods
No artifacts or reflux
Averaged
3 and 5 cm above LES

Using MNBI in GERD Diagnosis

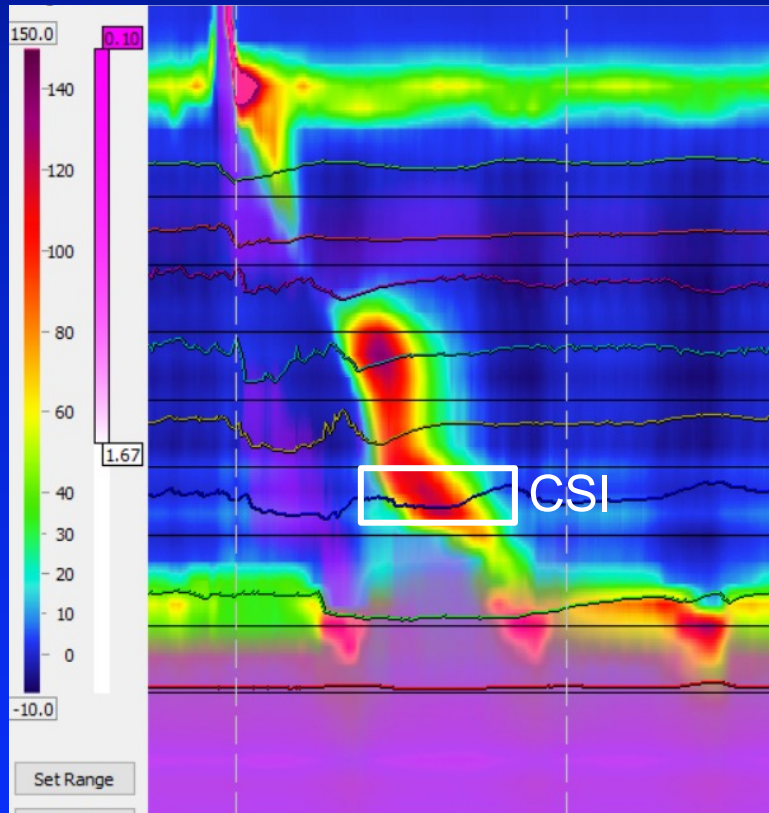


Baseline Impedance from High Resolution Impedance Manometry



Contractile Segment Impedance (CSI)

Prediction of esophageal acid exposure and MNBI



Baseline impedance from HRIM correlates with MNBI
Presence of water bolus can confound recording

40 patients

59.0±1.6 years

28% female

BMI 30.9±0.8

85%:heartburn

15%: regurgitation

All studied with HRIM and pH-impedance monitoring off PPI

When CSI>500 ohms,
only 4% had AET>4%

Performance characteristics of
CSI<500 ohms in predicting AET>4%:
sensitivity: 91%
negative predictive value: 96%

Baseline Impedance

- ✓ Easy to calculate
- ✓ Inversely correlates with AET
- ✓ Predicts outcome
- ✓ Useful when AET is inconclusive

Influenced by

- fluid
- other inflammation
- dilated esophagus
- artifact

100
80
60
40
20

PSPW index

0.75
0.65
0.55
0.45
0.35
0.25

p<0.001 across groups for PSPW
p<0.001 across groups for total, upright and supine AET

PSPW index
upright AET
total AET
supine AET

100% intact <50% ineffective 50-70% ineffective ≥80% ineffective 100% absent

motor pattern

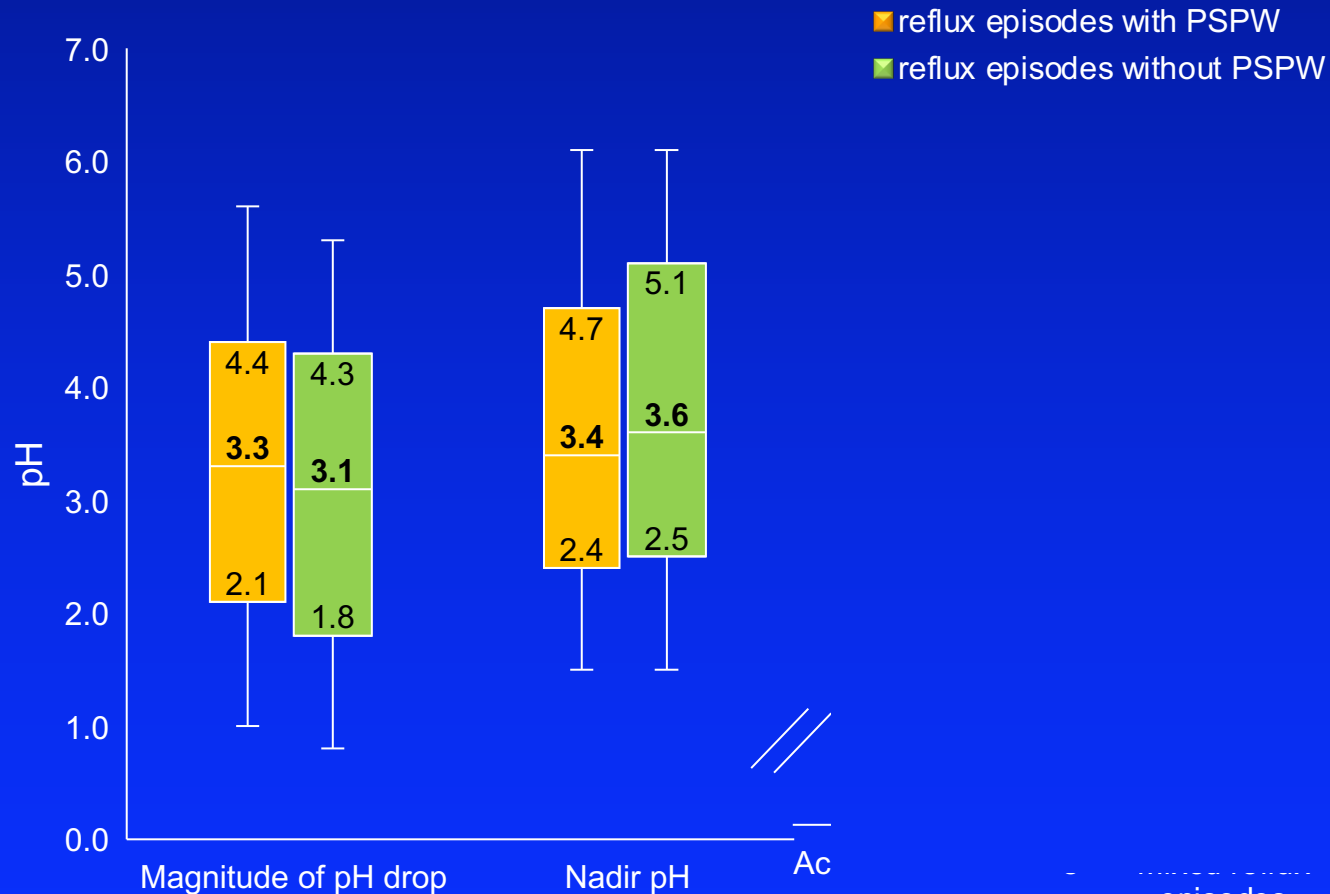
Rogers BD et al, Neurogastroenterol Motil 2020



