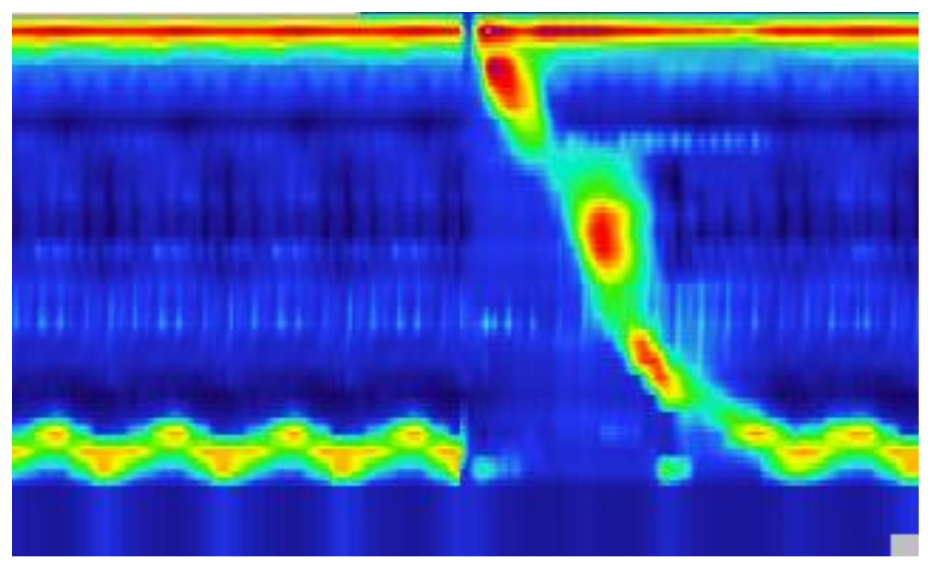
ESOPHAGEAL MANOMETRY
and
pH TESTING



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Introduction

Manometry

- Principles
- Normal values
- Motility abnormalities
- New directions: high resolution manometry

Introduction

pH Testing

- Principles
- Normal values and interpreting the study
- pH-impedance and the Bravo probe

Esophageal Manometry—Principles

Simply put, measure of the (circular) muscle function of the esophagus, including 3 zones:

- Upper esophageal sphincter (UES)
- Esophageal body
- Lower esophageal sphincter (LES)

Unit of measure is pressure, reported in mmHg

Esophageal Manometry—Principles

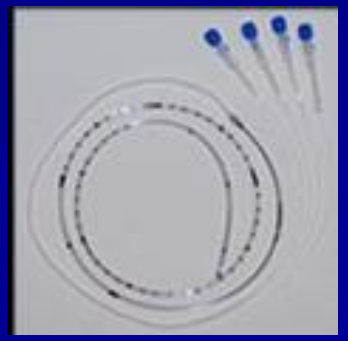
Manometry systems consist of:

- Catheter (inserted transnasally or orally), with multiple pressure sensor channels
- Pressure transducers
- Recording device with computer for analysis

Esophageal Manometry—Principles

Water-perfused system:

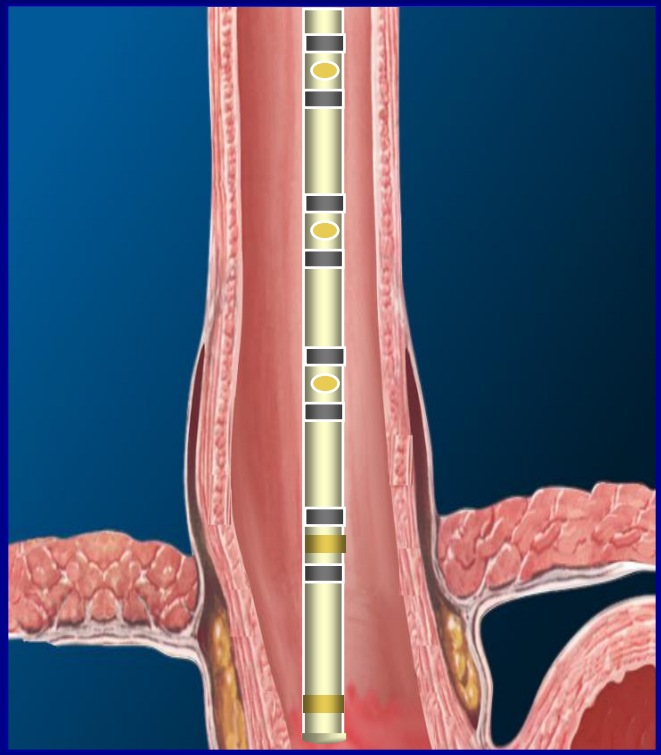
- Catheter contains multiple lumens each leading to a side-hole along the catheter length
- Water is pumped continuously through channels and resistance to flow is sensed by transducers
- Relatively reliable and easy to troubleshoot and fix



