

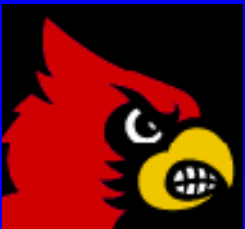
Overview of GI Motility

John M. Wo, M.D.

Division of Gastroenterology/Hepatology

University of Louisville

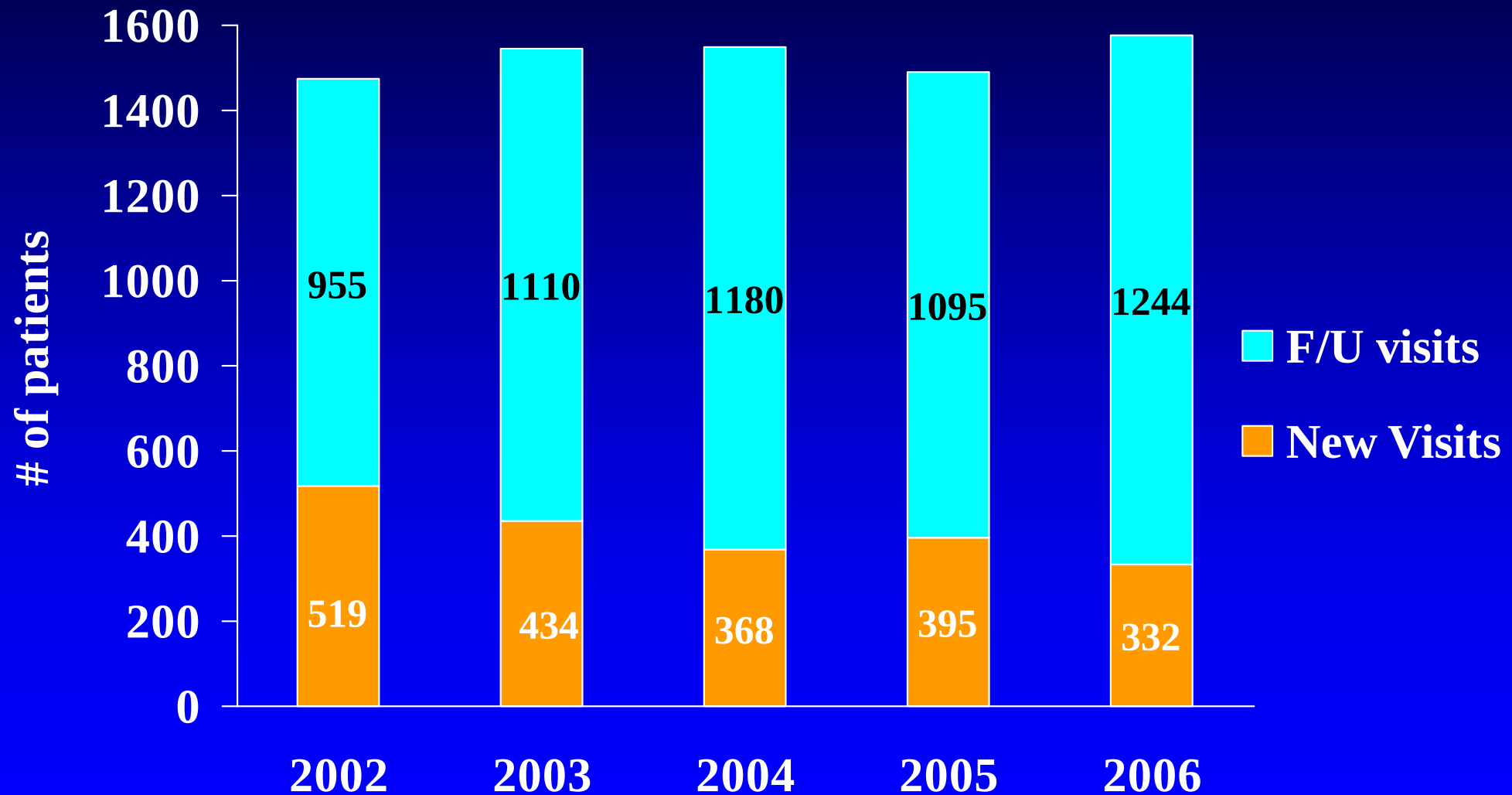
July 5, 2007



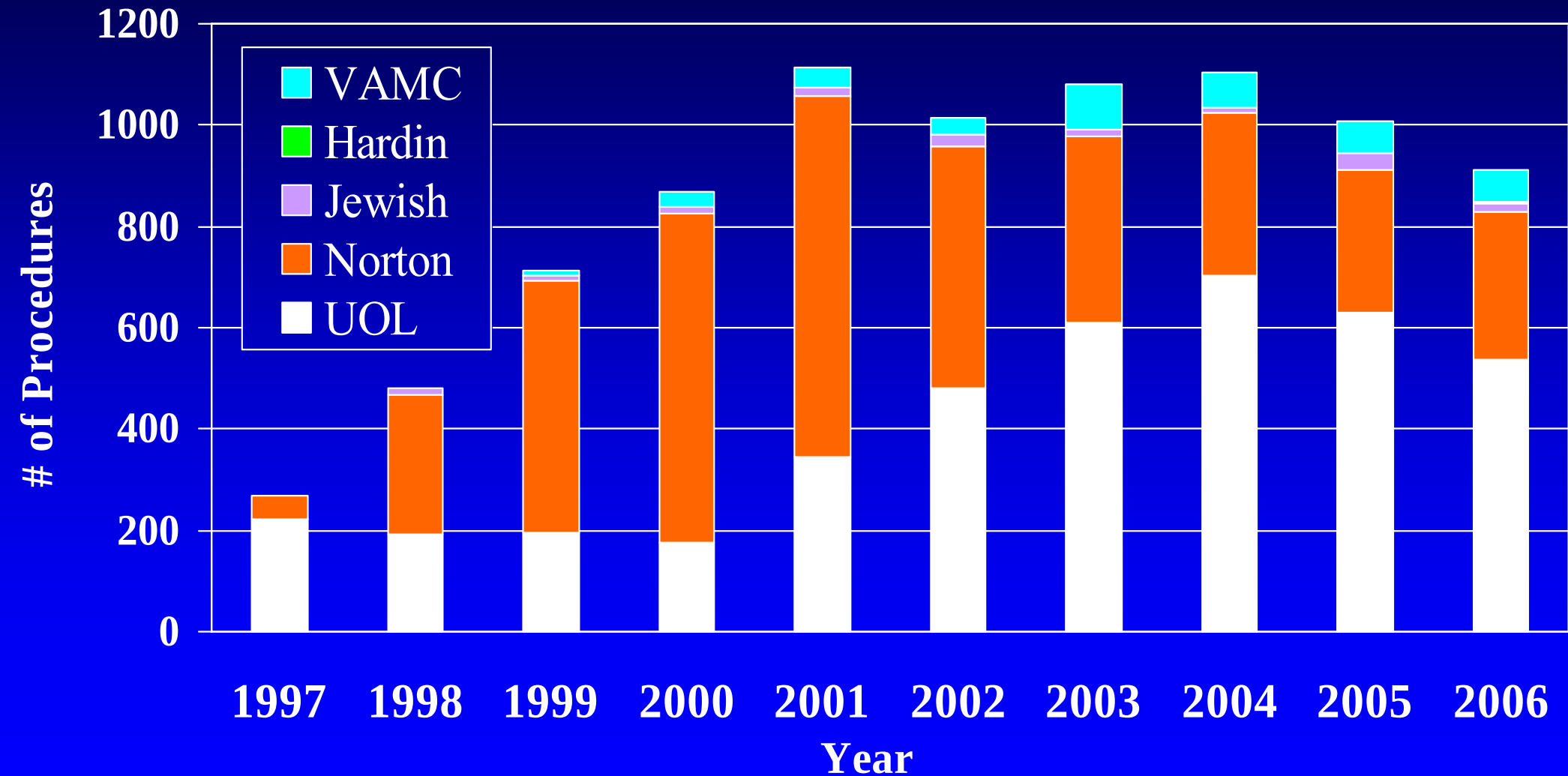
Overview of GI Motility (Neurogastroenterology)

- Motility training during fellowship
- Do's and Don'ts for taking care of motility patients
- Control of GI motility
- Overview of motility diagnostic testing

DHC Motility Clinic Patients



Motility Diagnostic Testing*



*Studies read by Dr. Wo

Motility Training during Fellowship

- VA 3rd GI fellow

	Monday	Tuesday	Wednesday	Thursday	Friday
7	VA GI	VA GI		GI Conferences	VA GI
8			*Nutrition Mtg		
9			Motility Lab		
10				Motility Lab	
11					
Noon				Motility Conference	
1pm	DHC Redinger	DHC Wo Clinic	VA Fellow	DHC Wo Clinic or	UofL Fellow
2	Clinic		Clinic	Research	Clinic
3					Read Motility with
4					Wo

Motility Training during Fellowship

- DHC clinic fellow/Research/Elective

	Monday	Tuesday	Wednesday	Thursday	Friday
7a				GI Conferences	
8	Marsano	Dryden	Nutrition Mtg		Research
9	or Research	or Wo	Research		or Motility Lab
10		or Research		Research	or DHC Endo
11					
Noon				Motility Conference	
1pm	Krueger	McClain	VA Fellow	Research	UofL Fellow
2	or McClave	or Dryden	Clinic		Clinic
3		or Wo		Transplant Mtg	
4		or Research			

Do's and Don'ts in Taking Care of Motility Patients

Do's

- Do call Dr. Wo if his patient is admitted
- Do call him on weekend and night if needed
- Do use home health

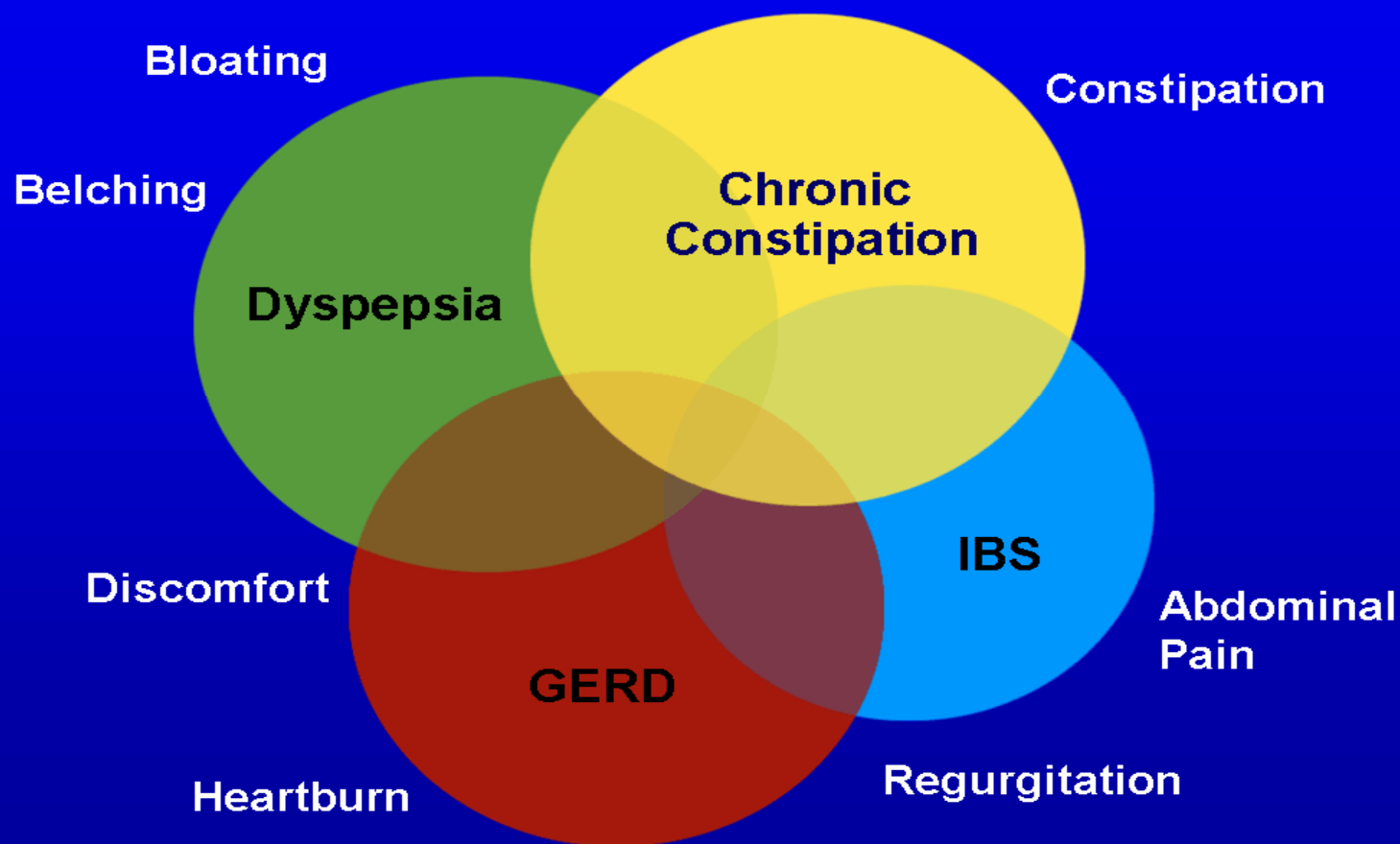
Don'ts

- Don't prescribe opiate
- Don't accept transfer for Dr. Wo
- Don't accept transfer from outside ER

Wo's Cocktail for Nausea and Vomiting: Home Health or In-Patient

- IV fluid bolus and drip
- IV zofran 8 mg IV q8 x 48hrs
- IV reglan 10 mg IV q6
- IV erythromycin 100 mg IV tid
- IV phenergan 25 mg IV q6 prn

There Is Significant Overlap Among GI Disorders



- 29% of GERD patients have Chronic Constipation*
- Diagnoses can shift from one disorder to another over time†
- Possible common pathophysiological mechanisms‡

*Locke GR et al. *Neurogastroenterol Motil.* 2004;16:1-6.

†Corazziari E. *Best Prac Res Clin Gastroenterol.* 2004;18:613-631.

‡Talley NJ et al. *Am J Gastroenterol.* 2003;98:2454-2459.

Differences in the GI Tract

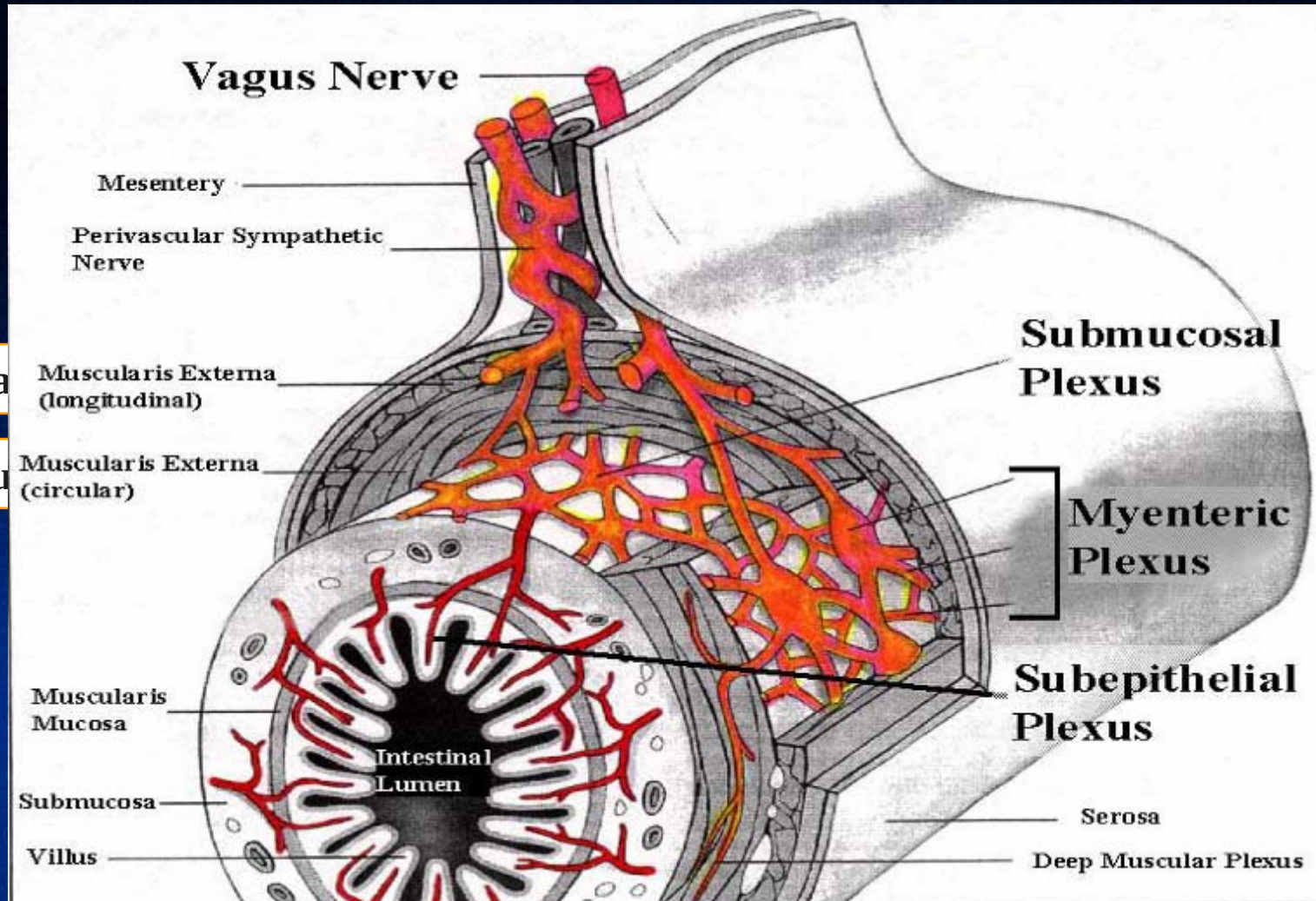
	Embryonic origin	ANS dependence	ENS dependence
Oropharynx to mid duod.	Foregut	+++	++
Small bowel to prox. colon	Midgut	++	+++
Colon to rectum	Hindgut	+	+++

ANS (autonomic nervous system); ENS (enteric nervous system)

Control of GI Motility

- Neurogenic
 - Enteric nervous system
 - Central nervous system
 - Autonomic nervous system
- Myogenic
- Regulatory peptides
 - Motilin, serotonin, secretin, ghrelin ...