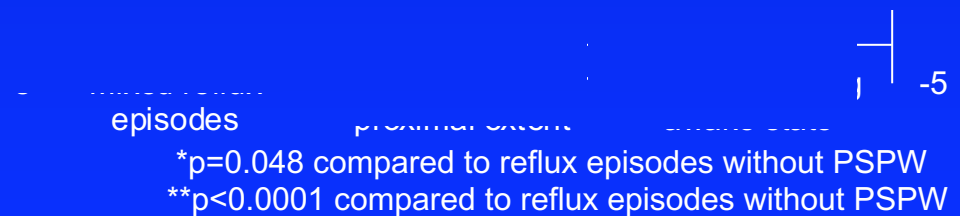
Frazzoni M, Savarino E et al, CGH 2016;14:40-6

VCPW: volume clearing peristaltic wave
PSPW: post-reflux swallow induced peristaltic wave

PSPW



p=ns for each pH comparison between reflux episodes with and without PSPW



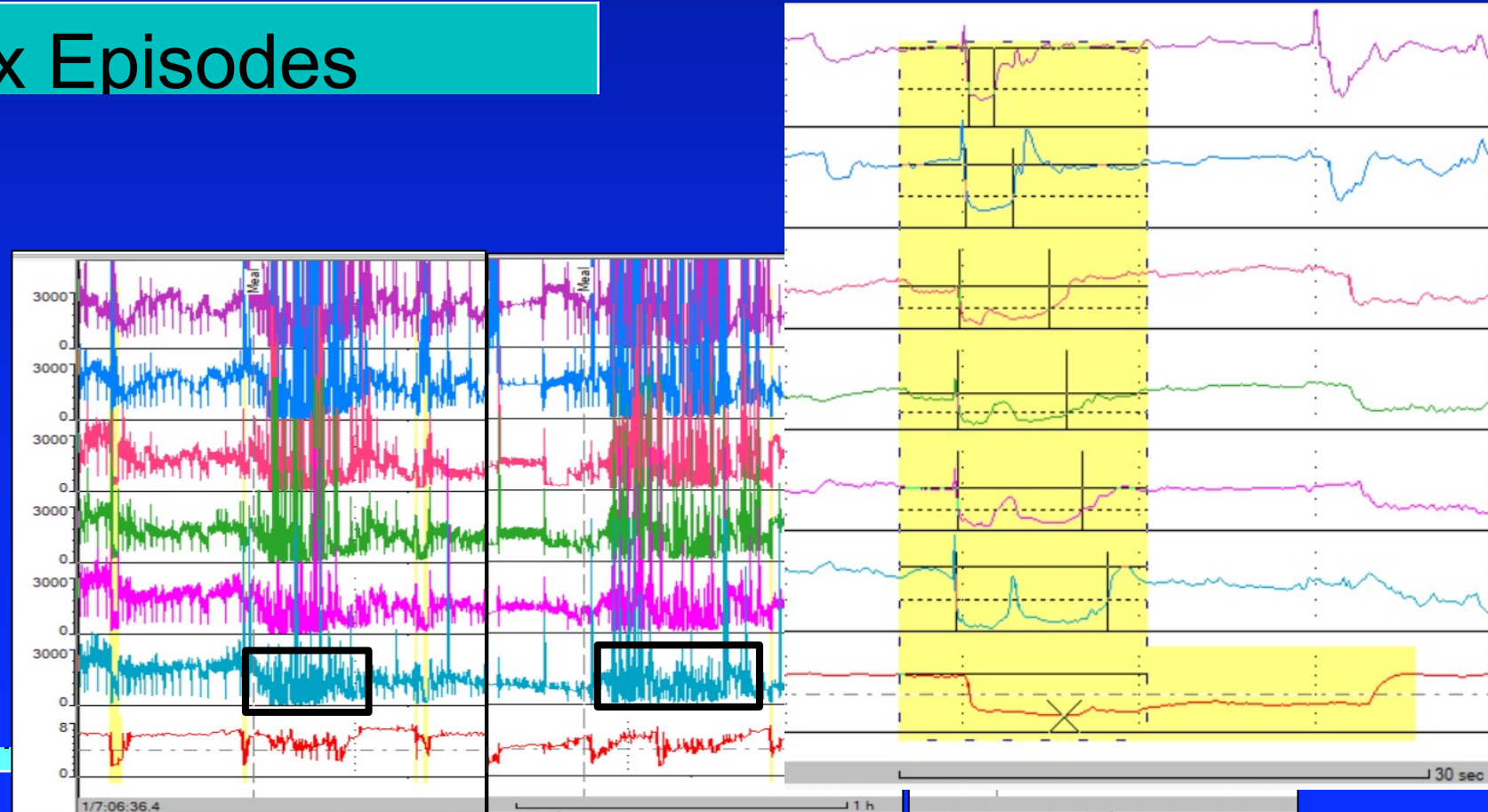
*p=0.048 compared to reflux episodes without PSPW
 **p<0.0001 compared to reflux episodes without PSPW