Esophageal Manometry—Principles

Solid-state system:

- Catheter incorporates electronic strain-gauge transducers along its length
- Circumferential transducers are useful for measuring LES and UES
- Advantages over water-perfused include:
  - More rapid response to changes in pressure
  - Easier to clean and set up



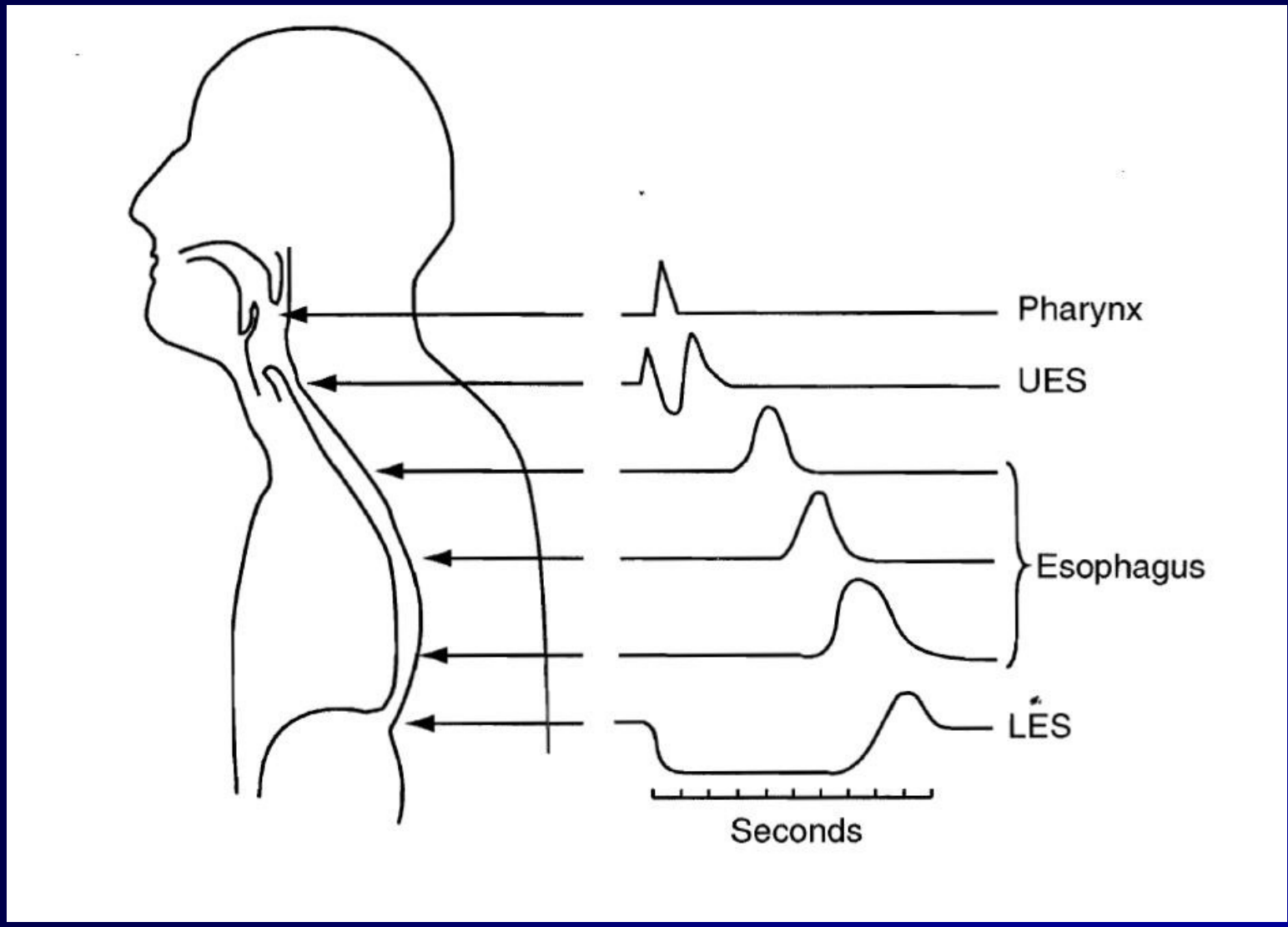
Esophageal Manometry
Technique

- 4 hour fast
- Place catheter transnasally
- Measure Gastric Baseline (LES is relative)
- Position Catheter (station pull-through technique)
- Wet Swallows (usually 10) of 5cc liquid