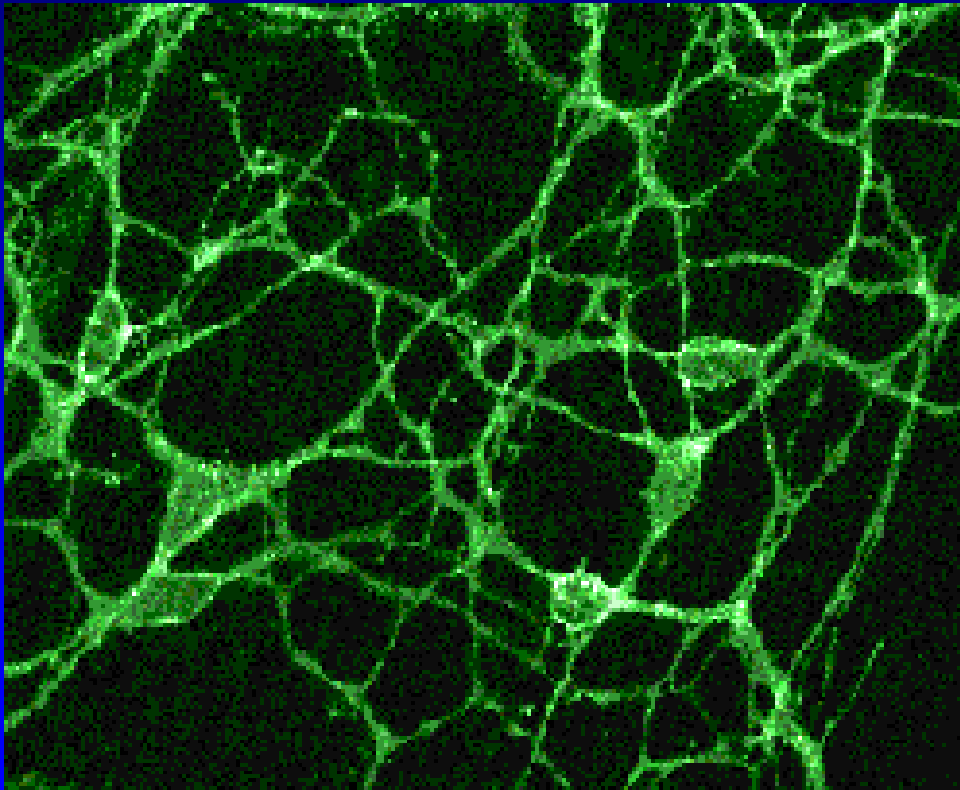
Enteric Nervous System (ENS)



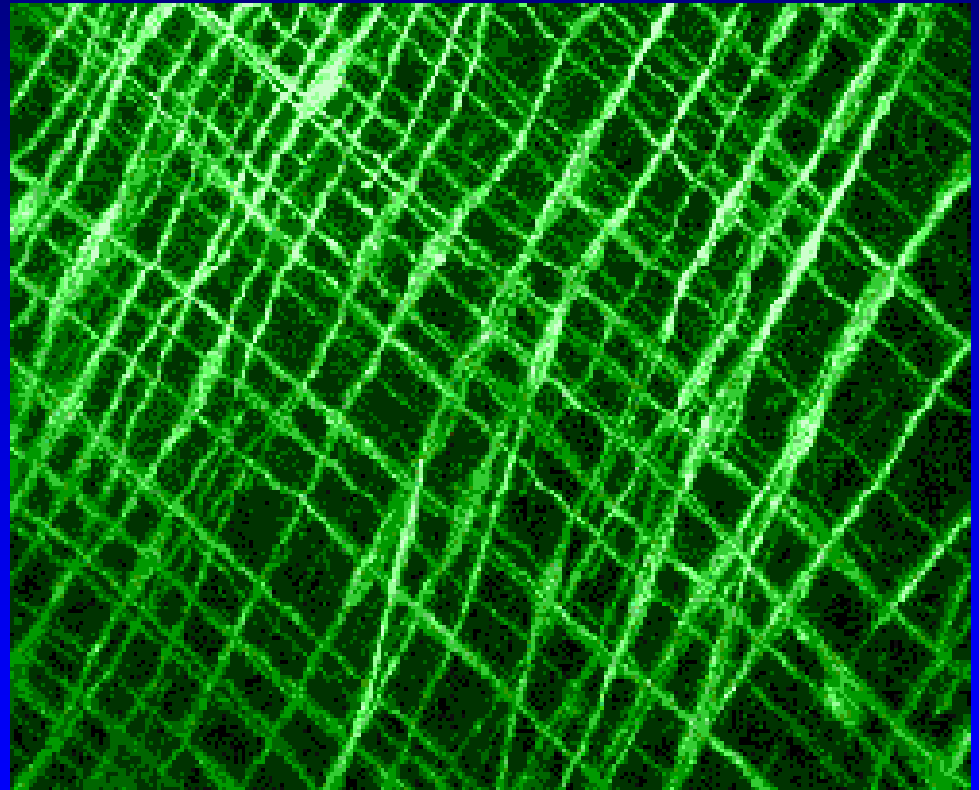
Longitudinal

Circular muscle

Interstitial Cells of Cajal: The GI Pacemakers



Small Intestines



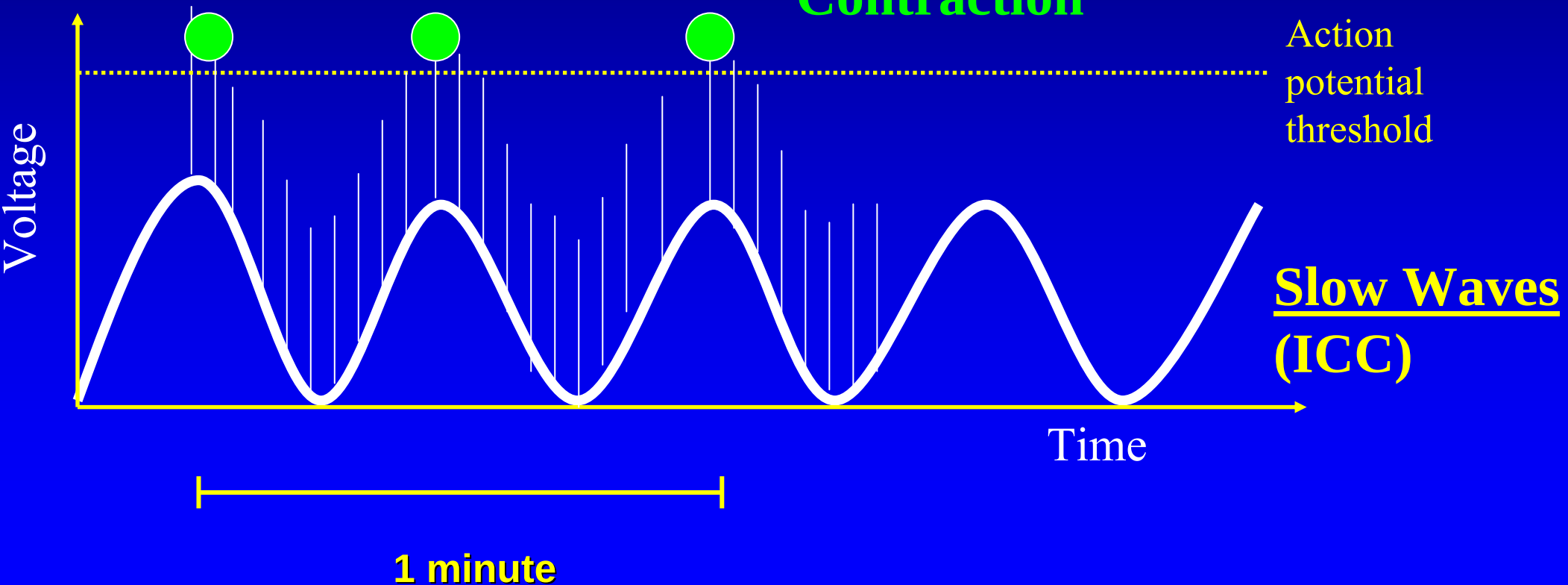
Gastric Fundus

Intrinsic Rhythm of Motility

Food, vagal input, peptides, distension

Spike Potentials

Contraction

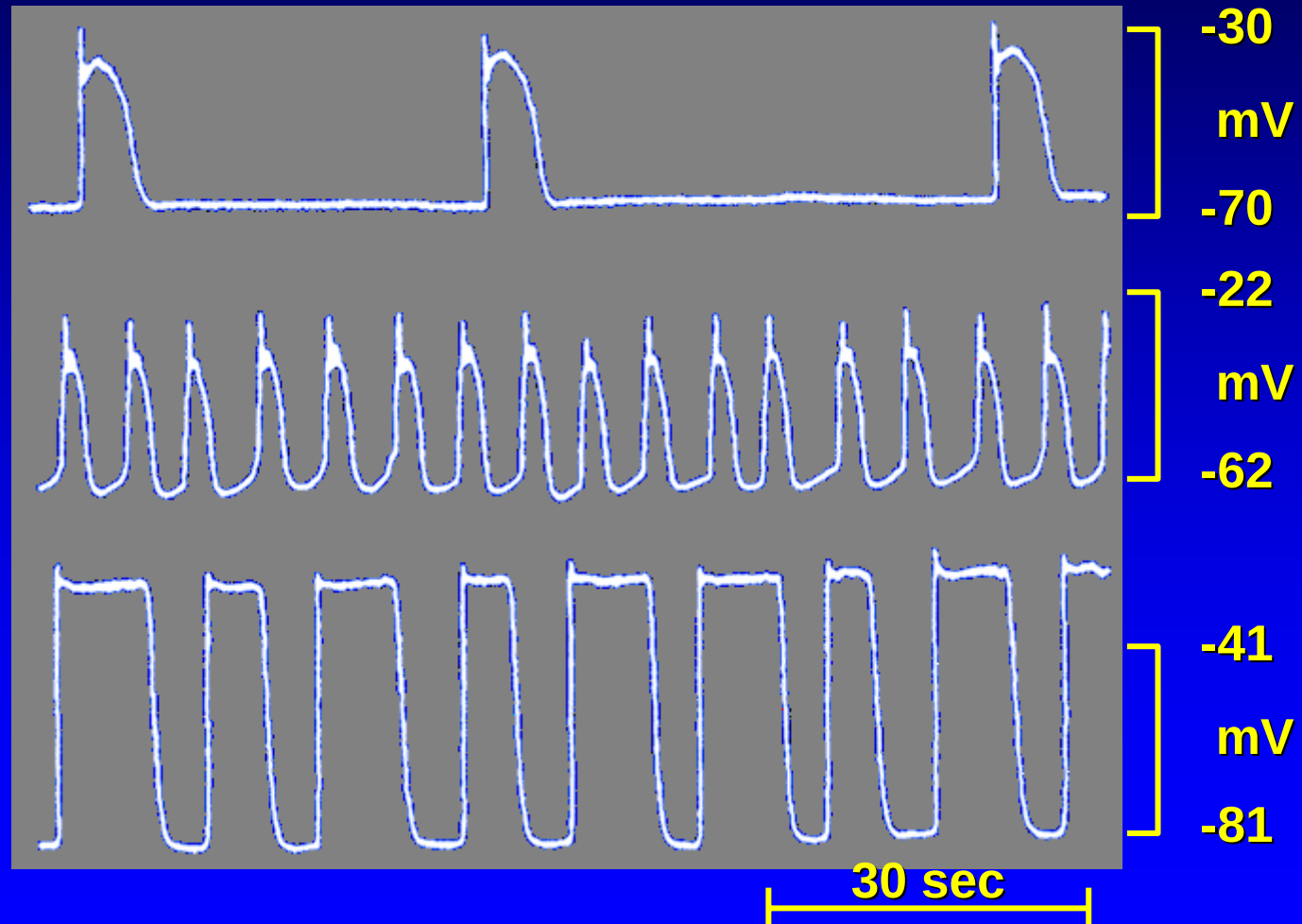


“Slow Waves”: Intrinsic Electrical Activity is Pre-programmed by Enteric Nervous System

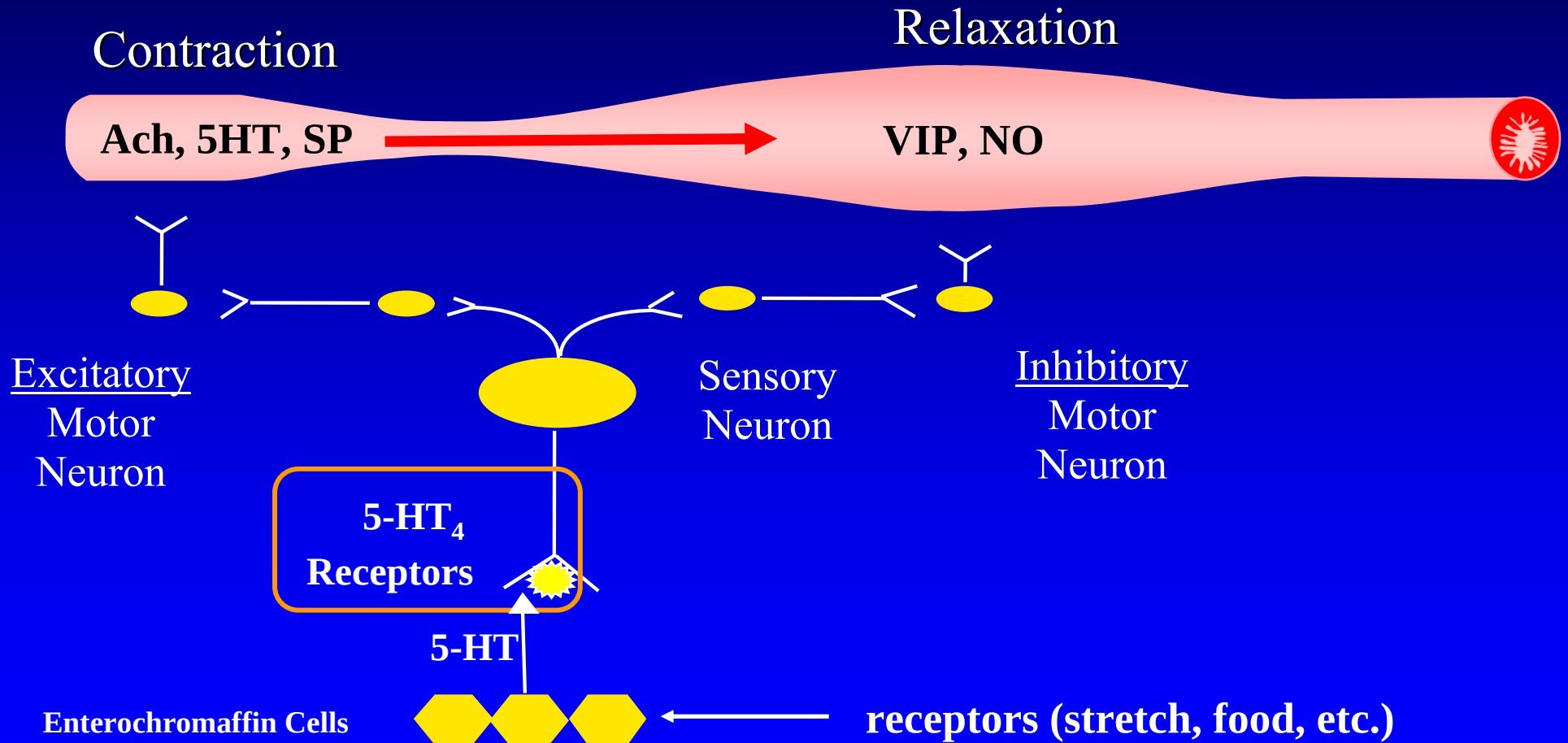
Stomach
(3/min)

Small intestine
(8-12/min)

Colon
(3-6/min)



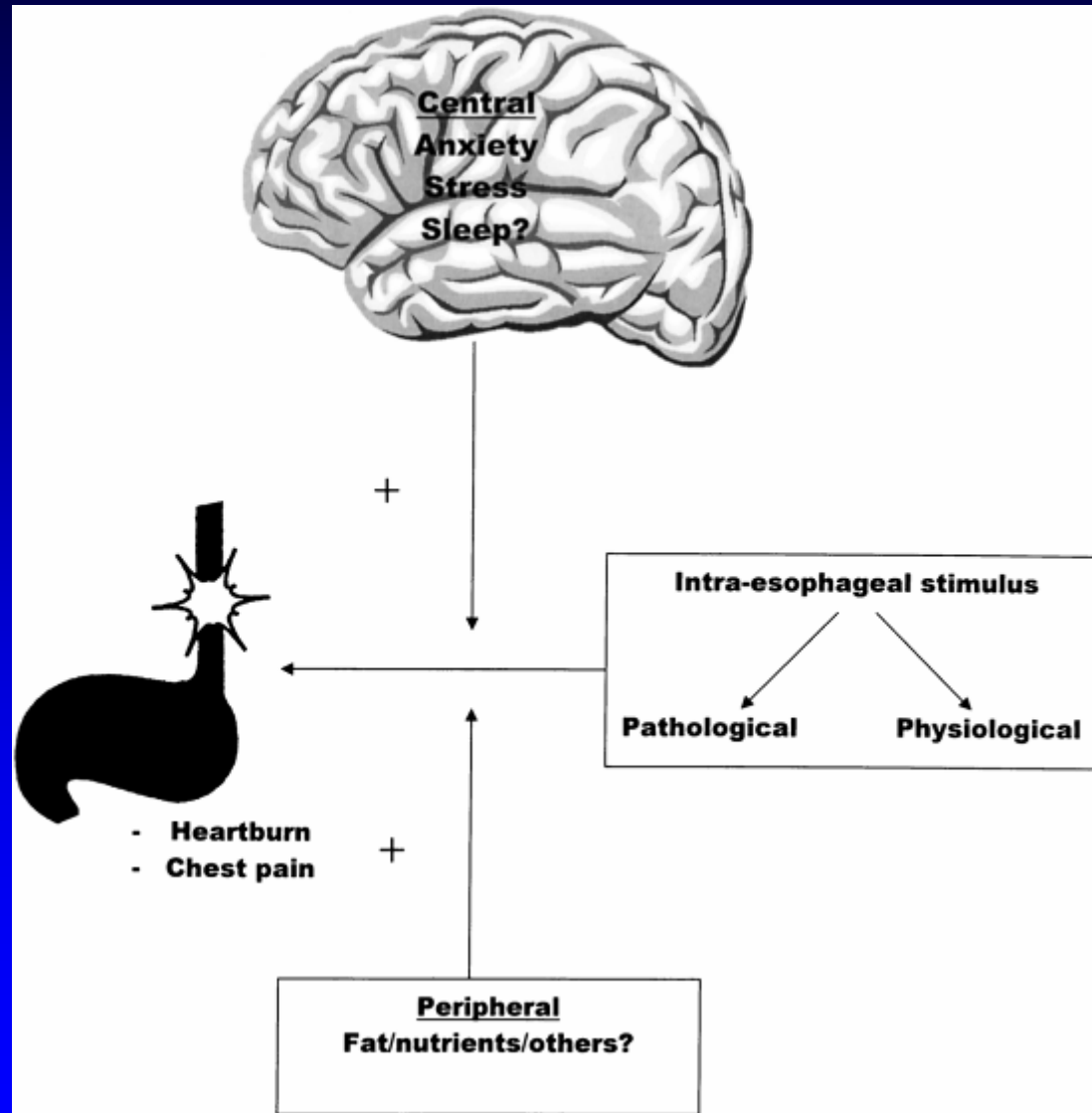
Enteric Nervous System: Peristalsis



Enteric Nervous System

- Most important control in GI motility
- Provided pre-programmed frequency and direction of peristalsis
- Can function independently of CNS
- Output is modulated by CNS, autonomic system, peptides, glucose, etc.