Zhang M et al, J Gastroenterol 2020; 55:1109-18.

pH Impedance Monitoring

The Wingate Consensus

Reflux Episodes



Gyawali CP et al, *Clin Gastroenterol Hepatol* 2021;19:1976-1978.

Multidisciplinary Collaboration. Personalized Treatment Strategies. Patient Advocacy.

pH Impedance Monitoring

The Wingate Consensus

Reflux Episodes

Meal times identified and excluded

50% retrograde impedance drop of ≥ 4 s in distal 2 impedance channels counted as reflux episode

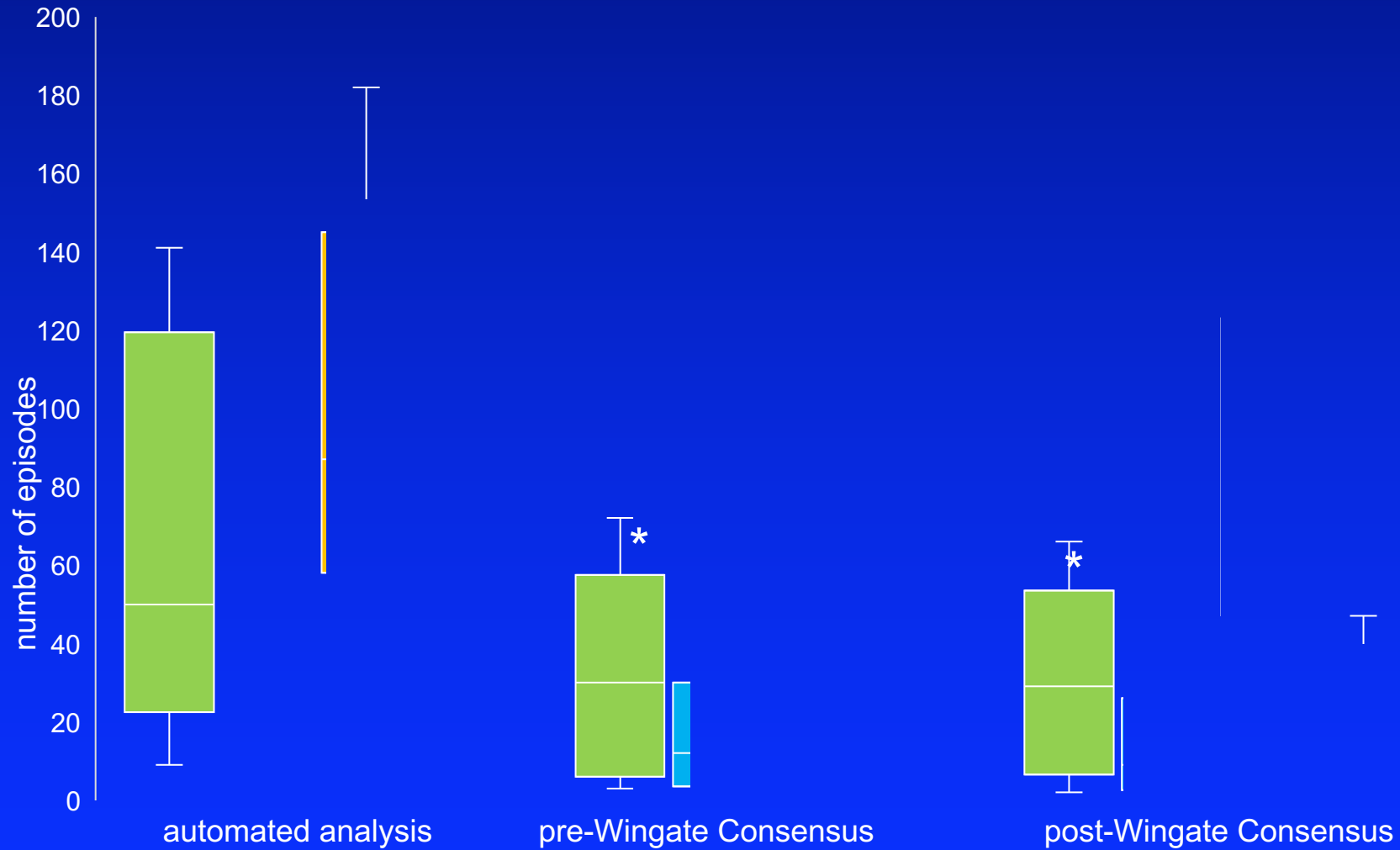
pH drop < 4.0 concurrent with above following a belch counted as a reflux episode

pH drop without above counted for AET but not as reflux episode

Automated analysis is followed by manual confirmation/deletion of reflux episodes