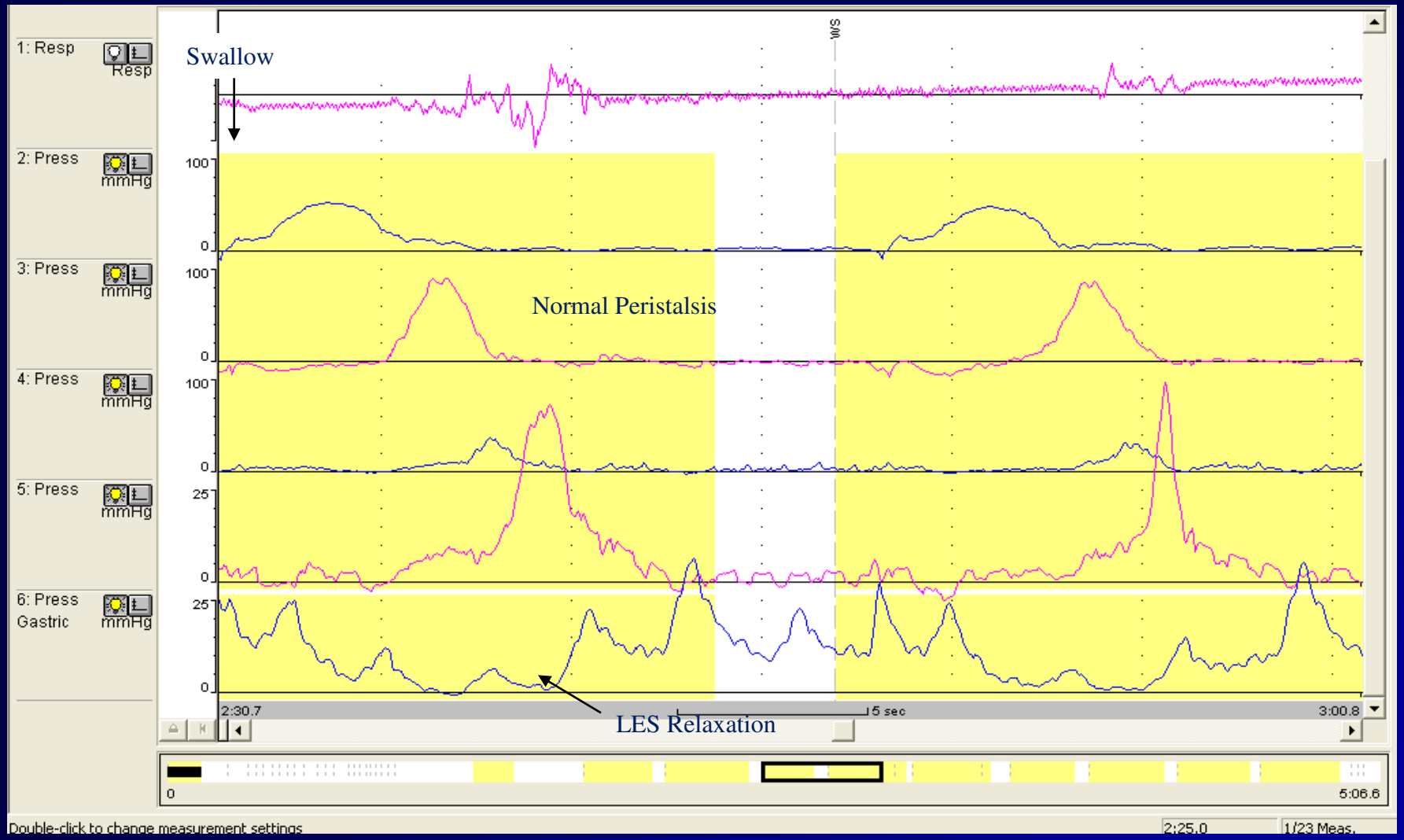
Esophageal Manometry
Method of Analysis

- Identify LES
  - Measure LES length, LES pressure, LESR
  - Identify PIP (pressure inversion point) and LES intra-abdominal length
- Analyze Swallows for peristalsis
- Evaluate UES length, pressure, and relaxation
- Run report and make corrections

Esophageal Manometry—Principles



Normal Manometry Tracing



Normal Manometric Parameters
Lower Esophageal Sphincter