Control of GI Sensation (Brain-Gut Axis)

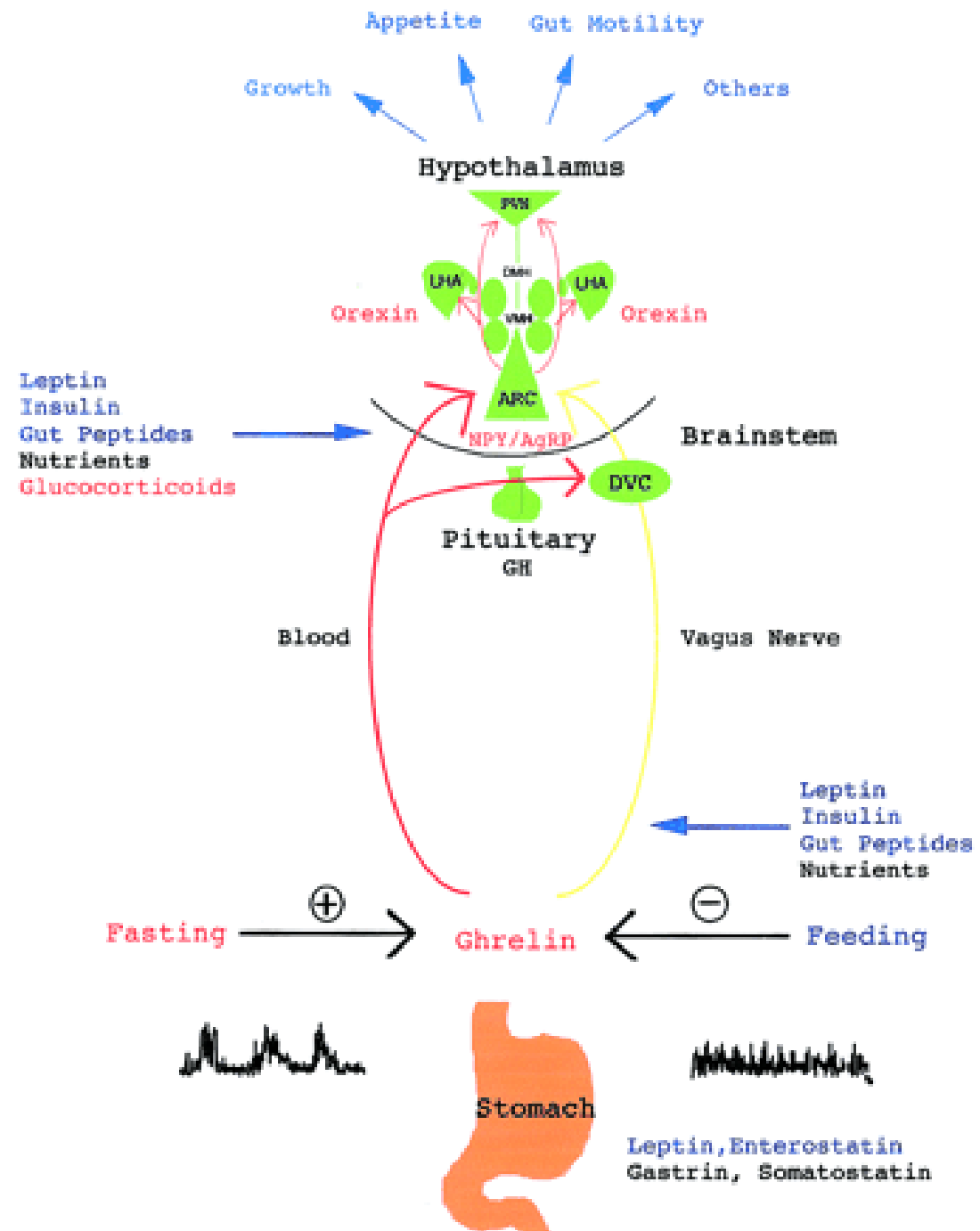


Ghrelin

- Growth hormone releasing peptide
- Synthesize by gastric neuroendocrine cells
- Activates hypothalamus →
↑↑ appetite & promote weight gain
- Motilin-related peptide

■ + Ghrelin regulation

■ - Ghrelin regulation

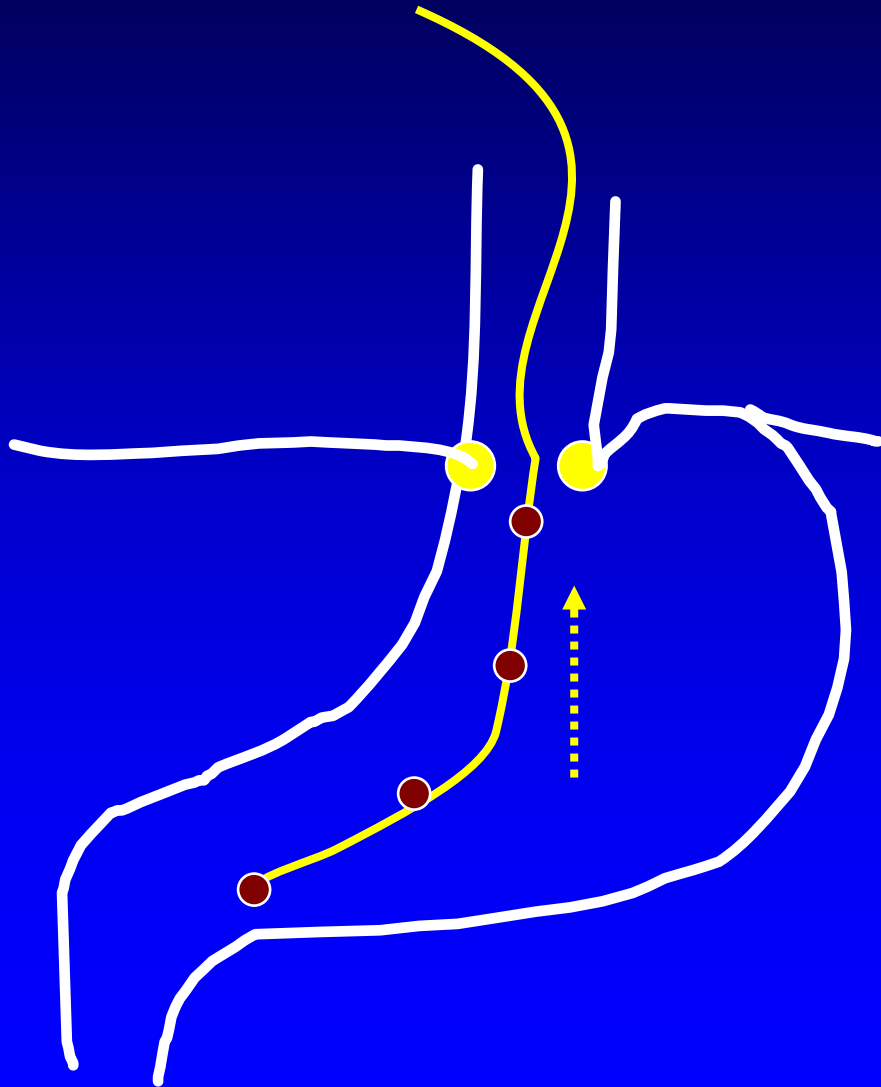


Esophagus

Esophageal Motility Testing

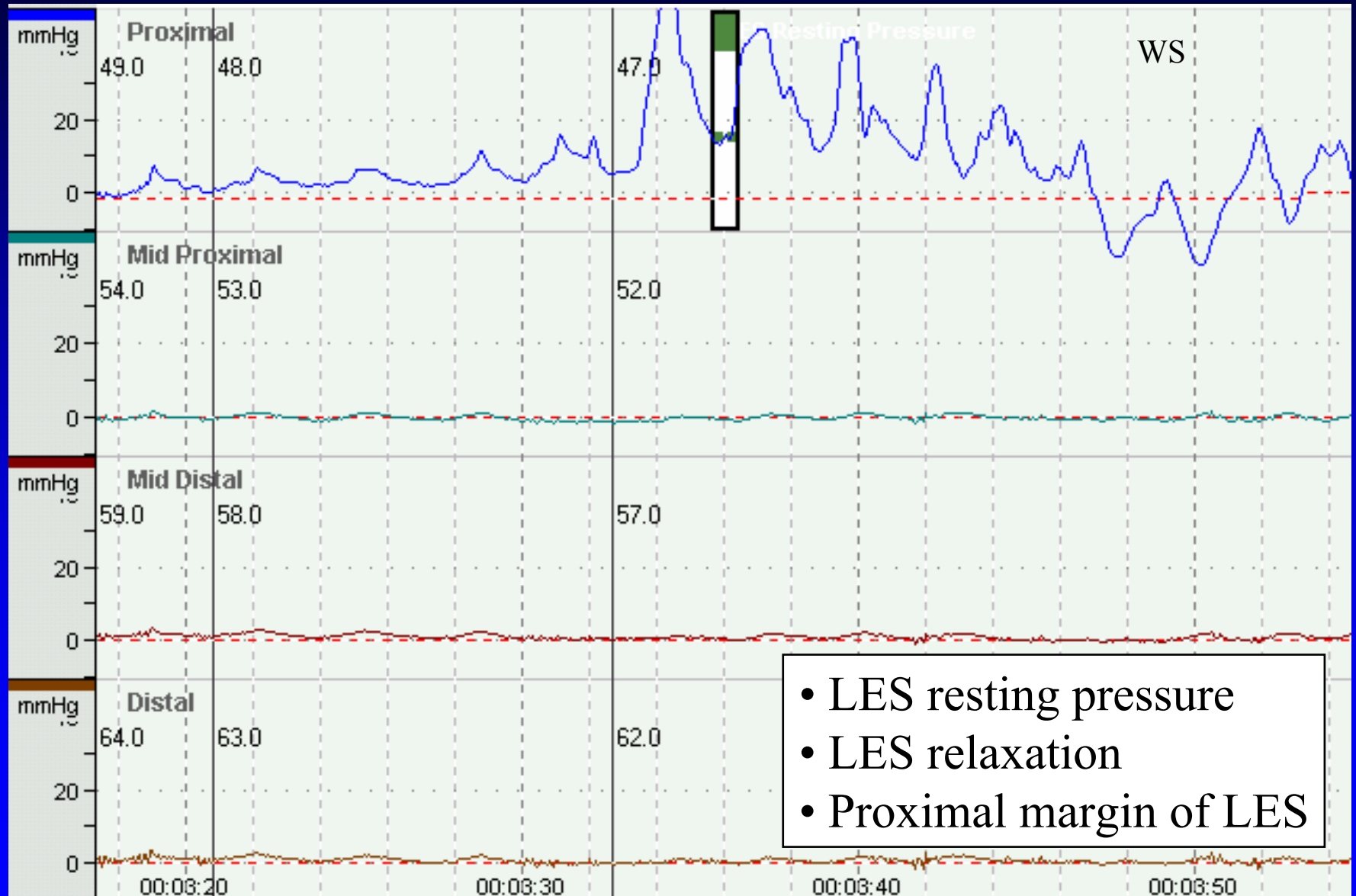
- Esophageal manometry
 - Traditional vs high resolution manometry
- Esophageal provocation tests
 - Bernstein, tensilon, balloon
- Ambulatory pH monitoring
 - Transnasal catheter
 - Bravo wireless telemetry
- Timed barium swallow
- (Ambulatory impedance monitoring)
- (Bile monitoring)

Esophageal Manometry

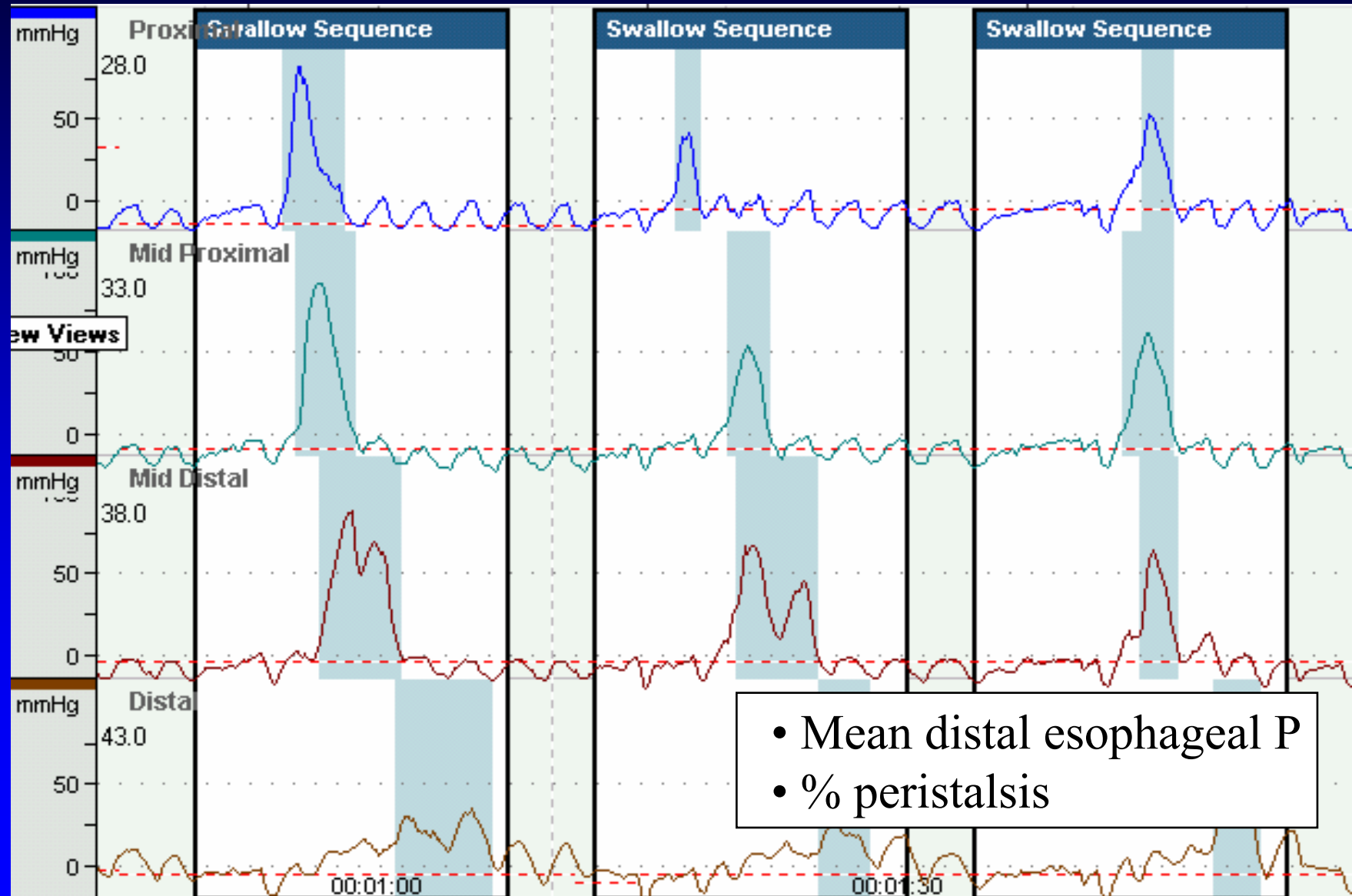


- Lower esophageal sphincter
- Esophageal body
- Upper esophageal sphincter

Esophageal Manometry: LES



Esophageal Manometry: Esophageal Body



Normal Esophageal Manometry

<u>Pressure*</u>	<u>mmHg (SD)</u>	<u>Normal</u>
- LES	15.2 (10.1)	15 - 45
- Mean dist P	99 (40)	40 - 180

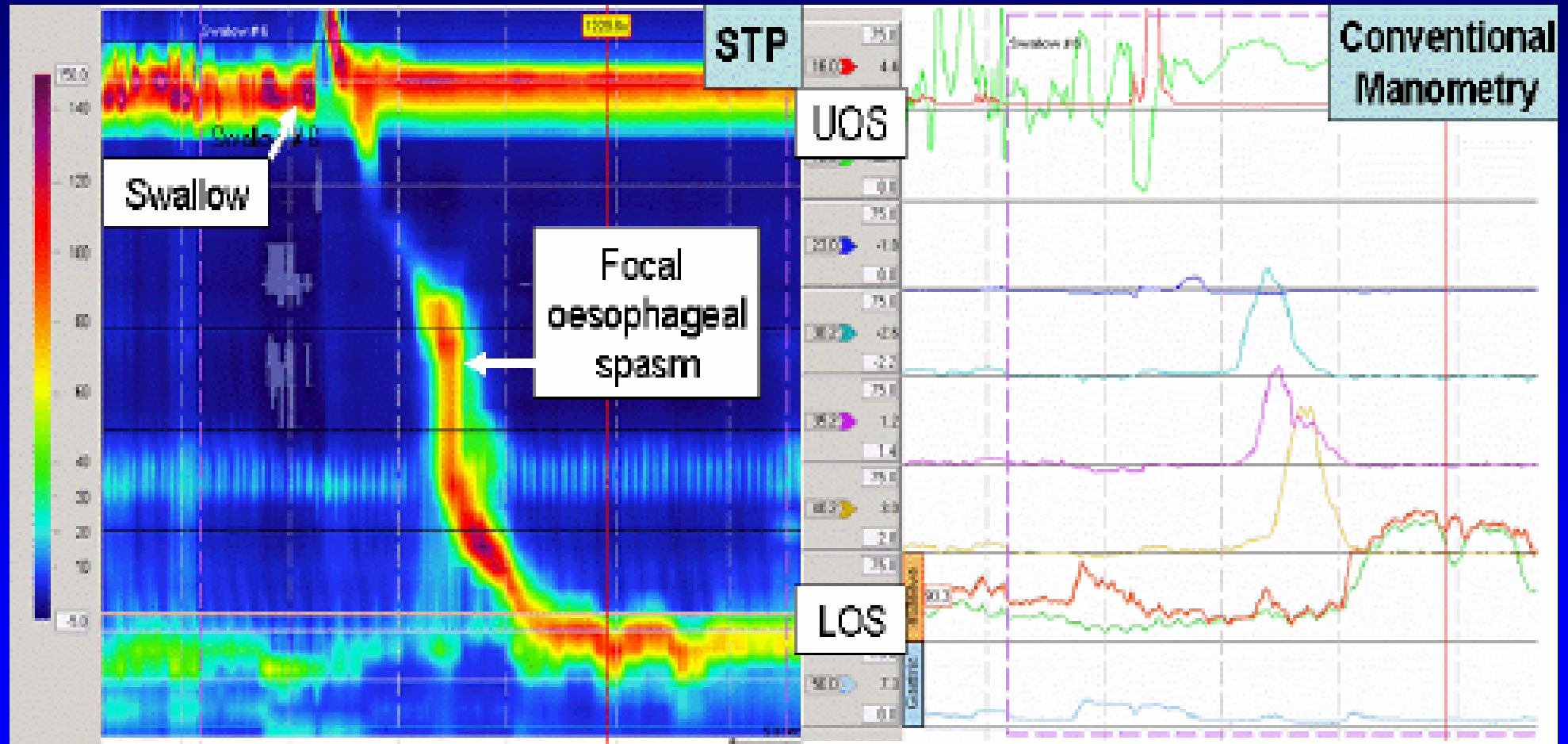
<u>Motor patterns*</u>	<u>% wet swallows (SD)</u>
- Double peaks	11 (19)
- Simultaneous	4 (8)
- Non-conducted	0.4 (2)
- Retrograde	0

<u>Overall findings**</u>	<u>Normal</u>
- Mean distal peristaltic P	> 40 mmHg
- Peristalsis waves	> 60%

*Richter et al. Dig Dis Sci 1987;32:583-592;

**Waring et al. Am J Gastroenterol 1995;90:35-37.

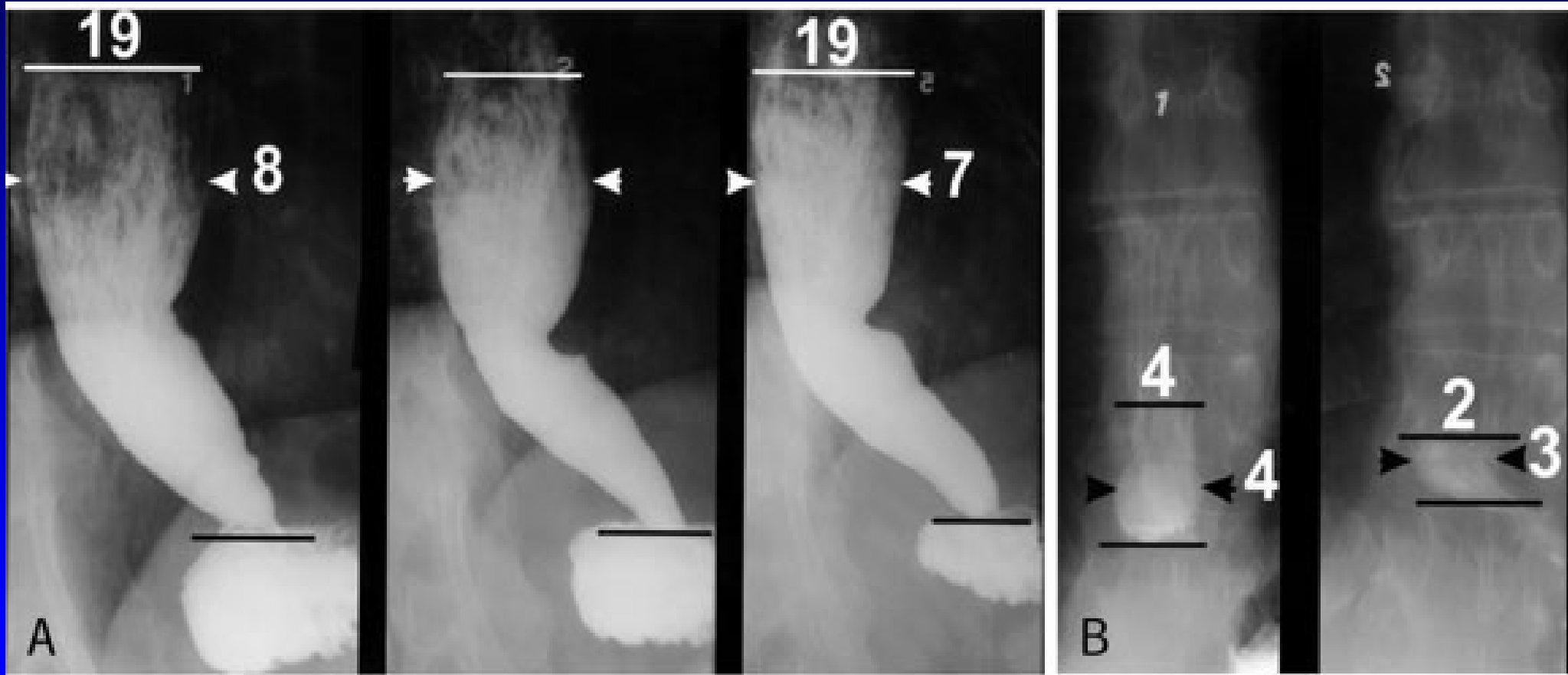
High Resolution Esophageal Manometry



Indications for Esophageal Manometry

- Dysphagia of unclear etiology
 - Achalasia, impaired esophageal motility, or diffuse GI dysmotility
- Pre-op fundoplication
- Post-op fundoplication problems
- Chest pain

Timed Barium Esophagram



Kostic et al. J Thorac CV Surg
200-;120:935.