PSPW: post-reflux swallow induced peristaltic wave

■ reflux episodes:healthy controls ■ PSPW:healthy controls
■ reflux episodes:GERD patients ■ PSPW:GERD patients



*p≤0.001 compared to automated analysis

**p=0.05 compared to pre-Wingate Consensus

Gyawali CP et al, Clin Gastroenterol Hepatol 2021;19:1976-1978

Multidisciplinary Collaboration. Personalized Treatment Strategies. Patient Advocacy.



Baseline Impedance

- ✓ Easy to calculate
- ✓ Inversely correlates with AET
- ✓ Predicts outcome
- ✓ Useful when AET is inconclusive

Influenced by

- fluid
- other inflammation
- dilated esophagus
- artifact

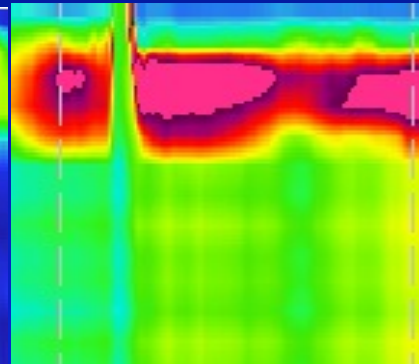
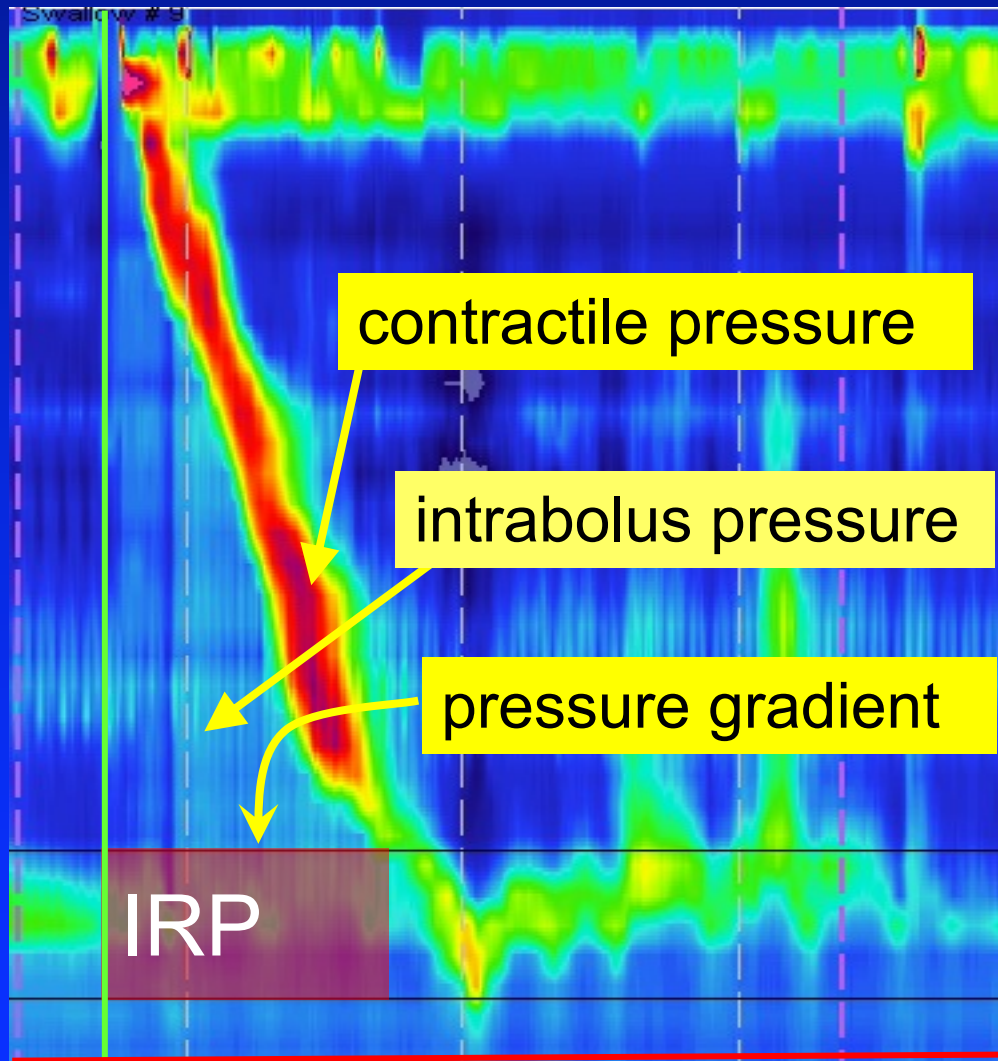
Esophageal Clearance

- ✓ PSPW assesses chemical clearance
- ✓ Triggered by reflux
- ✓ Inversely correlates with AET