- Lower Esophageal Sphincter Resting Pressure (LESP) = 10-45 mmHg
- LES relaxation > 80%
- LES nadir pressure (lowest pressure during relaxation) < 8 mmHg

Note: all pressures are referenced to baseline of intragastric pressure

Normal Manometric Parameters
Esophageal Body

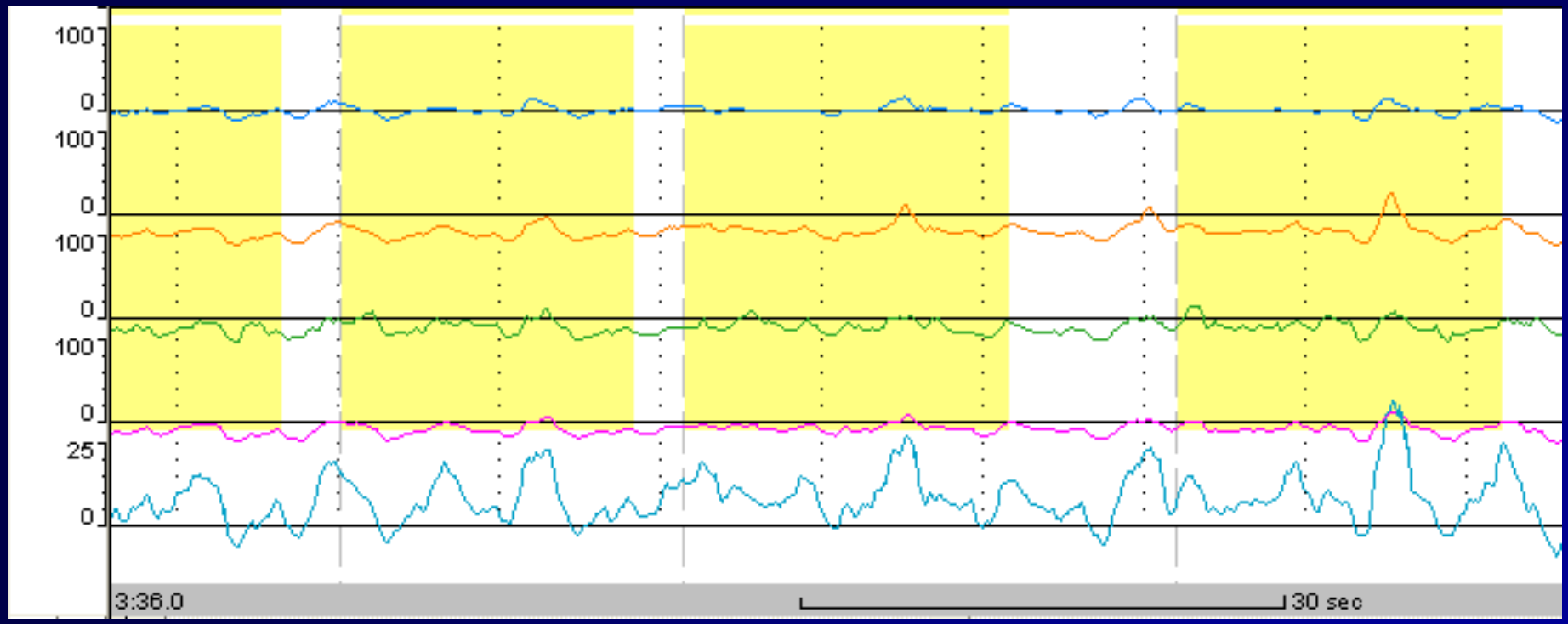
- Peristaltic Pressure wave amplitude = 30-180 mmHg
- Pressure wave duration < 6 seconds
- Normal peristalsis is defined as at least 80% normal peristaltic sequences