Swallow 100-250cc of 45% barium over 30-45
seconds. Take pictures at 1, 2 and 5 minutes

Timed Barium Swallow

- Quantify esophageal emptying
- Aperistalsis by manometry $\neq$ Poor esophageal emptying
- Useful for many reasons
 - Differentiate primary from secondary achalasia
 - Recurrence of dysphagia after dilation or myotomy

Transnasal Ambulatory pH Monitoring

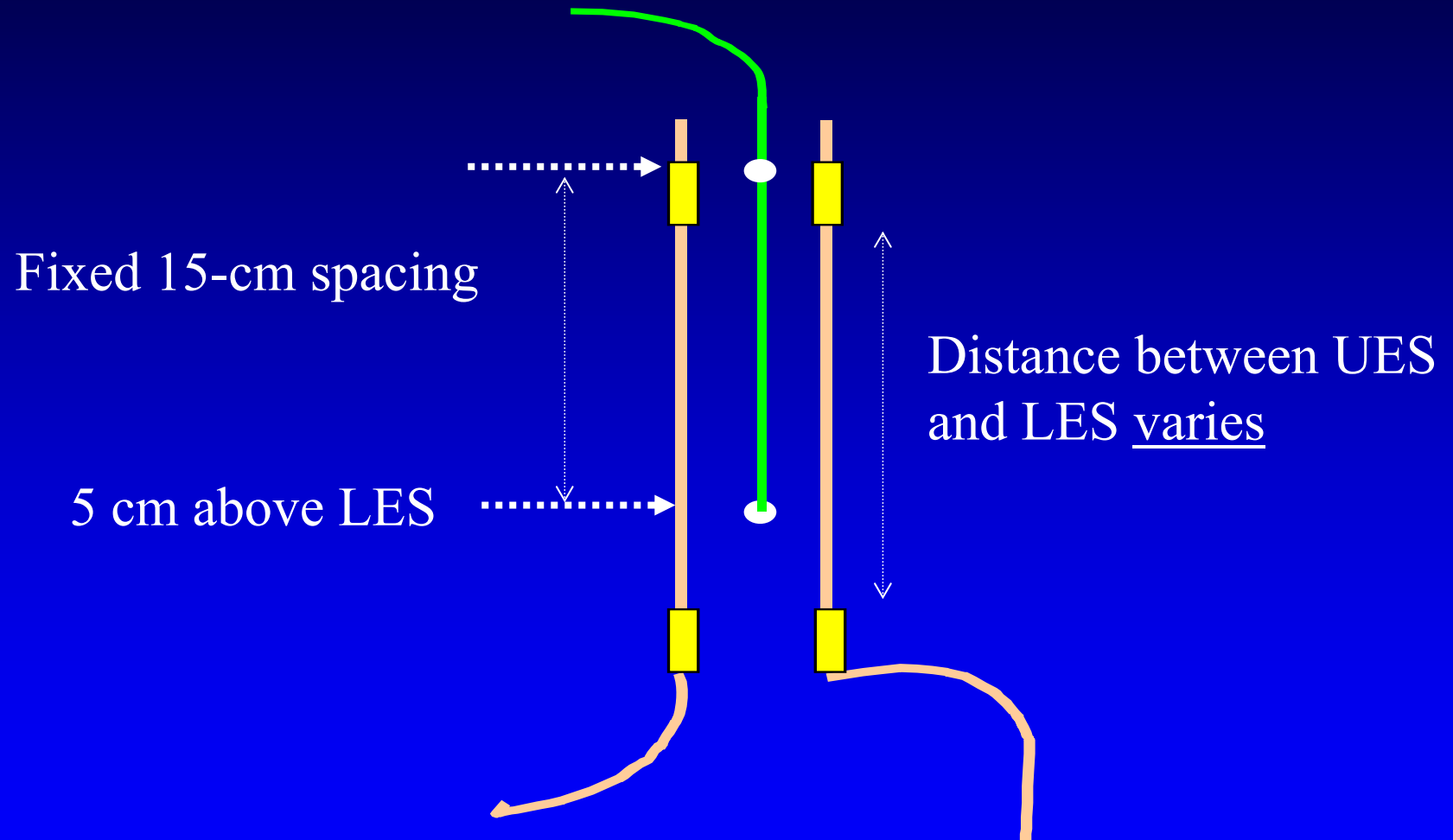


- “Gold” Standard for typical GERD
 - Sensitivity (81-96%)
 - Specificity (93-100%)
 - Reproducibility (80%)
- “Best” test available
 - Yield for non-erosive reflux disease (61-71%)
 - Yield: LPR (55-80%)

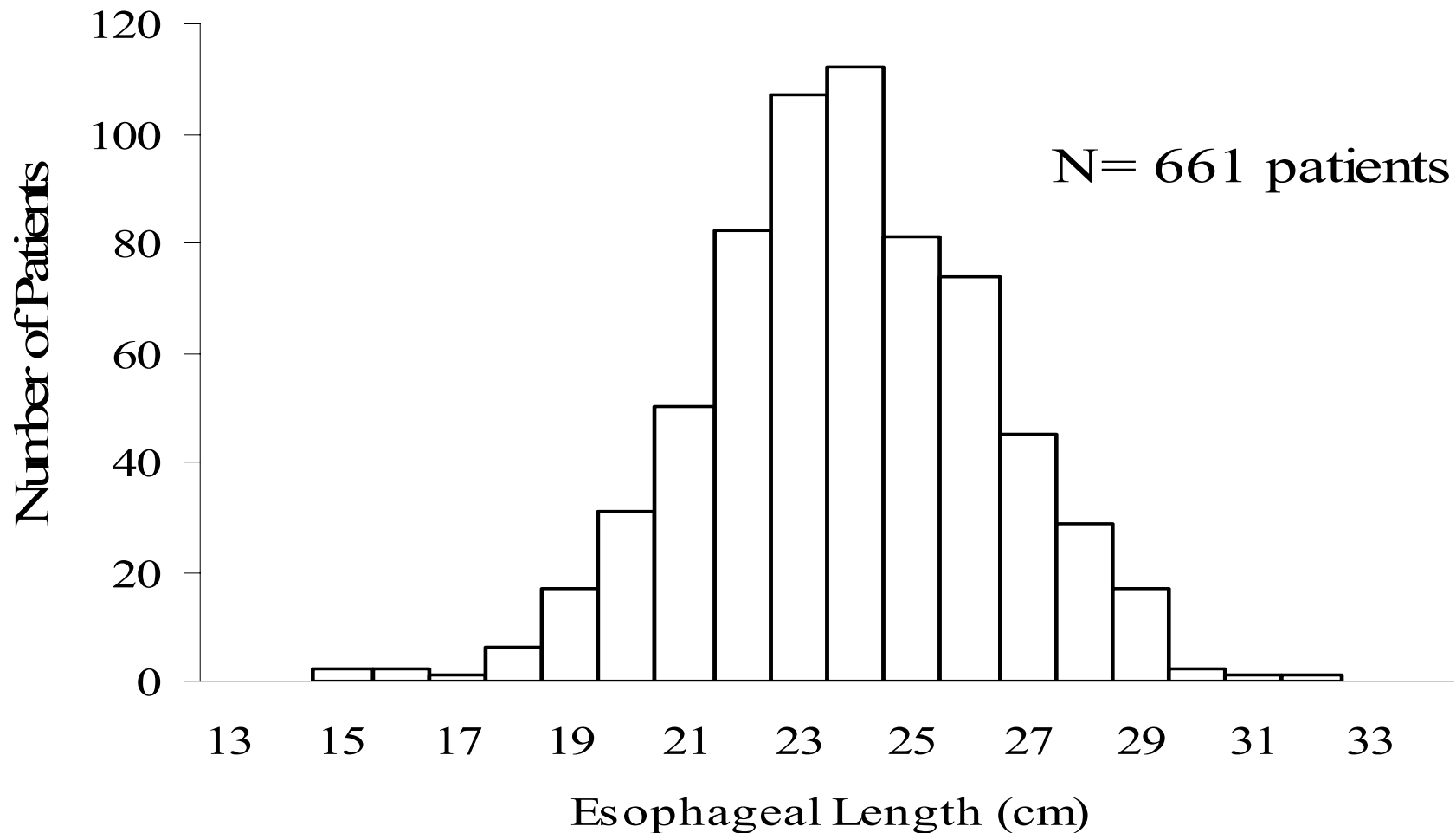
Parameters in Ambulatory pH Monitoring

- Acid exposure time
 - Percent time pH<4 =
$$\frac{(\text{Duration of time where pH} < 4)}{(\text{Duration of monitoring})} \times \text{Period}$$
 - Periods: total, supine and upright
- Number of reflux episodes
- Number of reflux episodes > 5 min
- Time of longest reflux episode
- DeMeester Score (combination of above)

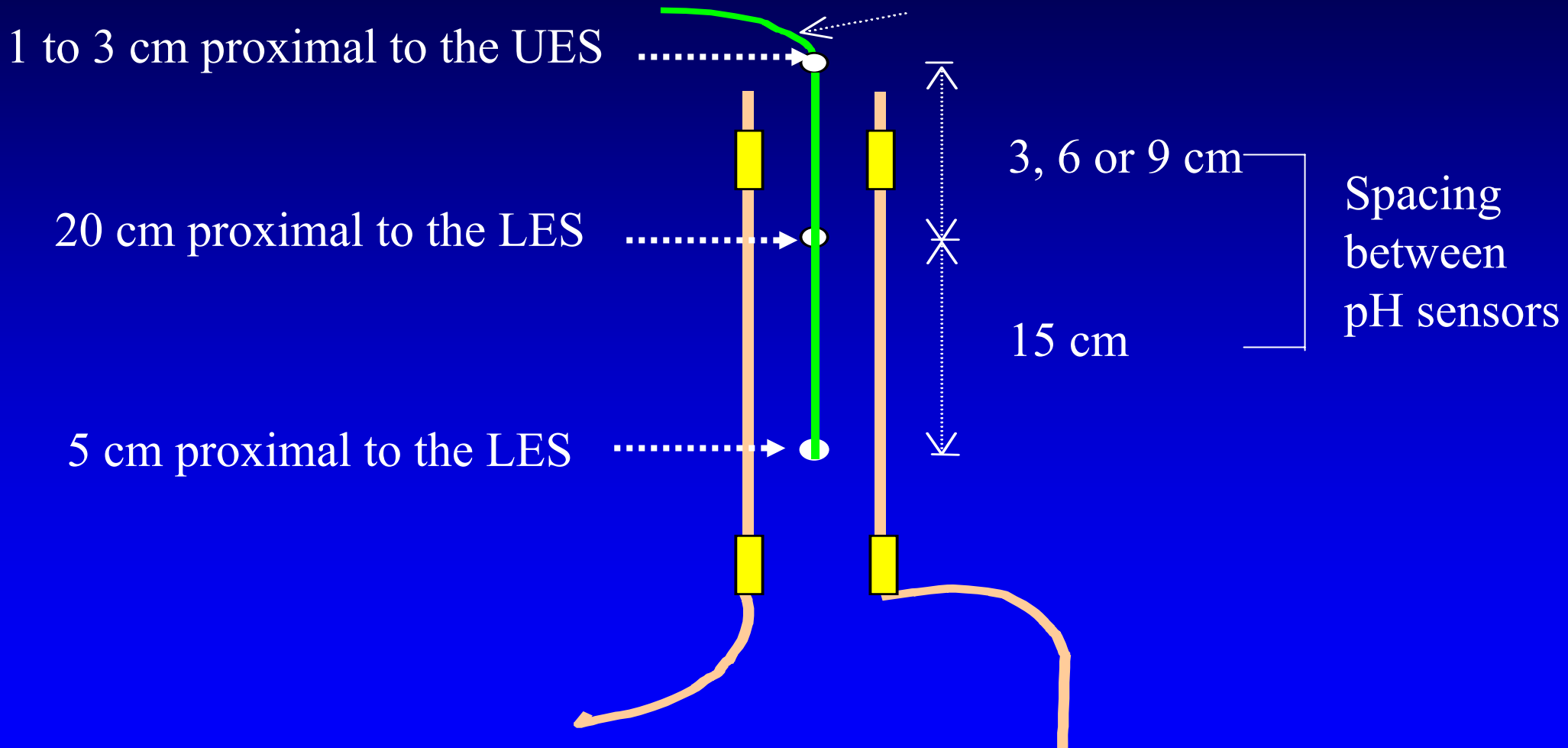
Dual-Sensor Esophageal pH Monitoring



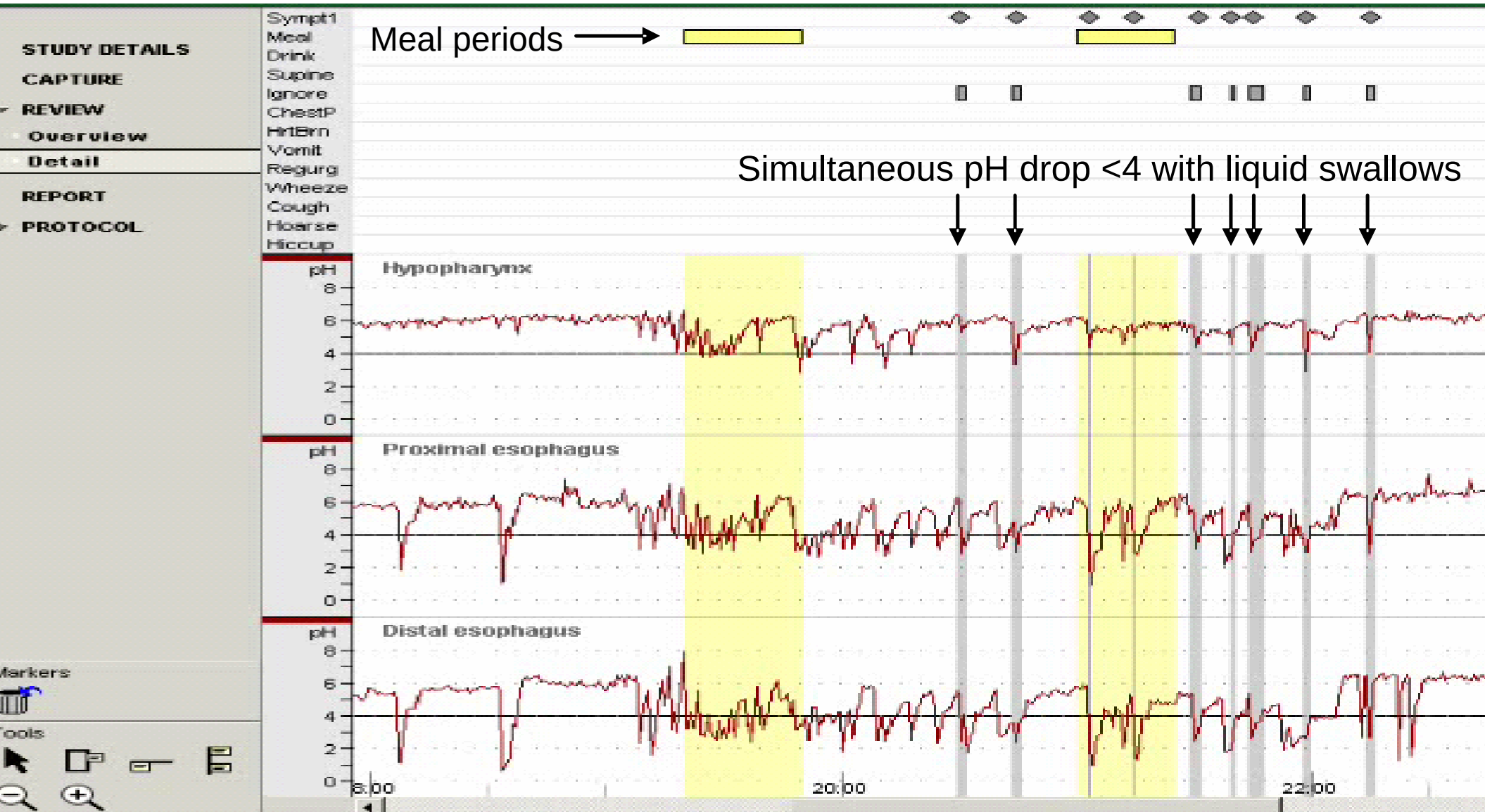
Esophageal Length Varies Among Individuals



Triple-Sensor pH Monitoring



Single-Probe, Triple-Sensor Hypopharyngeal and Esophageal pH Test



Bravo Wireless pH Telemetry



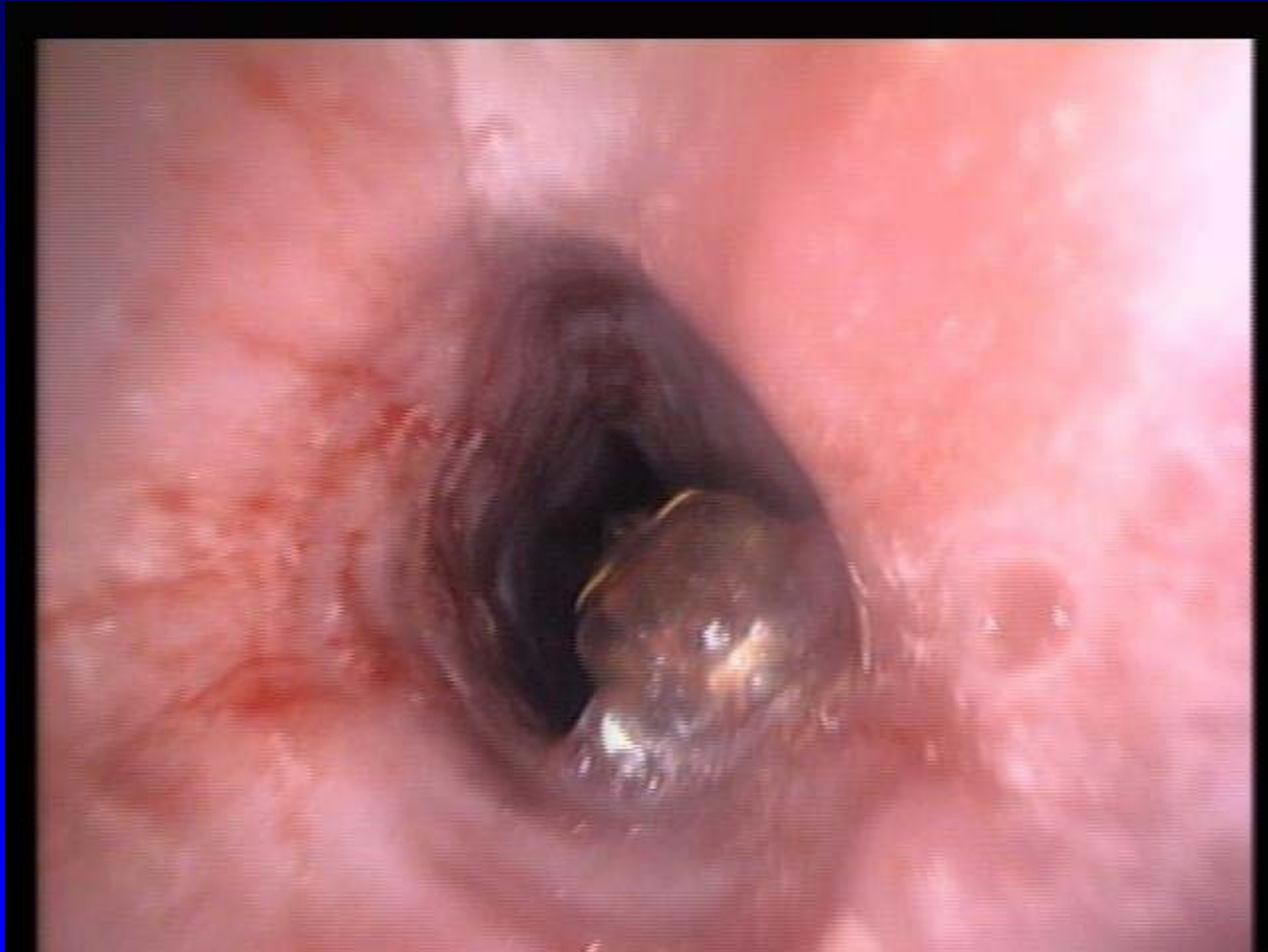
- **Pros**

- Minimal or no patient discomfort
- Allows longer monitoring
- More representative if a “usual” day
- Easy to place (after EGD or after manometry)