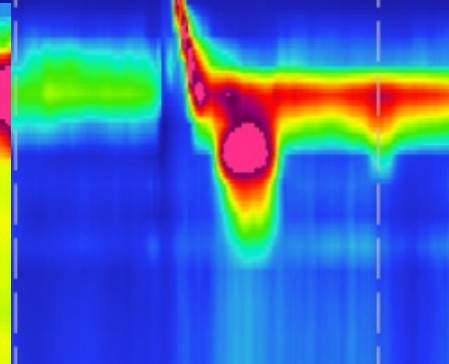
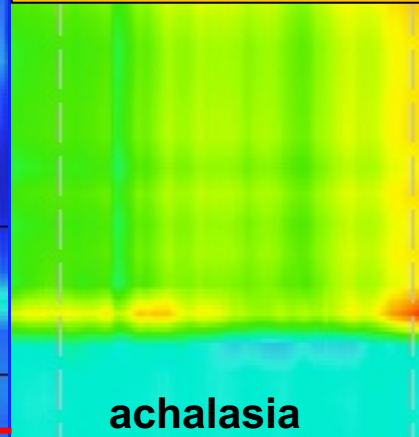
Influenced by

- interpretation/reviewer
- reflux episodes
- ?saliva formation
- motor pattern

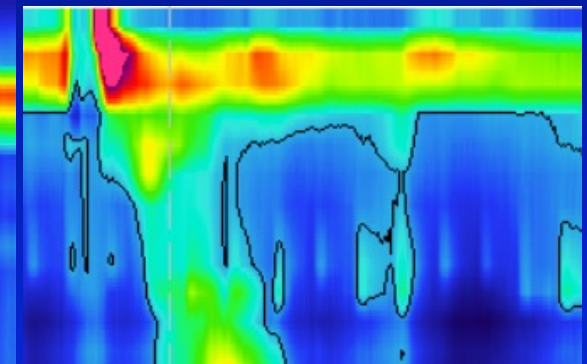
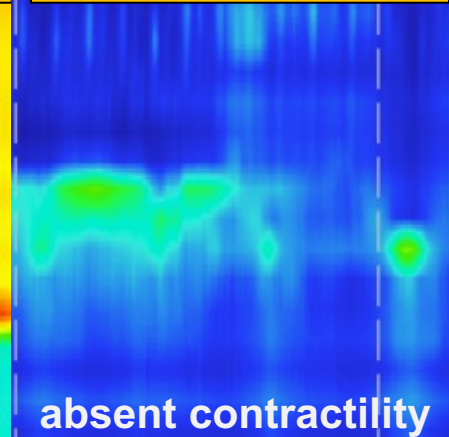
HRM



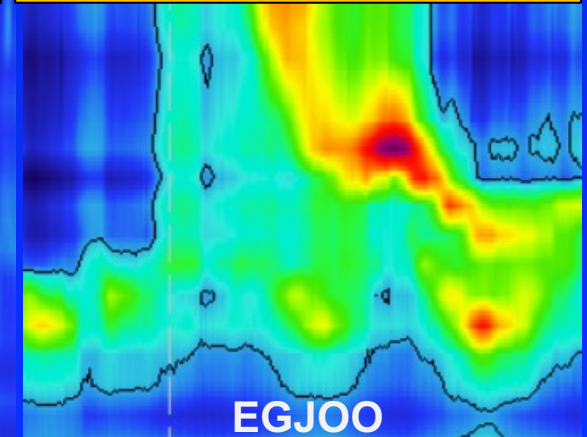
1.0-2.5% of 'GERD' referred for anti-reflux surgery



3.2% of 'GERD' referred for anti-reflux surgery

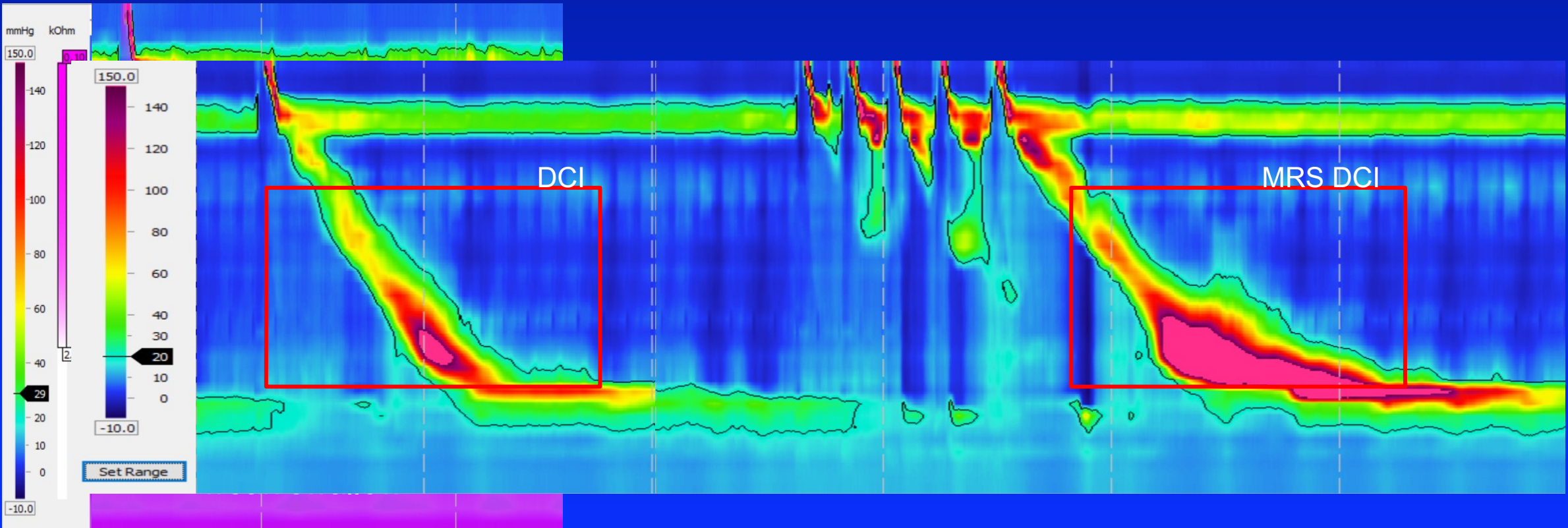


Heterogenous pattern
Artifact in some cases
Stricture, hiatus hernia
Achalasia variant