ESOPHAGEAL MOTILTY ABNORMALITIES

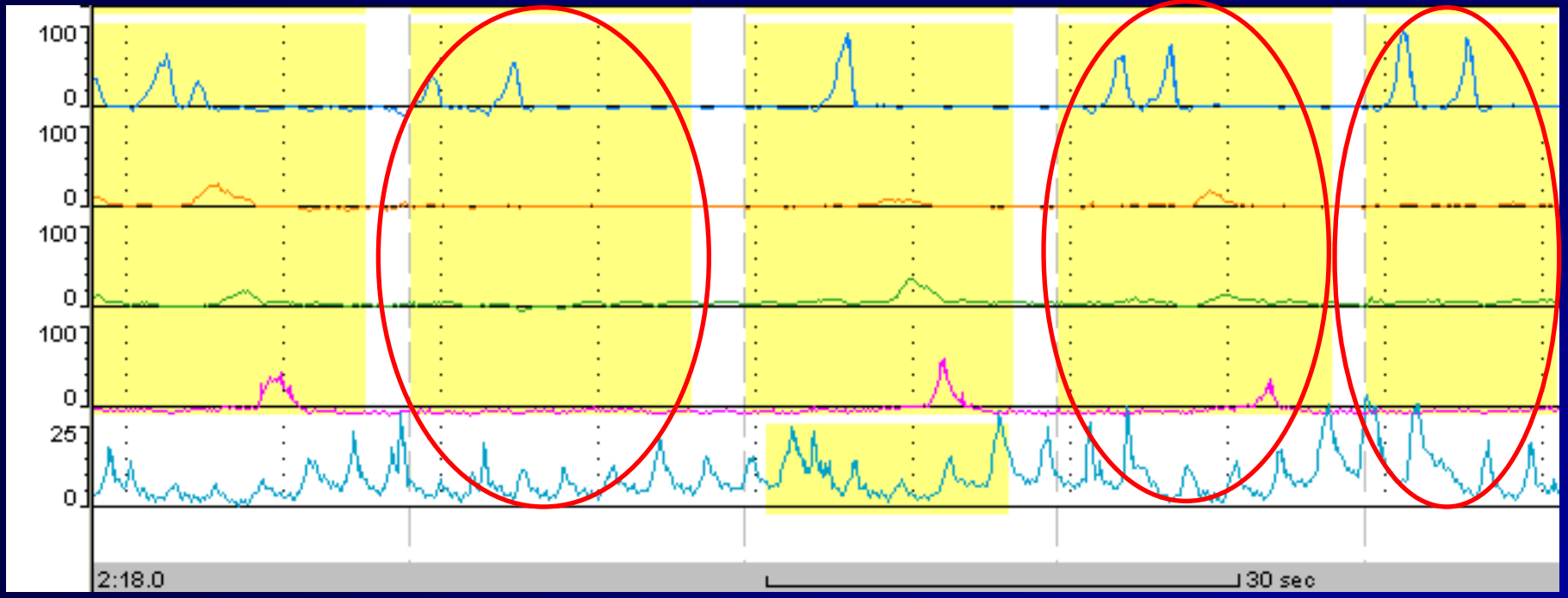
Motility Abnormalities
Definitions

Revised Classification of Esophageal Motility Abnormalities
- Inadequate LES relaxation (RP >8 mmHg) Classic achalasia – idiopathic or secondary Absent peristalsis required Atypical patterns
- Uncoordinated motility Diffuse esophageal spasm (>10% simultaneous contractions >30 mmHg)
- Hypercontraction Body = nutcracker esophagus (mean amplitude >180 mmHg) LES = hypertensive LES (>45 mmHg)
- Hypocontraction: primary or secondary? (GERD; scleroderma) Body = IEM (≥30% contraction < 30 mmHg) LES = Hypotensive LES (<10 mmHg)