- **Cons**

- Normal data limited
- Monitoring only at one site
- Disposable and more costly
- Difficult to go through the nose

Bravo pH Telemetry



Bravo pH Telemetry for Barrett's Esophagus



Ambulatory Esophageal pH Monitoring Using a Wireless System

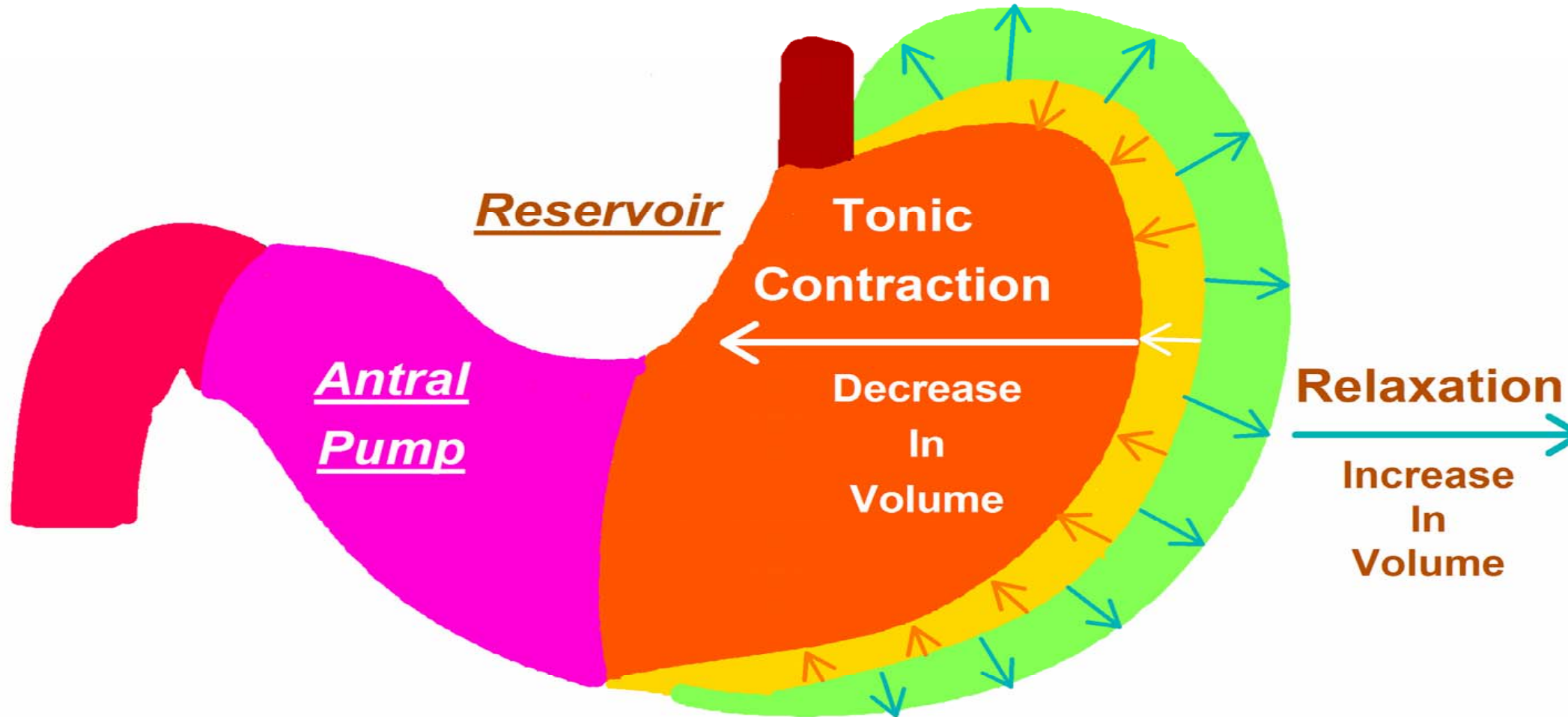
- 85 subjects
 - Detachment: 4 %
 - Poor data reception: 7 %
 - Successful 1 day study (>16 hrs): 96%
 - Successful 2 day study (>36 hrs): 89%
 - 3 subjects (4%) require endoscopic removal due to pain

Indications for Ambulatory pH Monitoring

- Diagnosis is unclear
- Persistent symptoms
- Recurrence of post-fundoplication symptoms

Stomach

NEURAL CONTROL OF MUSCULAR TONE DETERMINES VOLUME IN THE GASTRIC RESERVOIR



Gastric Motility Testing

- 4-hr gastric emptying test
- Antroduodenal motility
- *Smart Pill* (gastric retention time, pressure, pH, and temperature)
- (EGG: Electrogastrography)
- (Barostat)

Scintigraphy:

4-hr Gastric Emptying Test



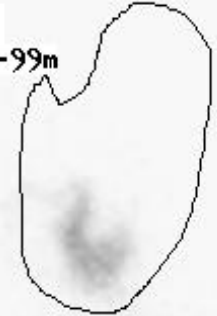
Desc: 0 HR ANT-Tc-99m
Frame: 1
Roi No.: 1
Pixels: 1155
Counts: 66244
Max: 439
Min: 0
Mean: 57.35
Std Dev: 72.89

Before test meal



Desc: 2 HR ANT-Tc-99m
Frame: 1
Roi No.: 1
Pixels: 1160
Counts: 39753
Max: 178
Min: 0
Mean: 34.27
Std Dev: 44.86

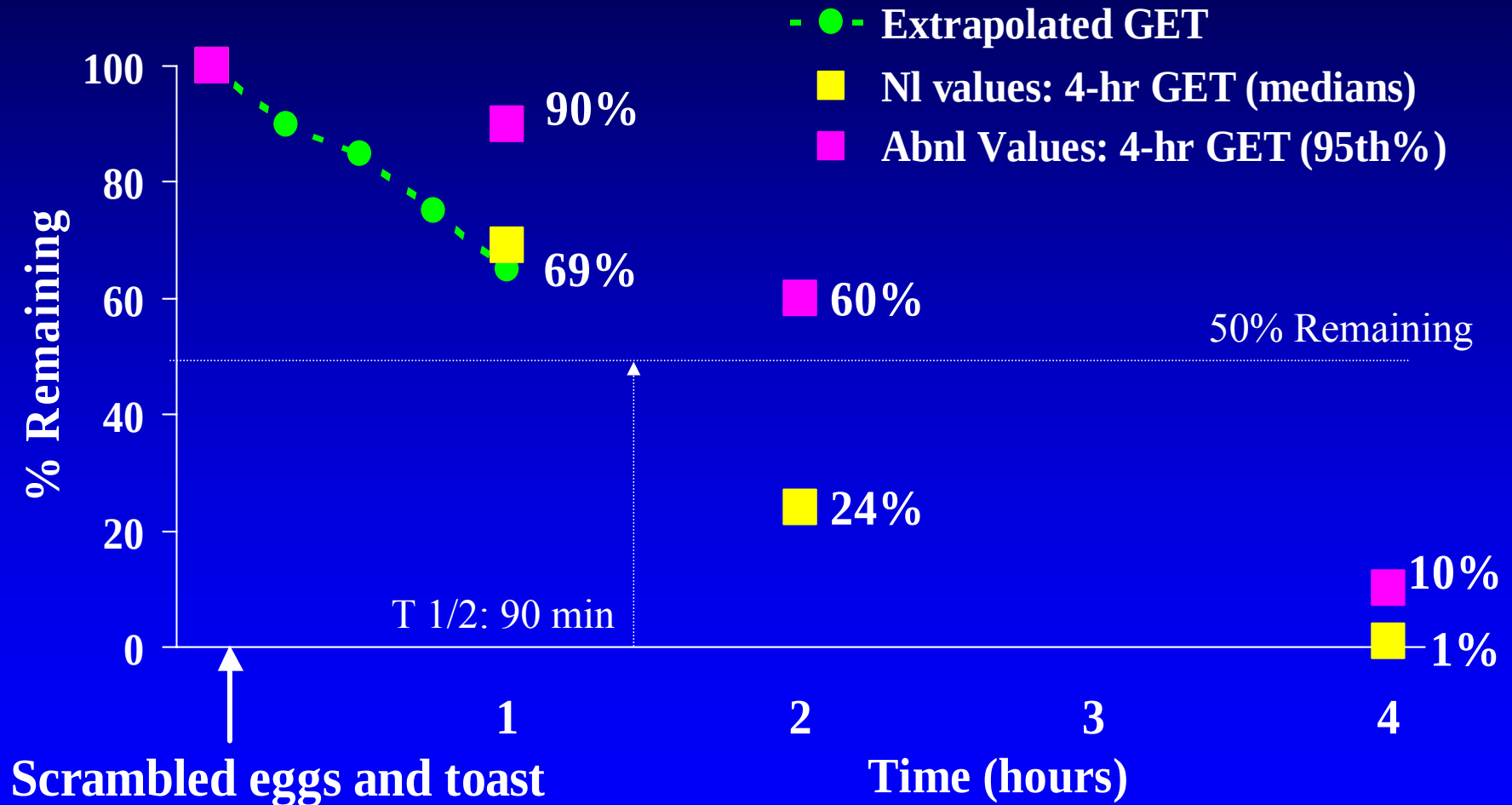
After 2 hours



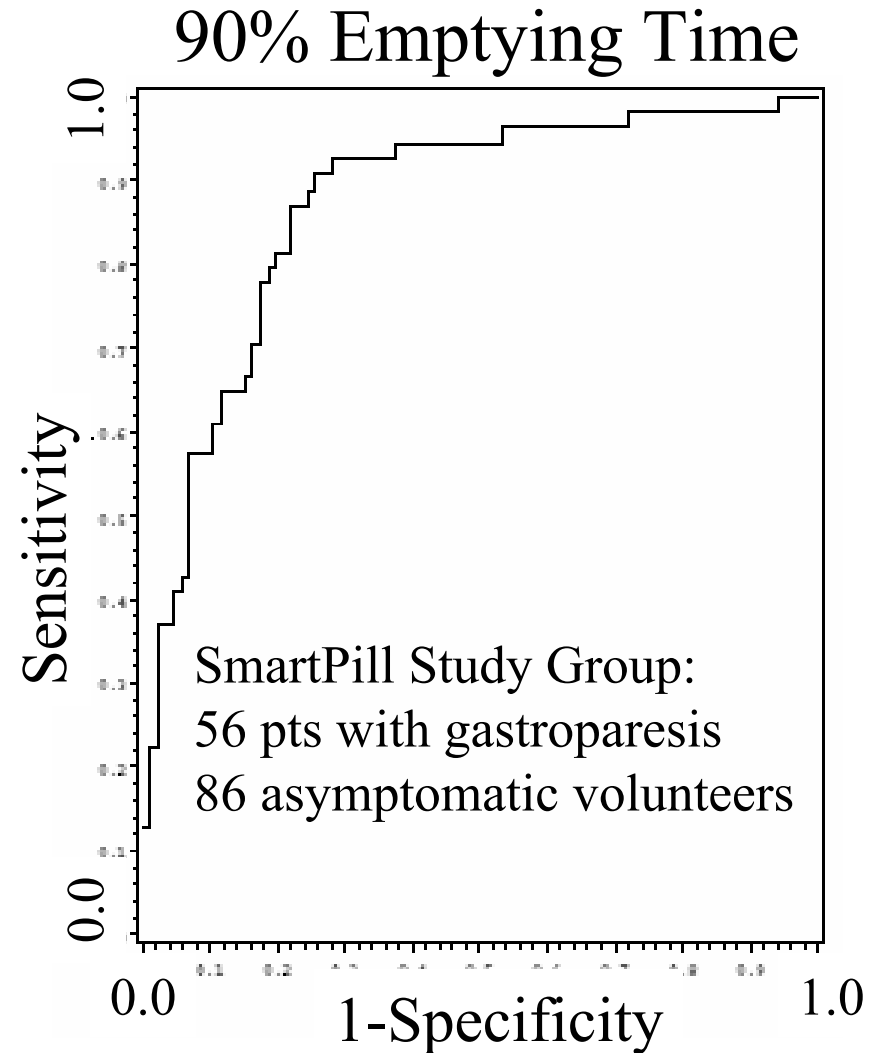
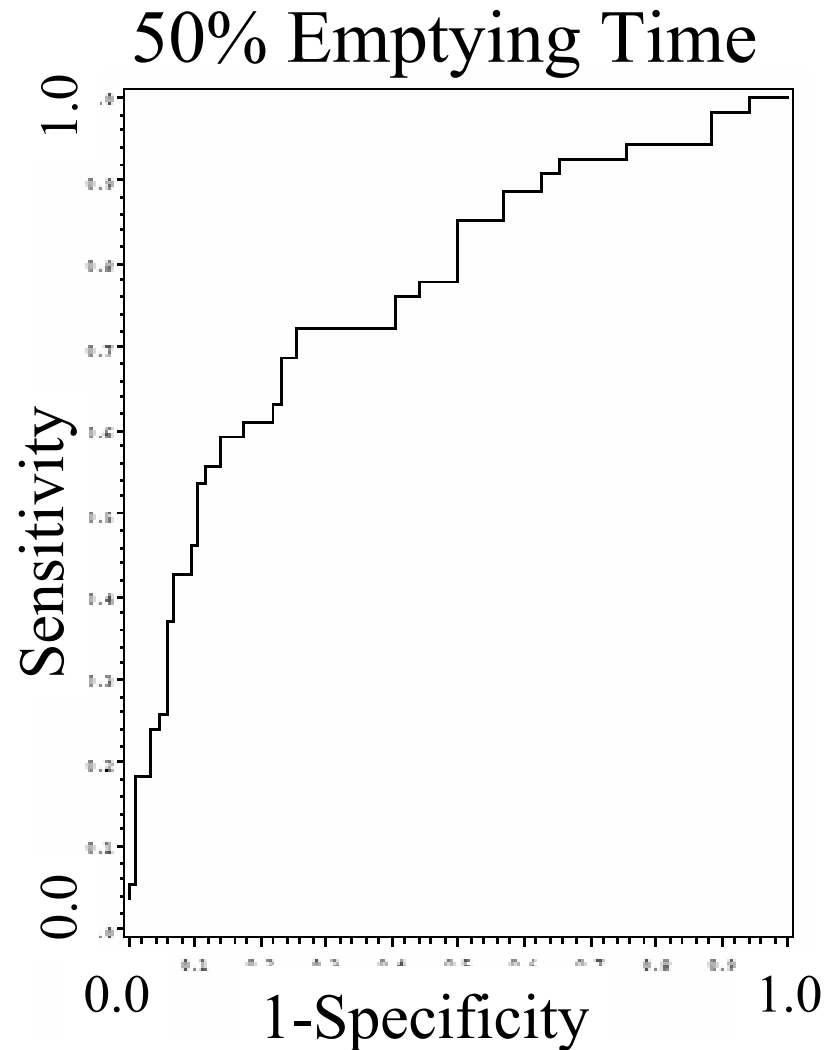
Desc: 4 HR ANT-Tc-99m
Frame: 1
Roi No.: 1
Pixels: 1158
Counts: 6596
Max: 69
Min: 0
Mean: 5.70
Std Dev: 12.00

After 4 hours

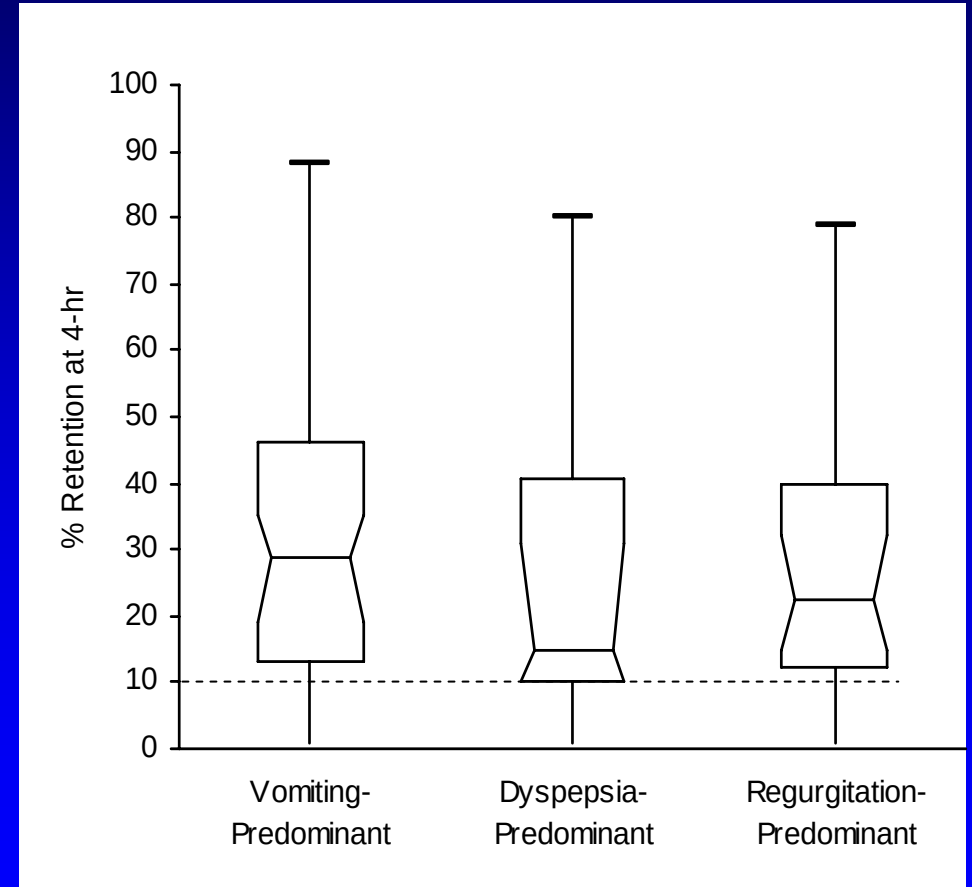
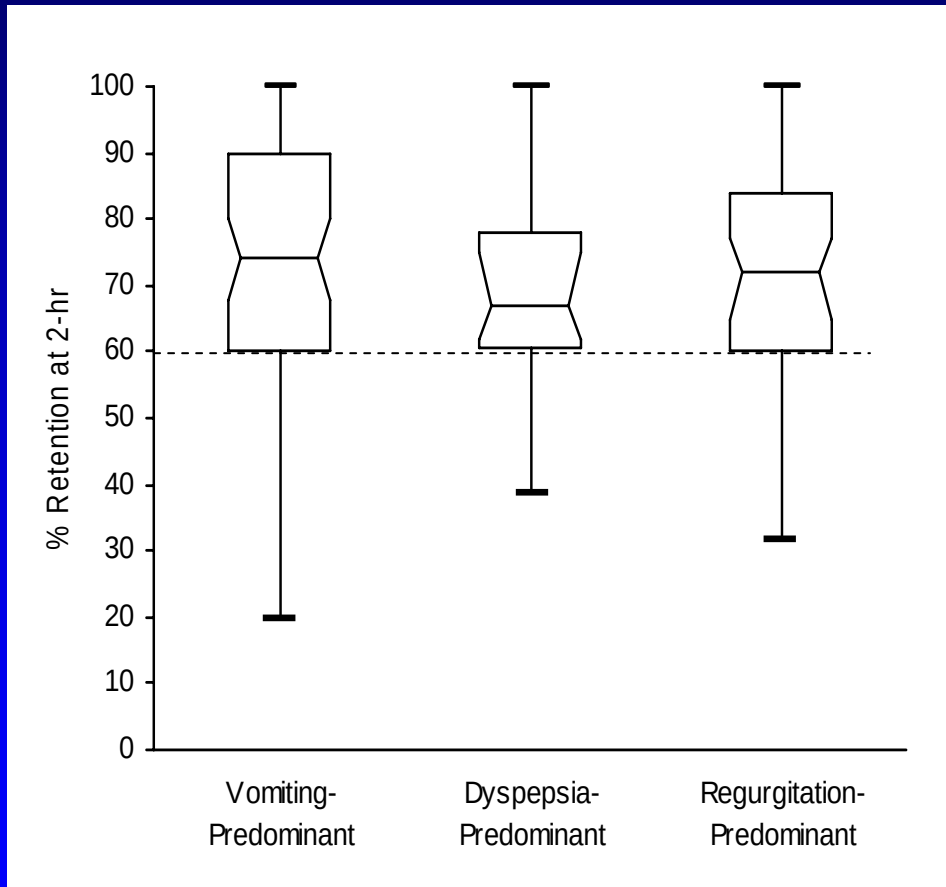
Gastric Emptying Scan (GET)