Concept of Contraction Reserve

Multiple Rapid Swallows: 5 rapid swallows of 2 mL water each



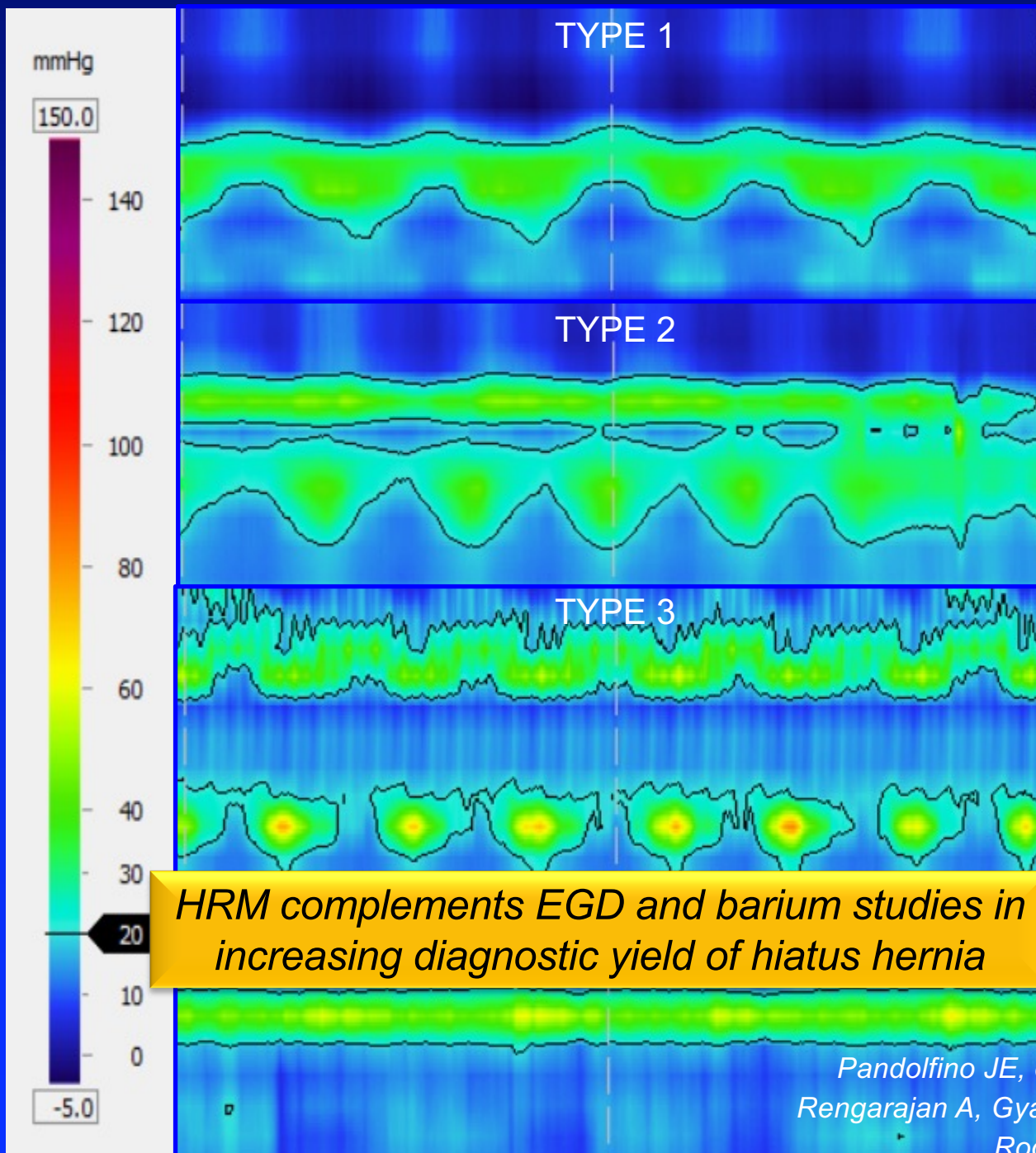
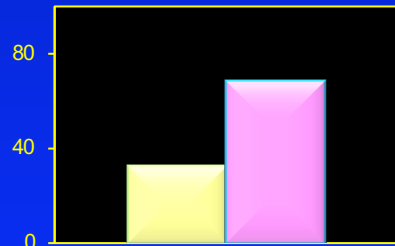
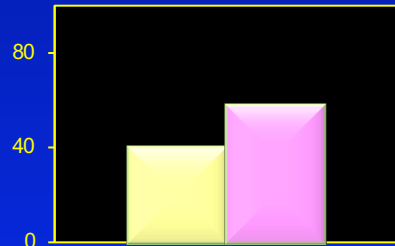
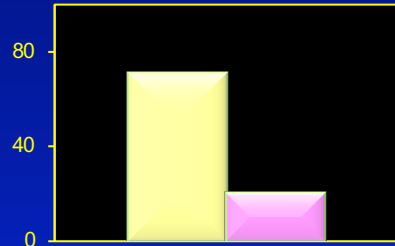
normal response: $MRS\ DCI > \text{mean DCI from single swallows}$
No contraction during multiple rapid swallows