Gastric Scintigraphy to Diagnose Gastroparesis



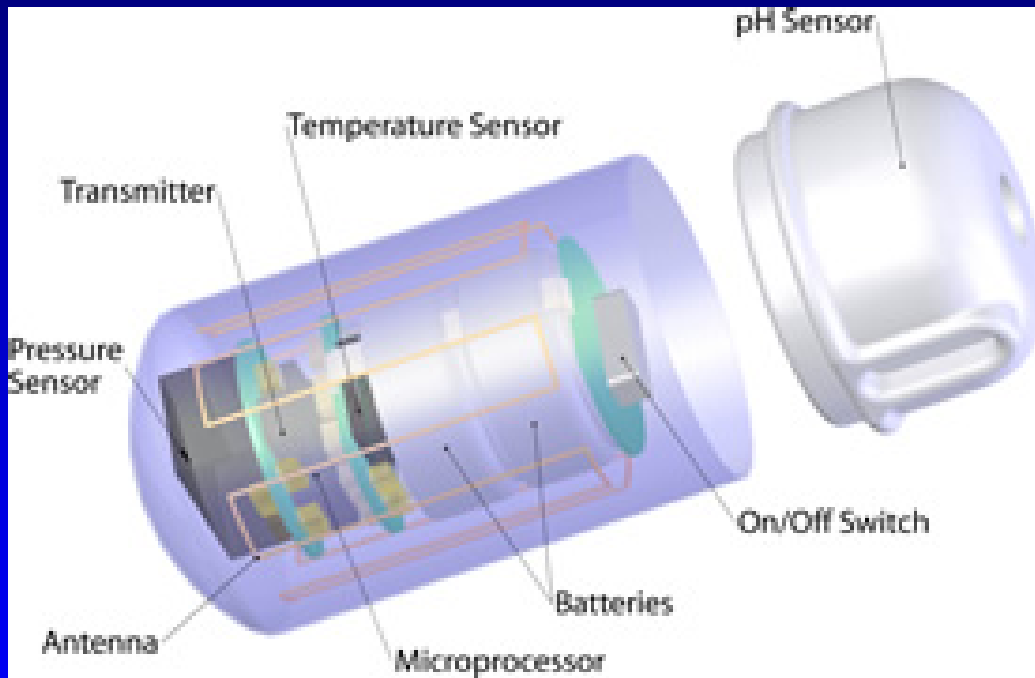
GET Results Do Not Correlate with Symptom Presentation



Gastric Emptying Test (GET)

- 4-hour GET is the new international standard
- Not sensitive to exclude gastric dysmotility
- Specific for gastroparesis
- Poor correlation with symptom severity & symptom improvement

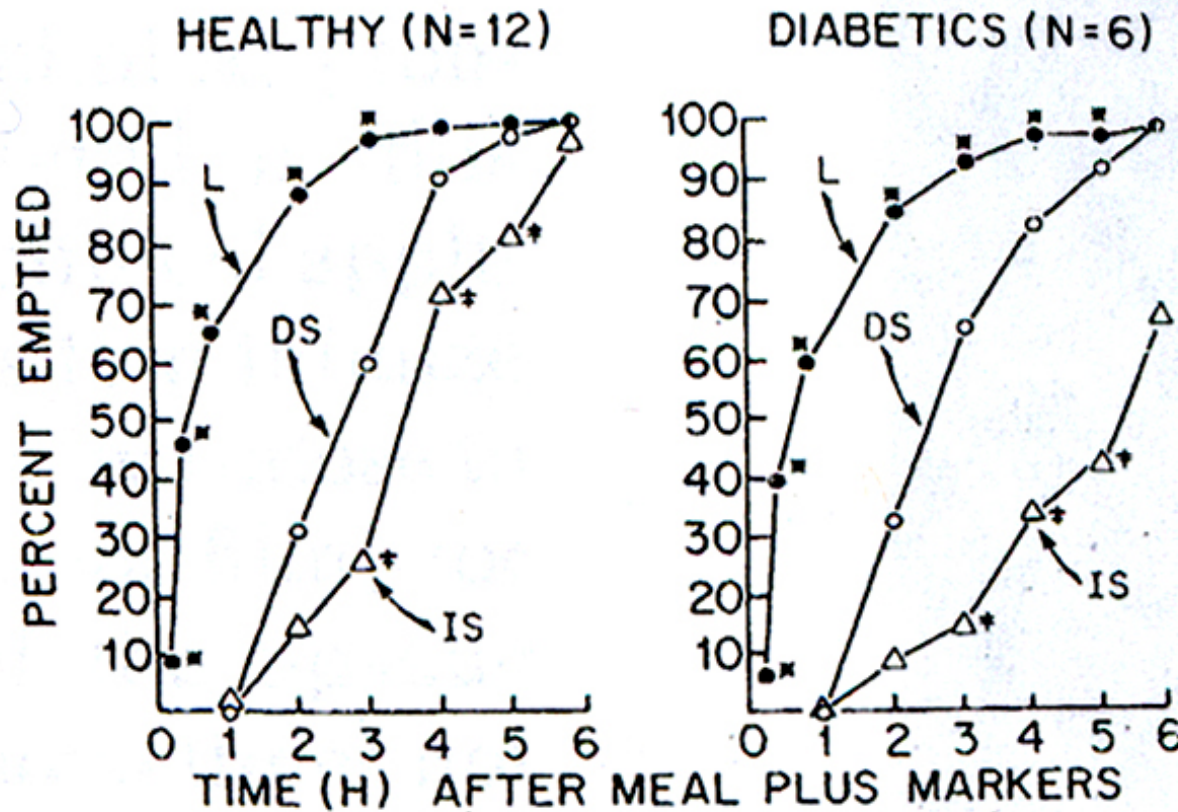
Smartpill® Wireless Diagnostics Capsule



- Wireless measurements:
 - Pressure
 - pH
 - Temperature

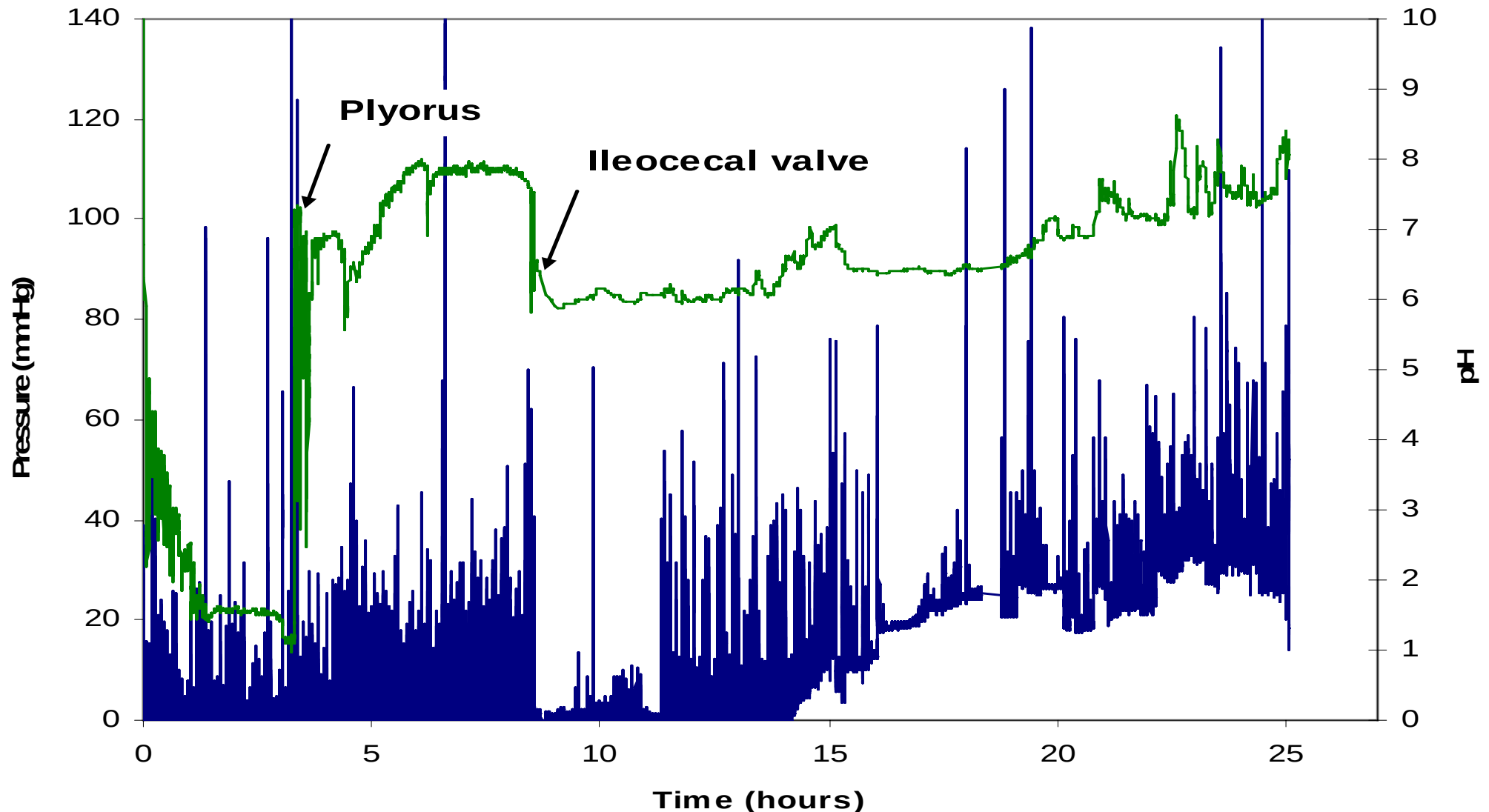


Gastric Emptying of Digestible and Indigestible Solids



L (Liquids)
DS (Digestible solids)
IS (Indigestible solids)

Smartpill® Wireless Pressure and pH Tracing



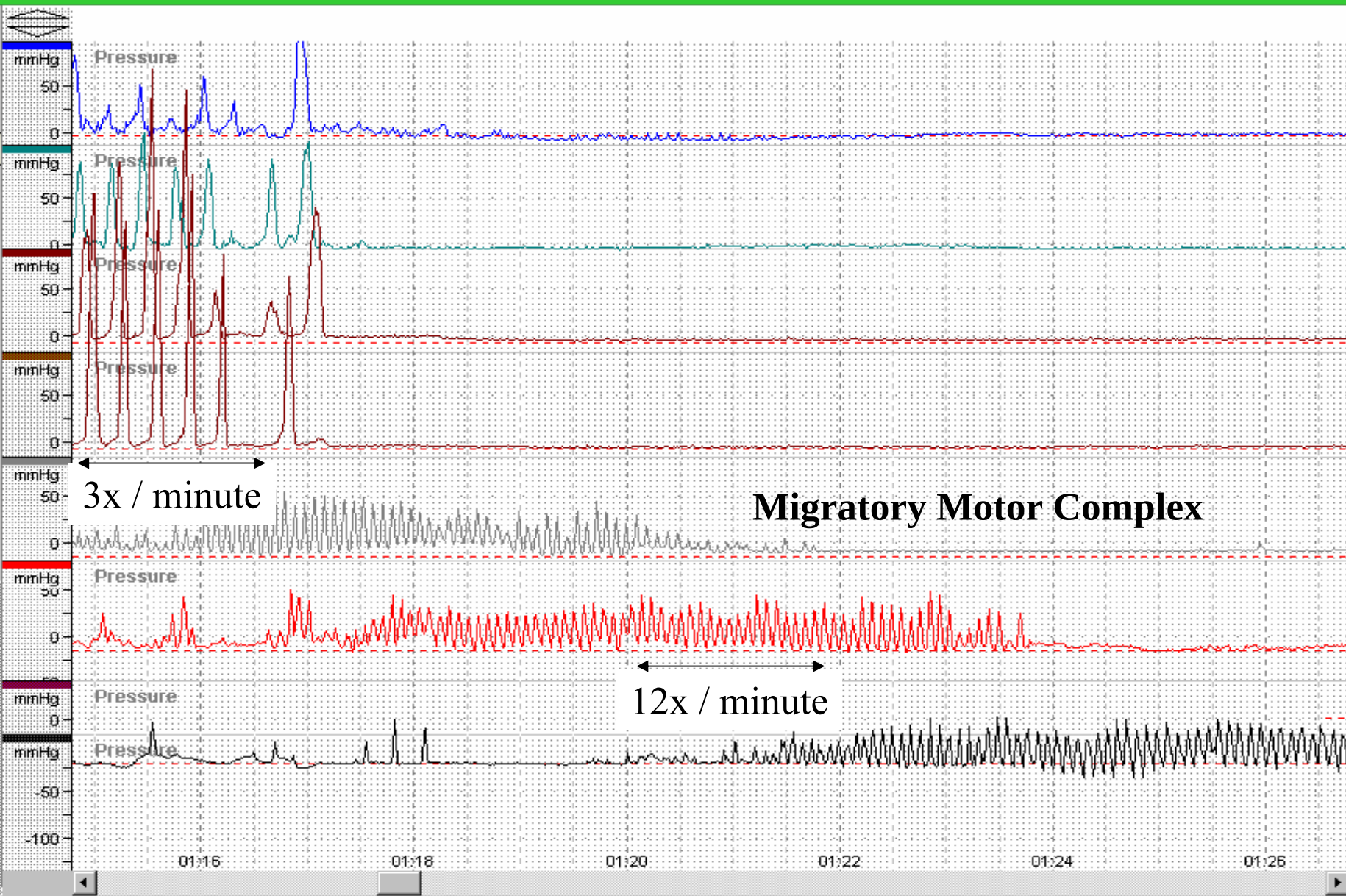
Small Intestine

Small Bowel Motility Testing

- Antroduodenal and small bowel manometry
- Hydrogen breath test
 - With lactulose, glucose, lactose, etc
- (Small bowel scintigraphy)
- (Smart Pill®)

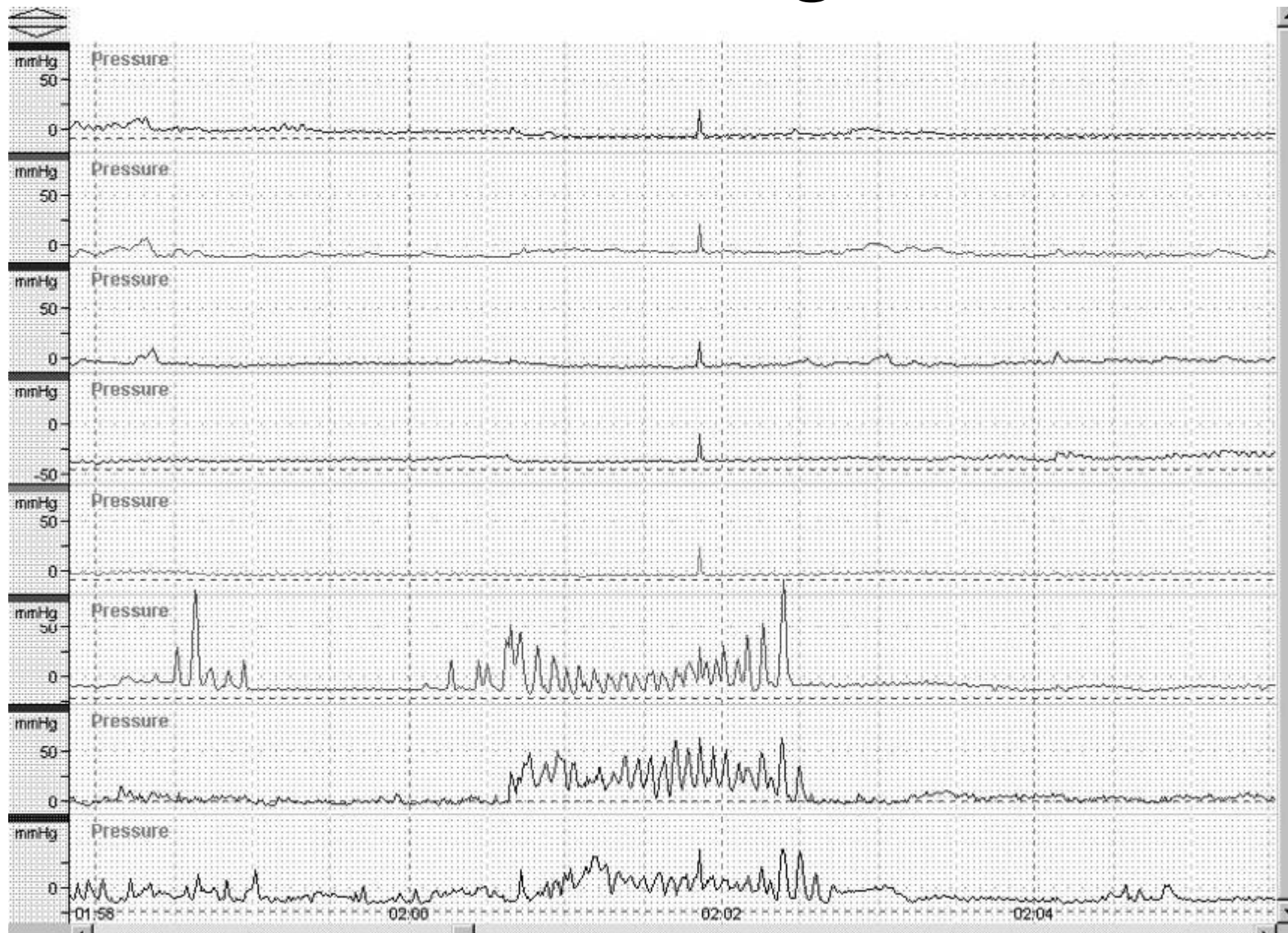
Antroduodenal Manometry

STUDY DETAILS
EQUIPMENT
CAPTURE
REVIEW
REPORT
PROTOCOL



Markers
Continuous Pull
Tools
ext

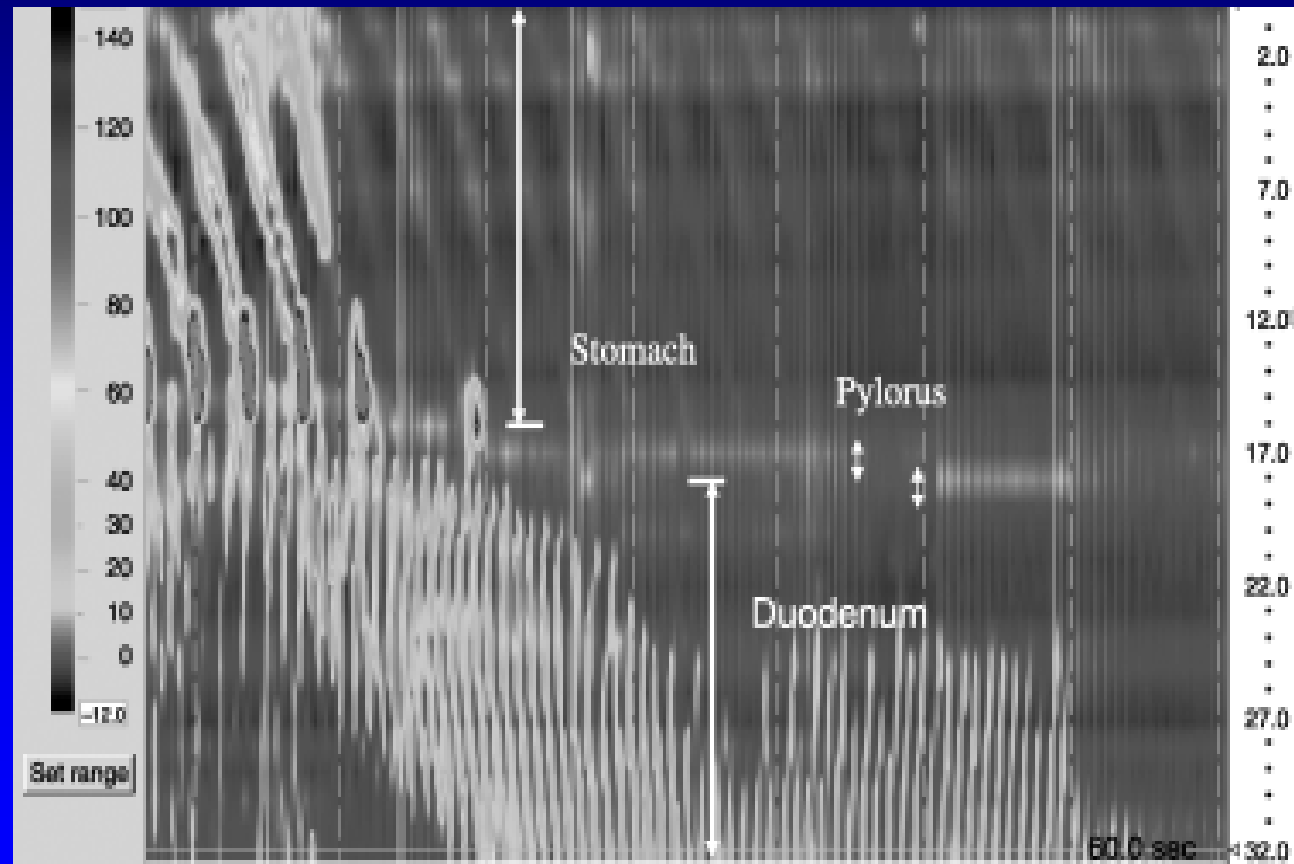
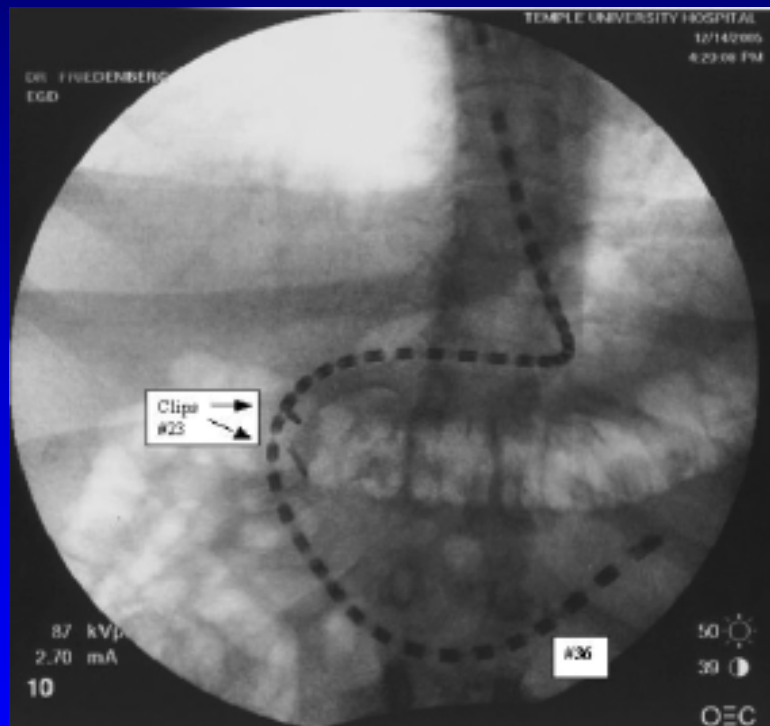
Abnormal Fasting Pattern



Abnormal Fed Pattern



High Resolution Antroduodenal Manometry



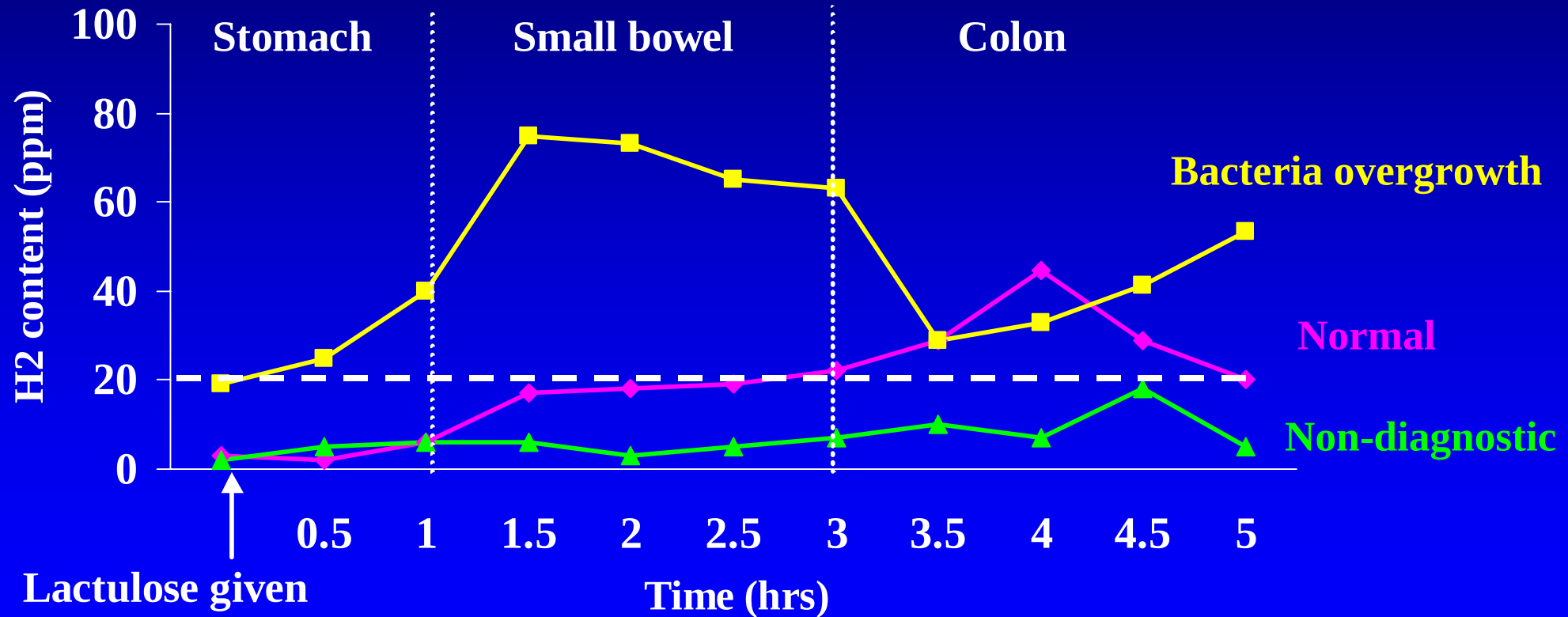
Abnormalities Identified by Small Bowel Manometry

- Intrinsic Neuropathy (enteric nervous system)
 - Abnormal fasting MMC
- Extrinsic Neuropathy (vagal neuropathy)
 - Abnormal postprandial response
- Intrinsic myopathy
 - Low contraction pressures

Indication for Small Bowel Manometry

- Refractory nausea and vomiting
- Unexplained nausea and vomiting
- Intolerance of jejunal feeding
- Considering colectomy for colonic inertia

H₂ Breath Testing with Lactulose



Accuracy of Tests for Small Intestinal Bacteria Overgrowth

Diagnostic test	Abnormal test	Sensitive*	Specificity*
Lactulose breath test	Double peaks of >20 ppm H ₂ above baseline	17 – 68%	70 – 100%
Glucose breath test	>12 ppm H ₂ above baseline	41 – 100%	67 – 98%

*Gold standard: >10⁵ aerobes or anaerobes CFU/ml of jejunal aspirate

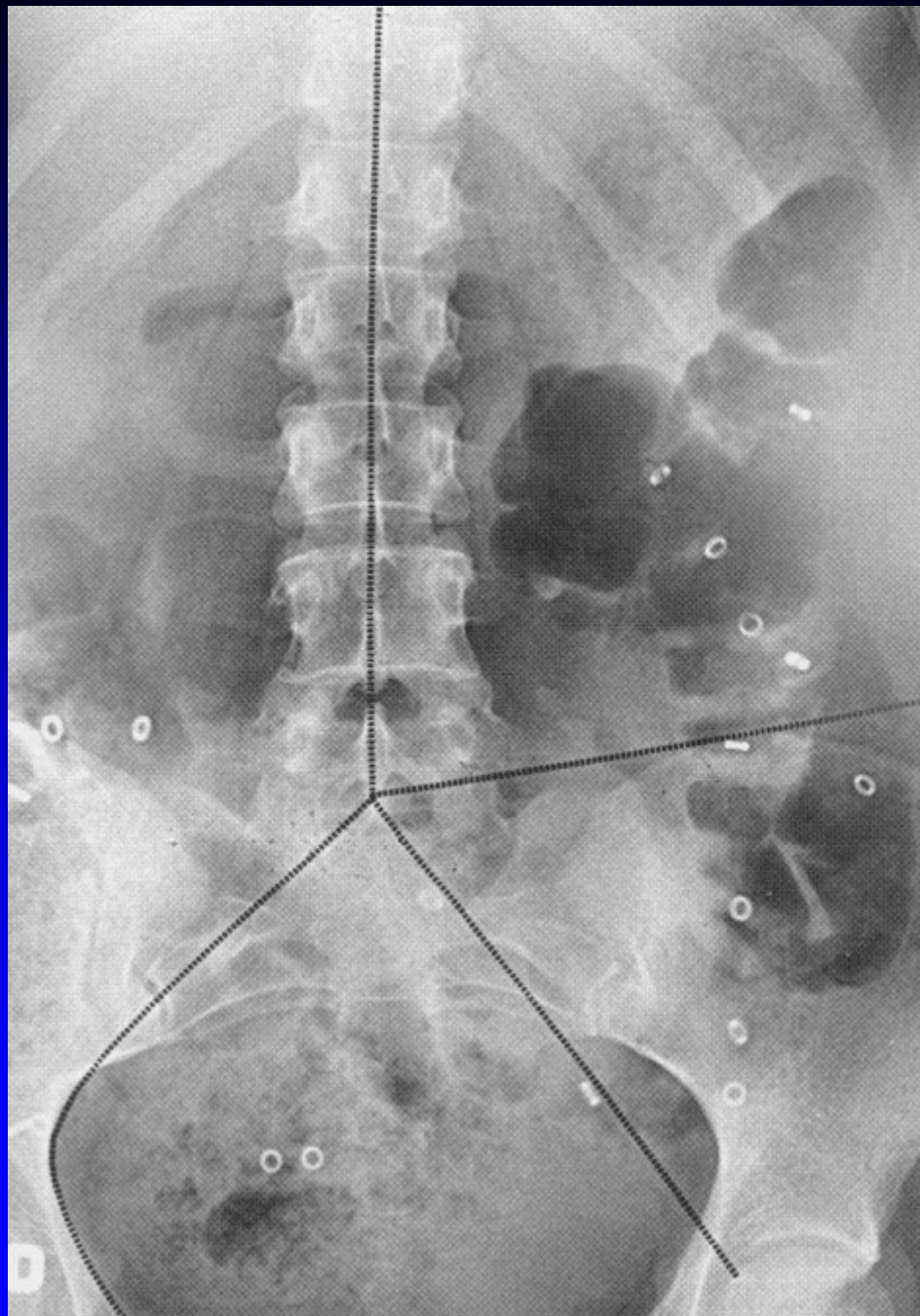
Colon and Rectum

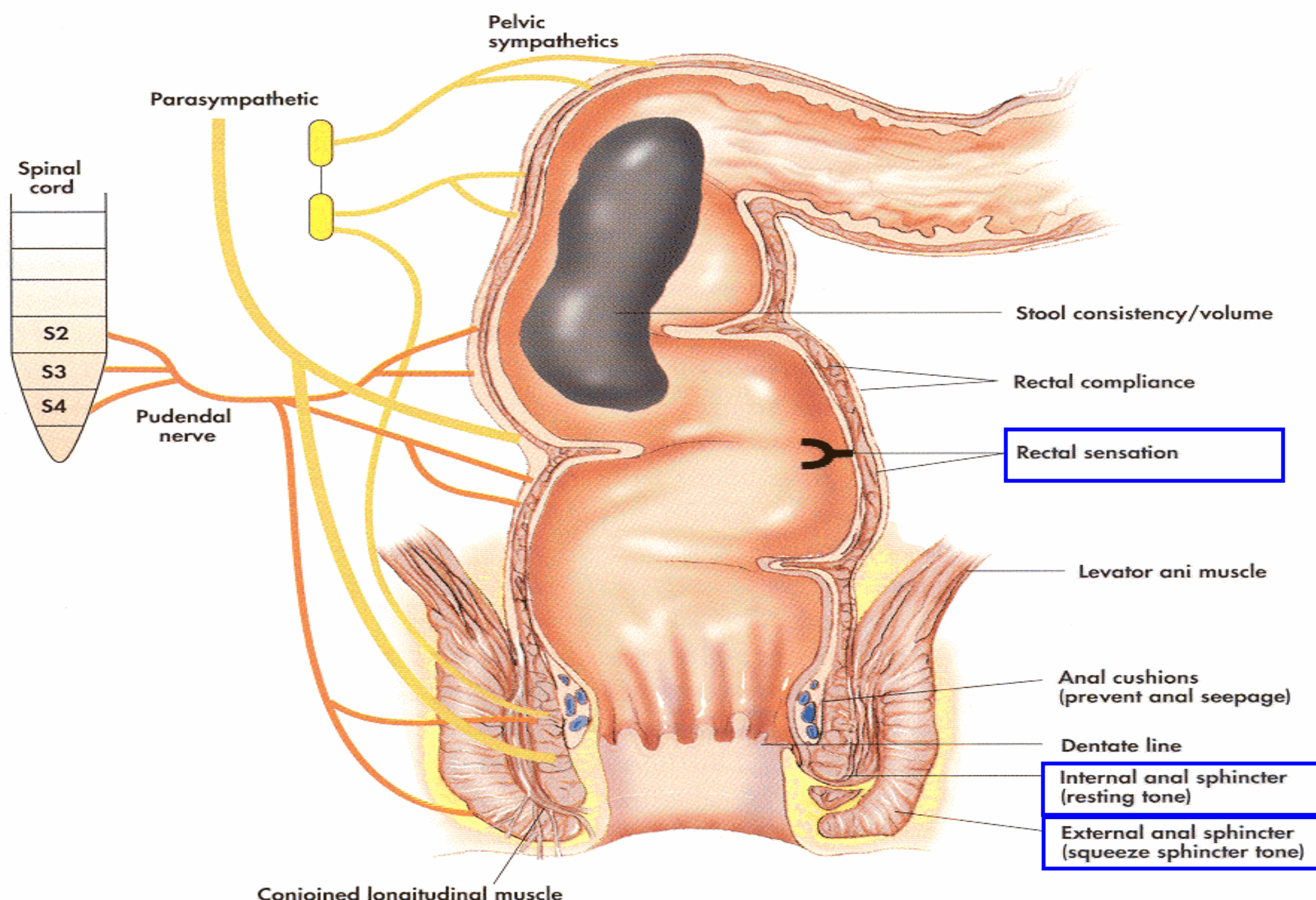
Colorectal Motility Testing

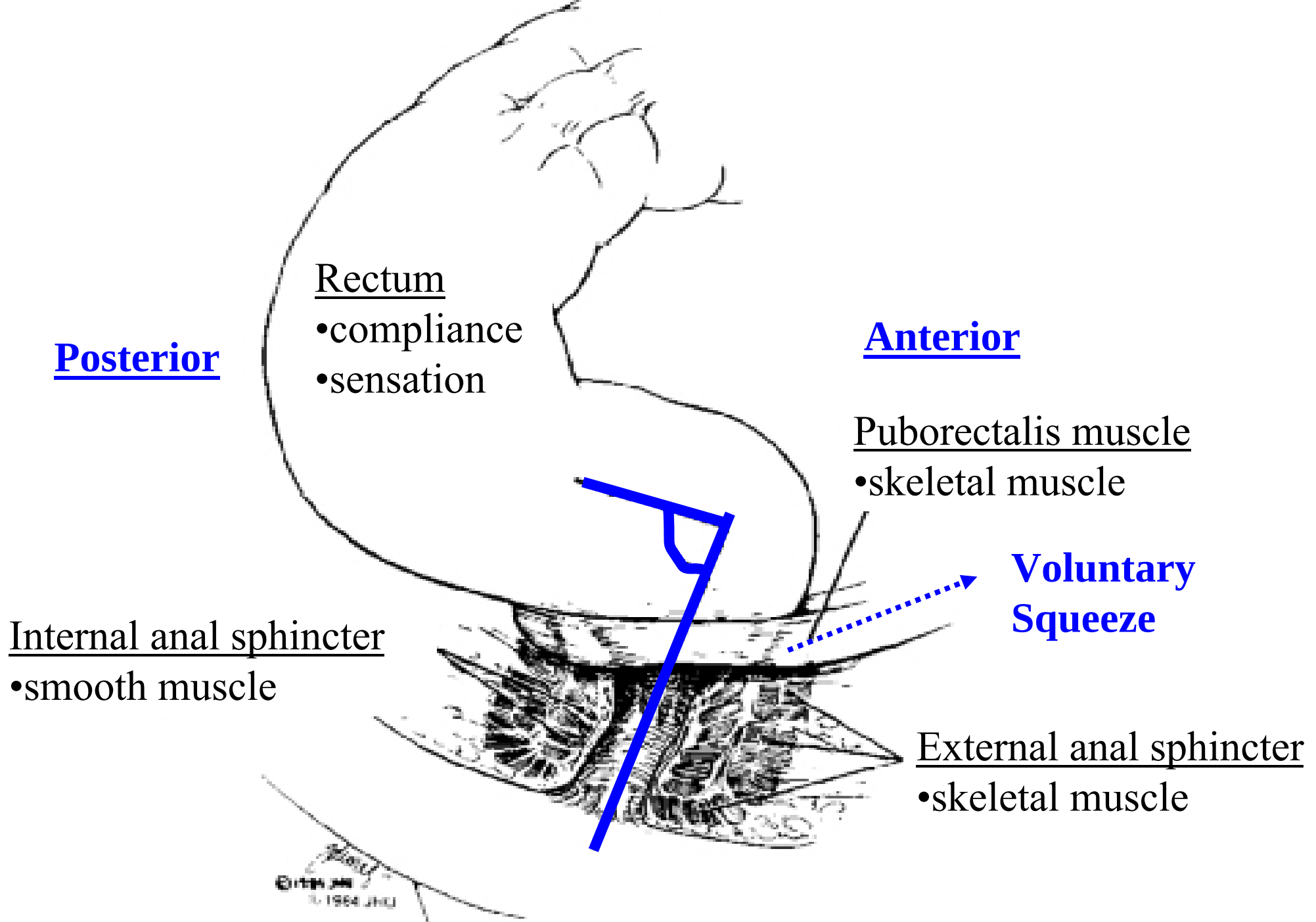
- Colonic Sitz markers
- Anorectal manometry
- Anal EMG
- Anal ultrasound
- Pudendal nerve testing (St. Marks test)
- Defecating proctogram