157 patients with 2.1 ±0.2 yr follow up
 54.8% had early post-fundoplication dysphagia
 18.5% had late post-fundoplication dysphagia (lasting >6 weeks post surgery)

Predictors of post-fundoplication dysphagia	Univariate		Multivariate	
	OR	95% CI	OR	95 % CI
<i>n=157, 2.1 yr follow up</i>				
Age (years)	0.99	0.96, 1.02	0.97	0.92, 1.02
Gender (F)	2.10	0.75, 5.92	1.12	0.25, 4.95
Pre-fundoplication dysphagia	2.95	1.25, 6.98	1.15	0.34, 3.87
Early post-fundoplication dysphagia	3.10	1.23, 7.76	1.40	0.34, 5.83
Dysmotility on post-fundoplication barium swallow	2.17	0.89, 5.24	1.43	0.19, 10.67
Recurrent Hernia on barium swallow			3.37	0.36, 31.50
Absent contraction reserve			3.73	1.11, 12.56

In patients with persistent reflux symptoms, HRM rules out motor disorders, and assesses esophageal peristaltic performance

Reflux burden: ■ normal ■ abnormal



Healthy controls <i>n</i> =484	GERD patients <i>n</i> =482
-----------------------------------	--------------------------------

97.1%	61.8%
-------	-------

2.9%	25.9%
------	-------

0	12.2%
---	-------

HRM had sensitivity of 94.3% and specificity of 91.5% in detecting hiatus hernia using hernia size at surgery as gold standard compared to endoscopy (96.2%, 74.5%) and barium radiography (69.8%, 97.9%)