Radiopaque Transit Markers

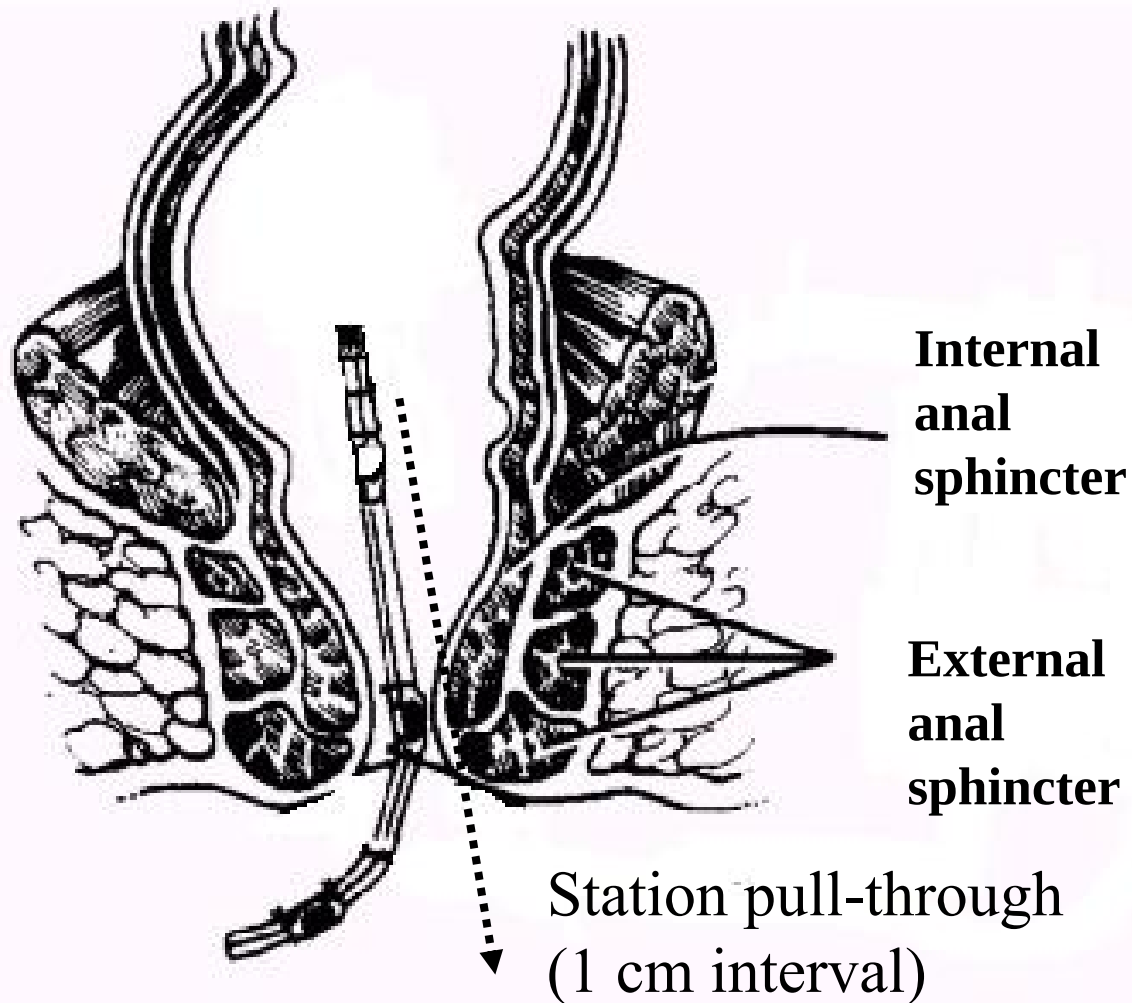
- *Sitzmark* capsule
 - 24 markers in capsule
 - Avoid laxatives
 - Abdominal x-ray
 - Normal: day 5 (≤ 4 markers), day 7 (none)







Anorectal Manometry



STUDY DETAILS
EQUIPMENT
CAPTURE
REVIEW
REPORT
PROTOCOL

Markers

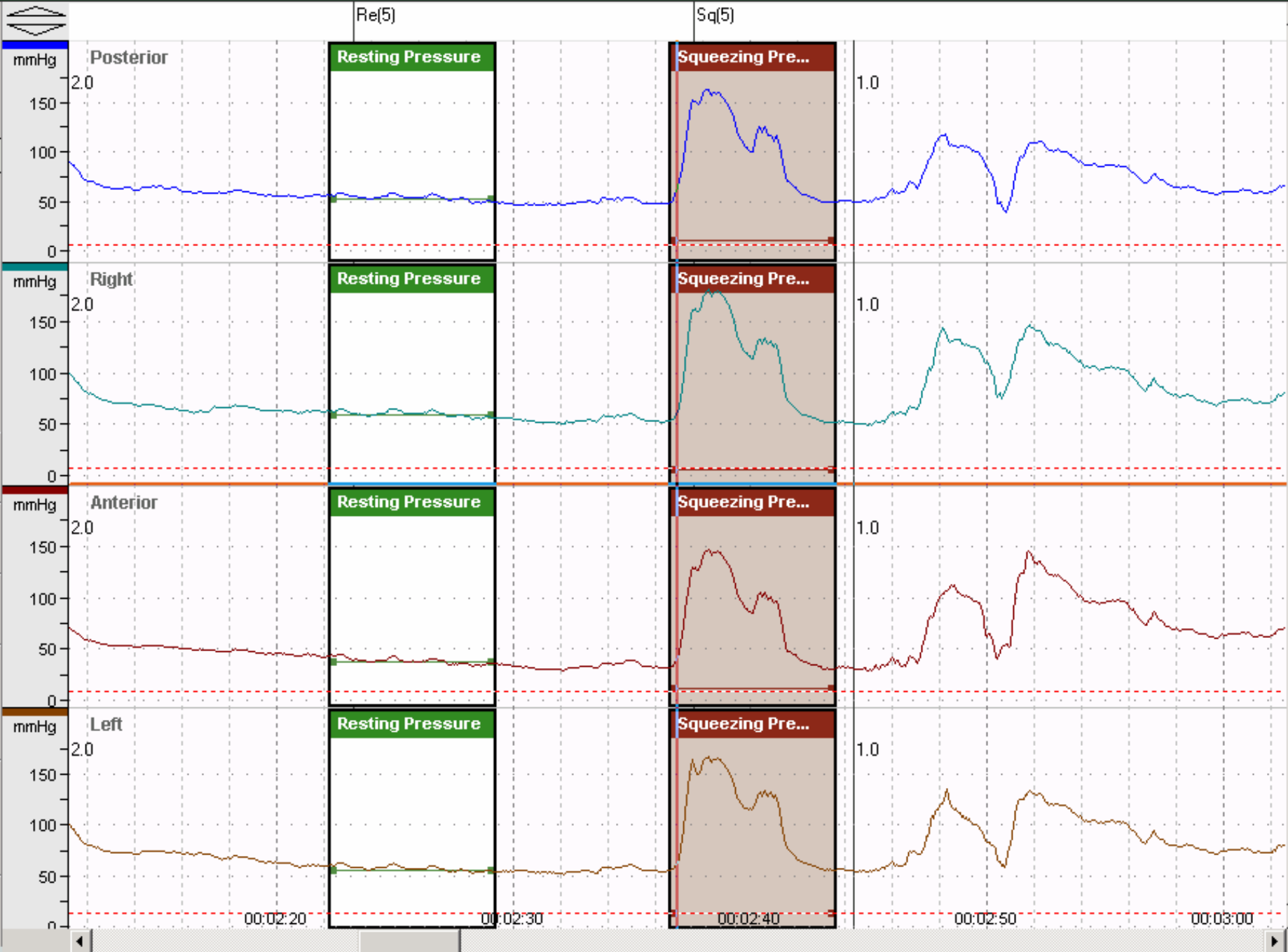
AIR

Sensory Threshold

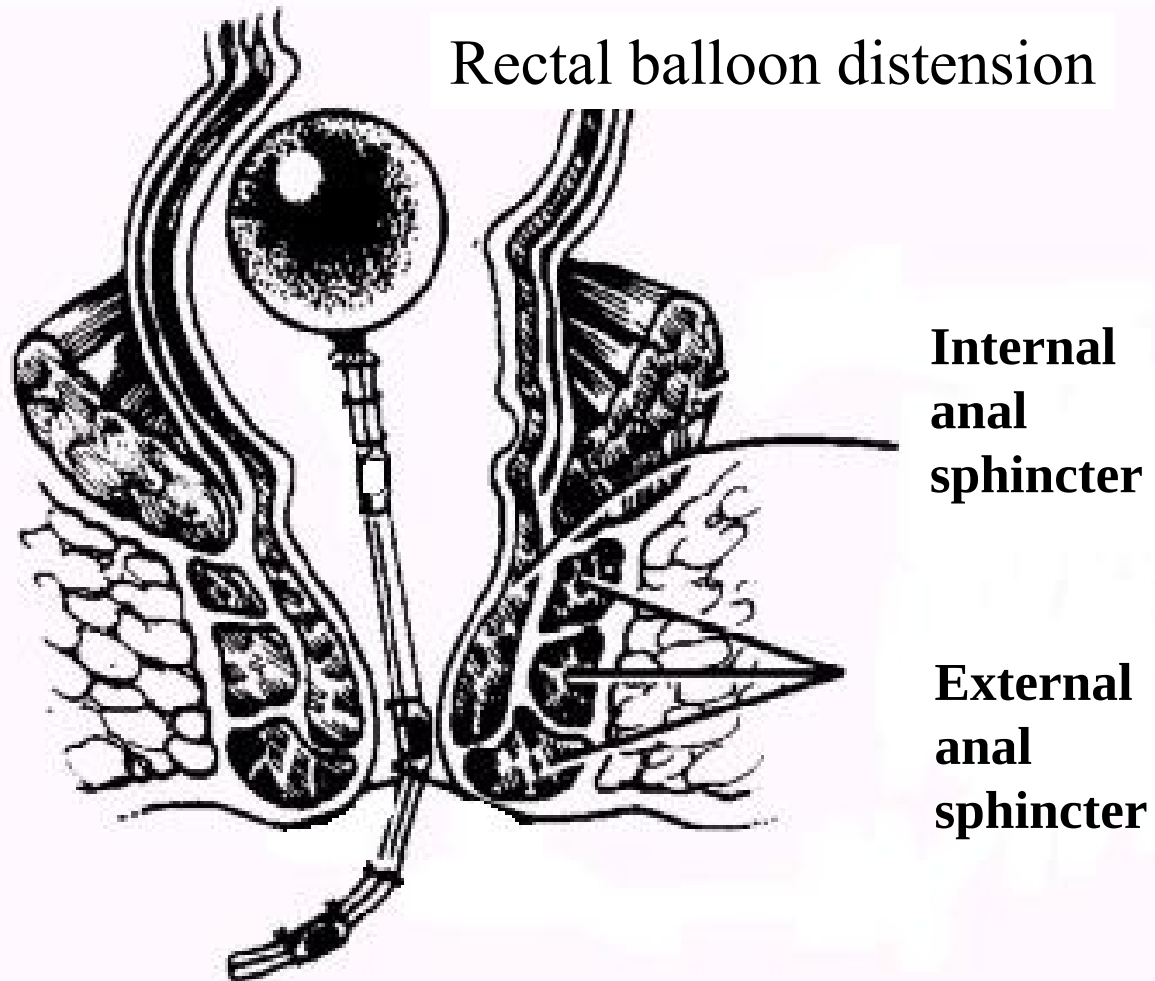
Station Pull

Tools

ext



Anorectal Manometry



STUDY DETAILS

EQUIPMENT

CAPTURE

REVIEW

Markers



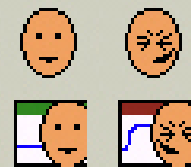
RAIR



Sensory Threshold



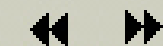
Station Pull



Tools



Text



mmHg

Posterior

6.0

100

0

mmHg

Right

6.0

100

0

mmHg

Anterior

6.0

100

0

mmHg

Left

6.0

100

0

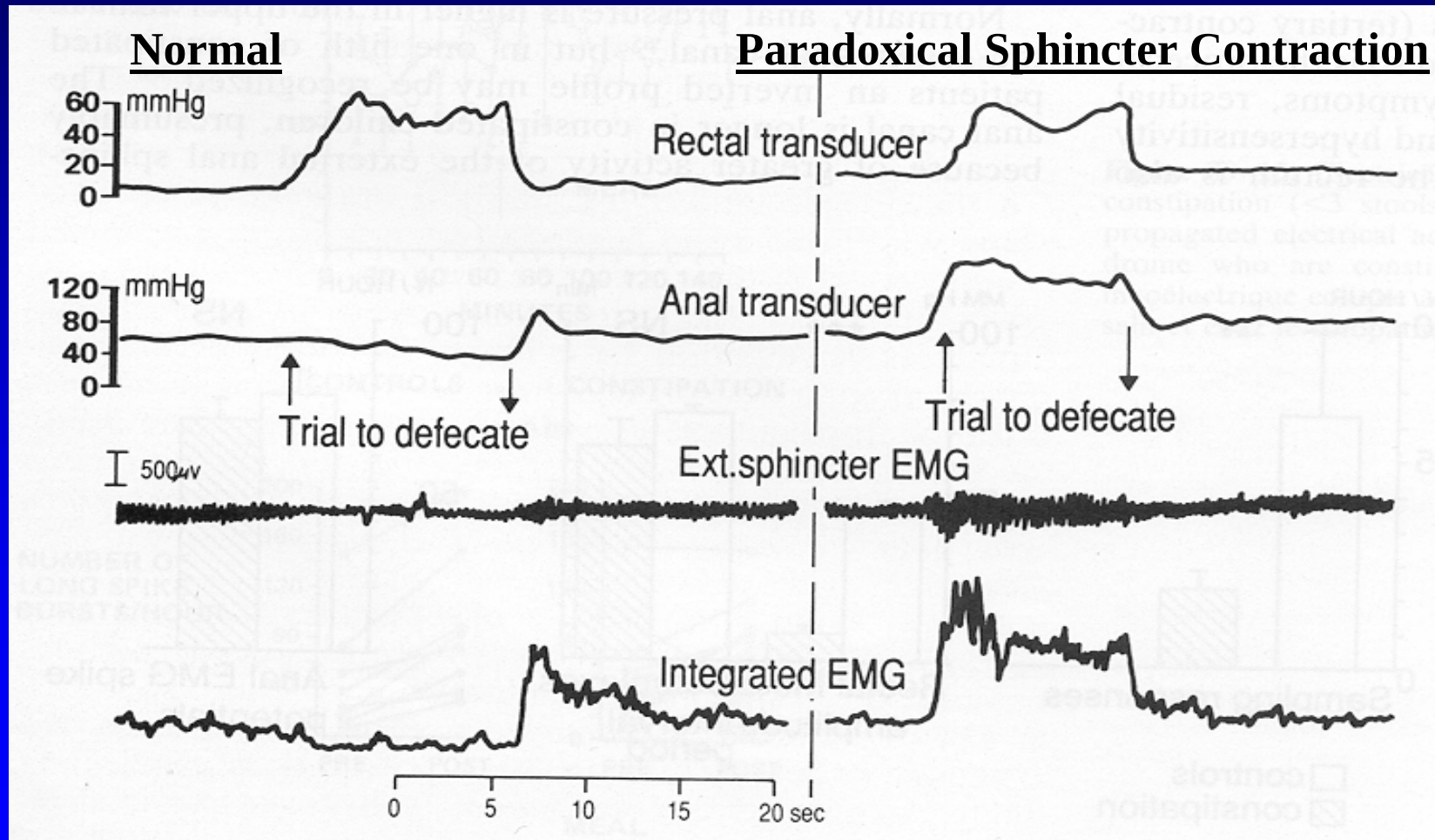
Rectal balloon distension

00:18:30

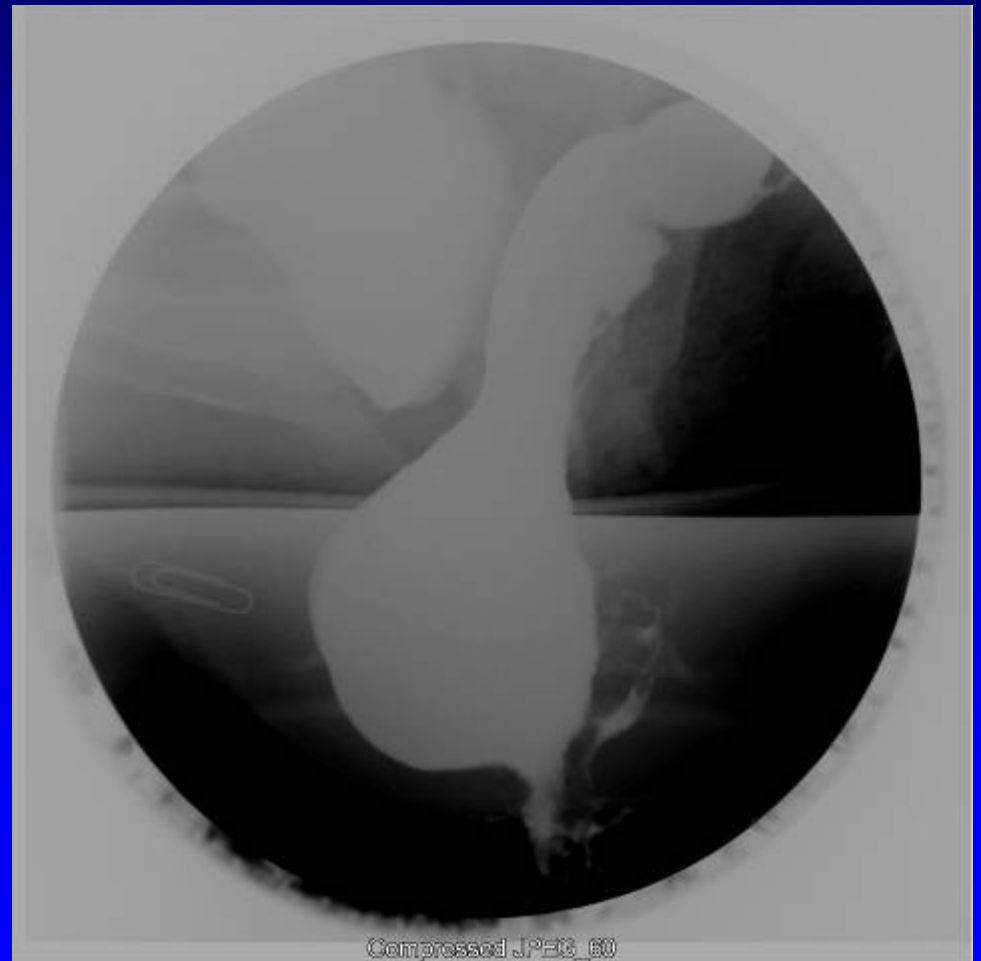
Anorectal Manometry

- Useful to identify functional defect
 - Resting pressure: 80% external anal sphincter
 - Squeeze pressure: 80% internal anal sphincter
 - Balloon sensation: sensory
 - Recto-anal inhibitory reflex: reflex relaxation
- Can direct therapy
 - Kegel exercises and biofeedback
 - Surgical repair

Anorectal Manometry and EMG in Paradoxical Sphincter Contraction



Defecation Proctogram



Conclusions:

Overview of GI Motility

- Motility overlaps
- Order the right test and know what are you looking for
- Clinical correlation is key