Tolone et al, UEG Journal 2018

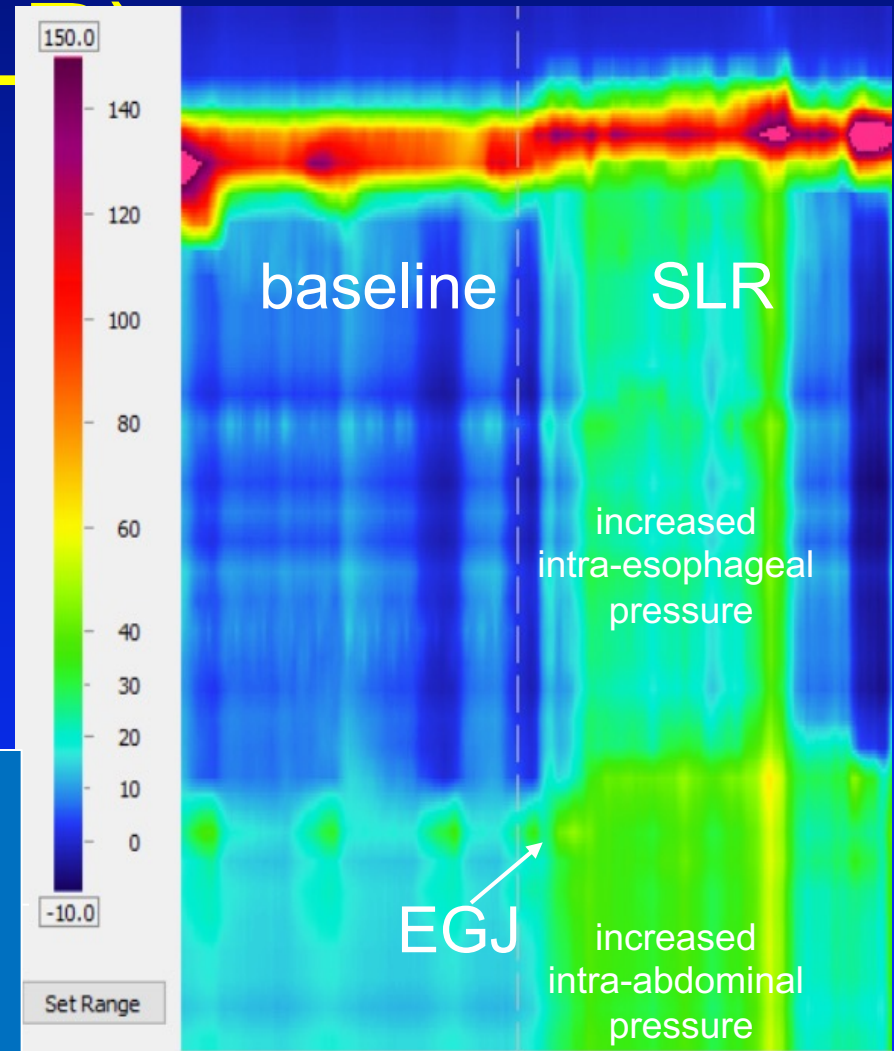
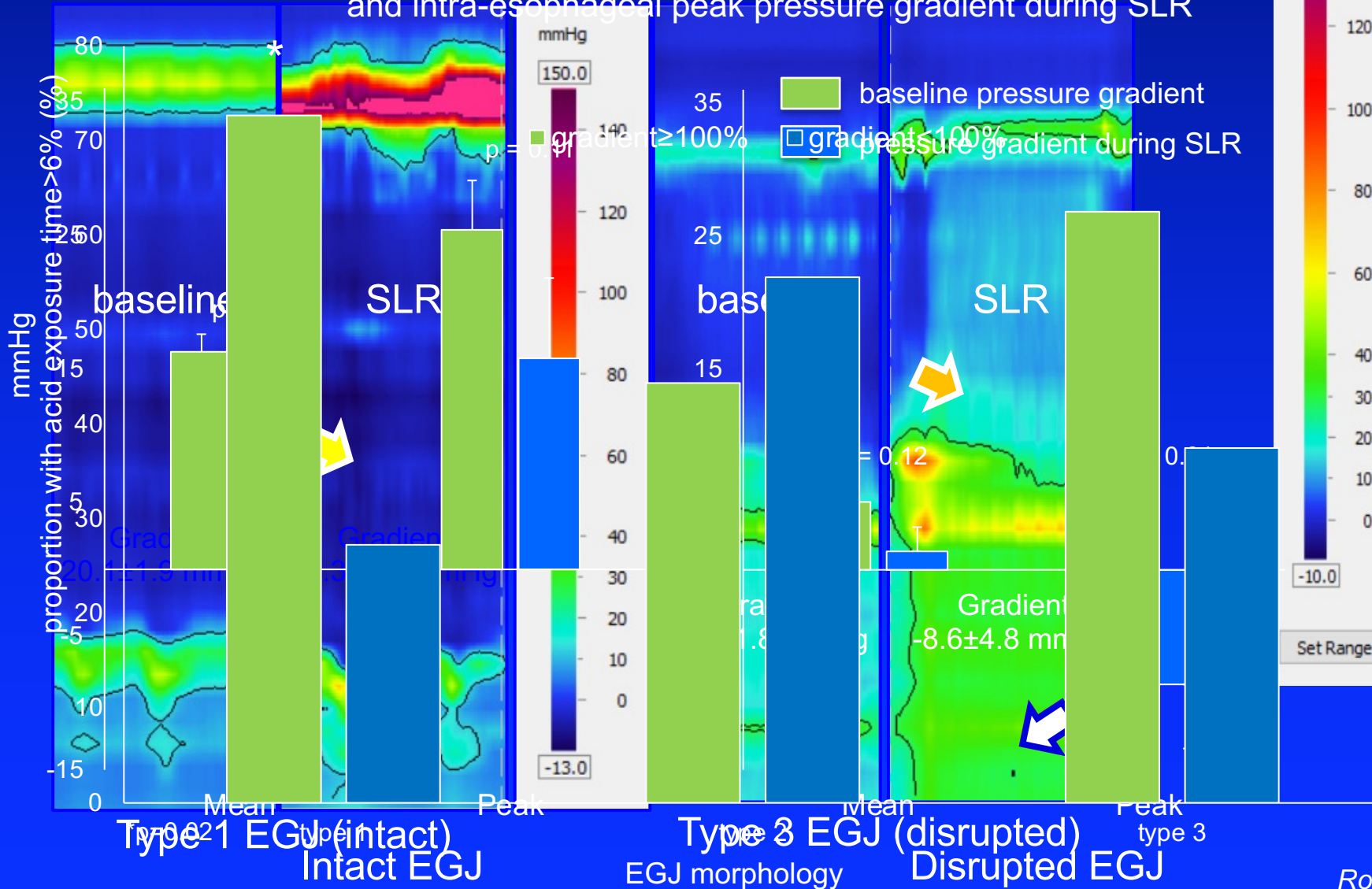
Pandolfino JE, et al. Am J Gastroenterol 2007; 102:1056-63

Rengarajan A, Gyawali CP. J Clin Gastroenterol 2020;54:22:27

Rogers BD et al. Neurogastroenterol Motil 2020

Straight Leg Raise (SLR)

proportion with total AET > 6% based on EGJ morphology and intra-esophageal peak pressure gradient during SLR



Other Mimickers of Esophageal Symptoms

Post prandial study: monitoring for 30-90 min following a meal

Clinical management: GERD mimickers not often identified

Behavioral Disorder

Supragastric Belching, Rumination

3 raters, 22 pH-impedance and PP HRIM studies

- Inter-rater agreement was higher for pH-impedance monitoring
 - Diagnostic yield was higher for post prandial HRIM
- Inter-rater agreement is higher when clinical context was provided

pH-impedance monitoring can be used for investigation of excessive belching

Post-prandial HRIM can be used for investigation of suspected rumination

Rumina

Normal

Baseline Impedance

- ✓ Easy to calculate
- ✓ Inversely correlates with AET
- ✓ Predicts outcome
- ✓ Useful when AET is inconclusive

Influenced by

- fluid
- other inflammation
- dilated esophagus
- artifact

Esophageal Clearance

- ✓ PSPW assesses chemical clearance
- ✓ Triggered by reflux
- ✓ Inversely correlates with AET

Influenced by

- interpretation/reviewer
- reflux episodes
- ?saliva formation
- motor pattern

Manometry

- ✓ Rules out achalasia
- ✓ Assesses peristaltic performance
- ✓ Identifies mimickers of reflux

Influenced by

- morphology and tone
- quality of study
- quality of interpretation
- provocative maneuvers



Division of **Gastroenterology**



 **Washington**
University in St. Louis
SCHOOL OF MEDICINE

Birthplace of High Resolution Manometry
St. Louis, Missouri, USA