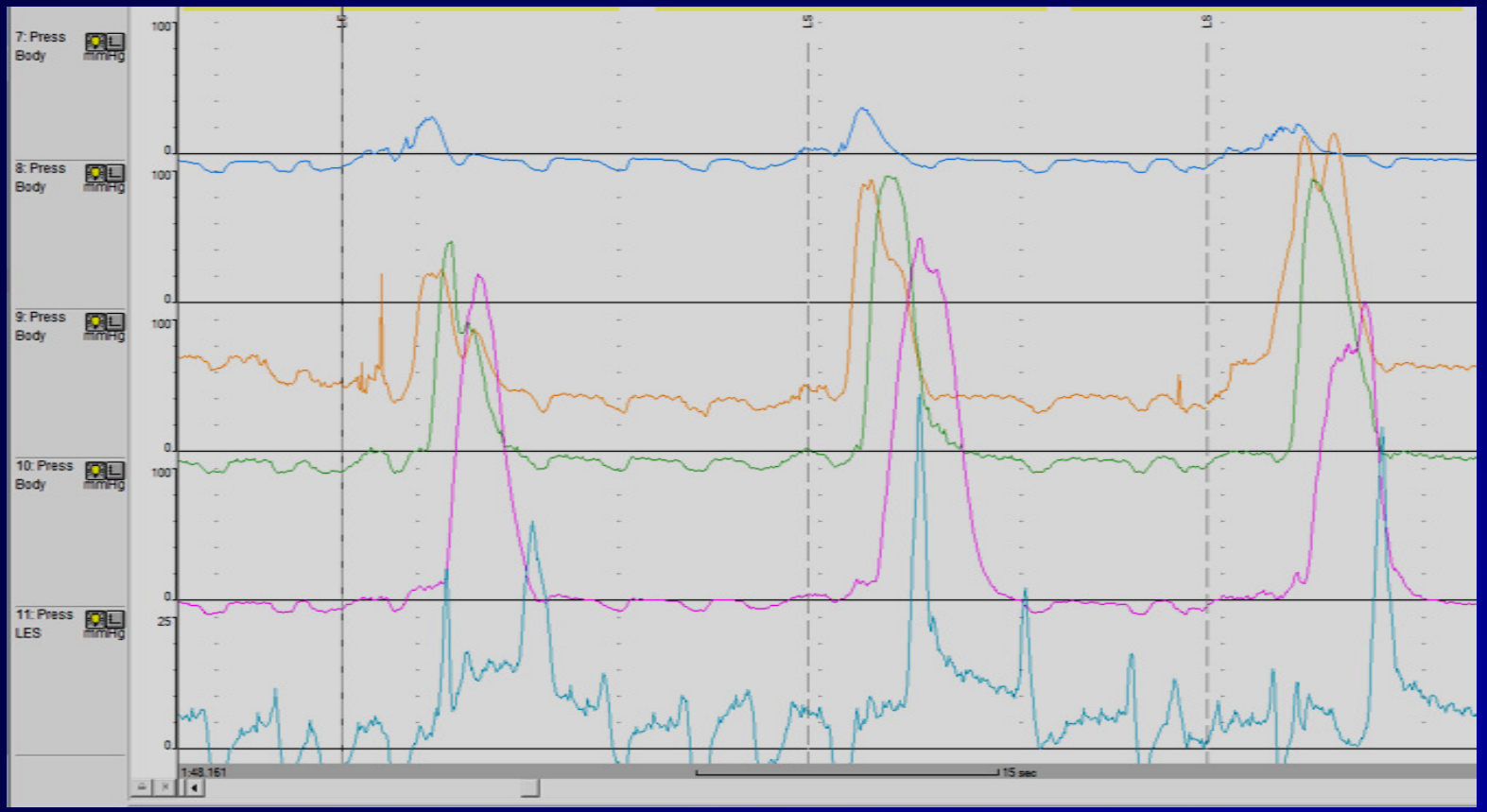
Achalasia



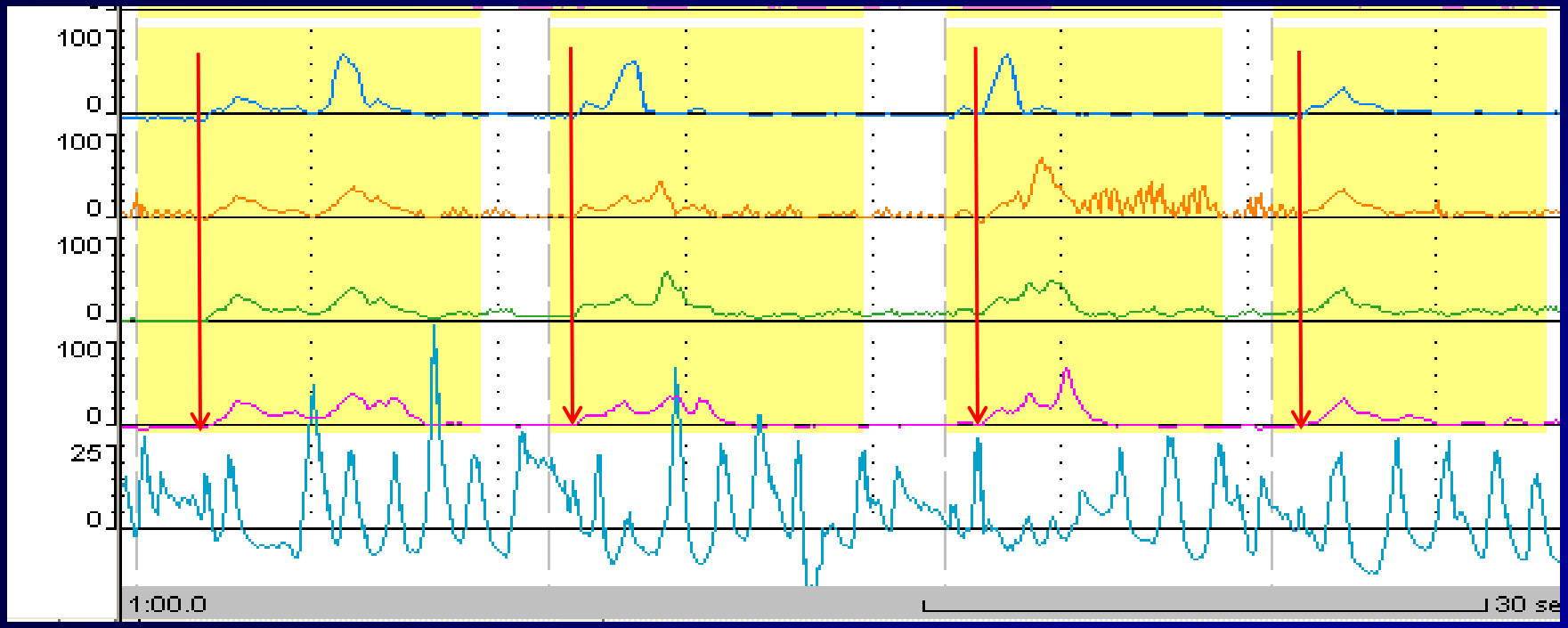
Ineffective Esophageal Motility



Nutcracker Esophagus



Diffuse Esophageal Spasm



High-Resolution Manometry

Concept:

- Effectively continuous recording of motor activity along entire esophageal length (UES to LES)
- Yields a more complete and detailed picture of esophageal motility
- Potentially better and more accurate characterization of esophageal function than standard manometry

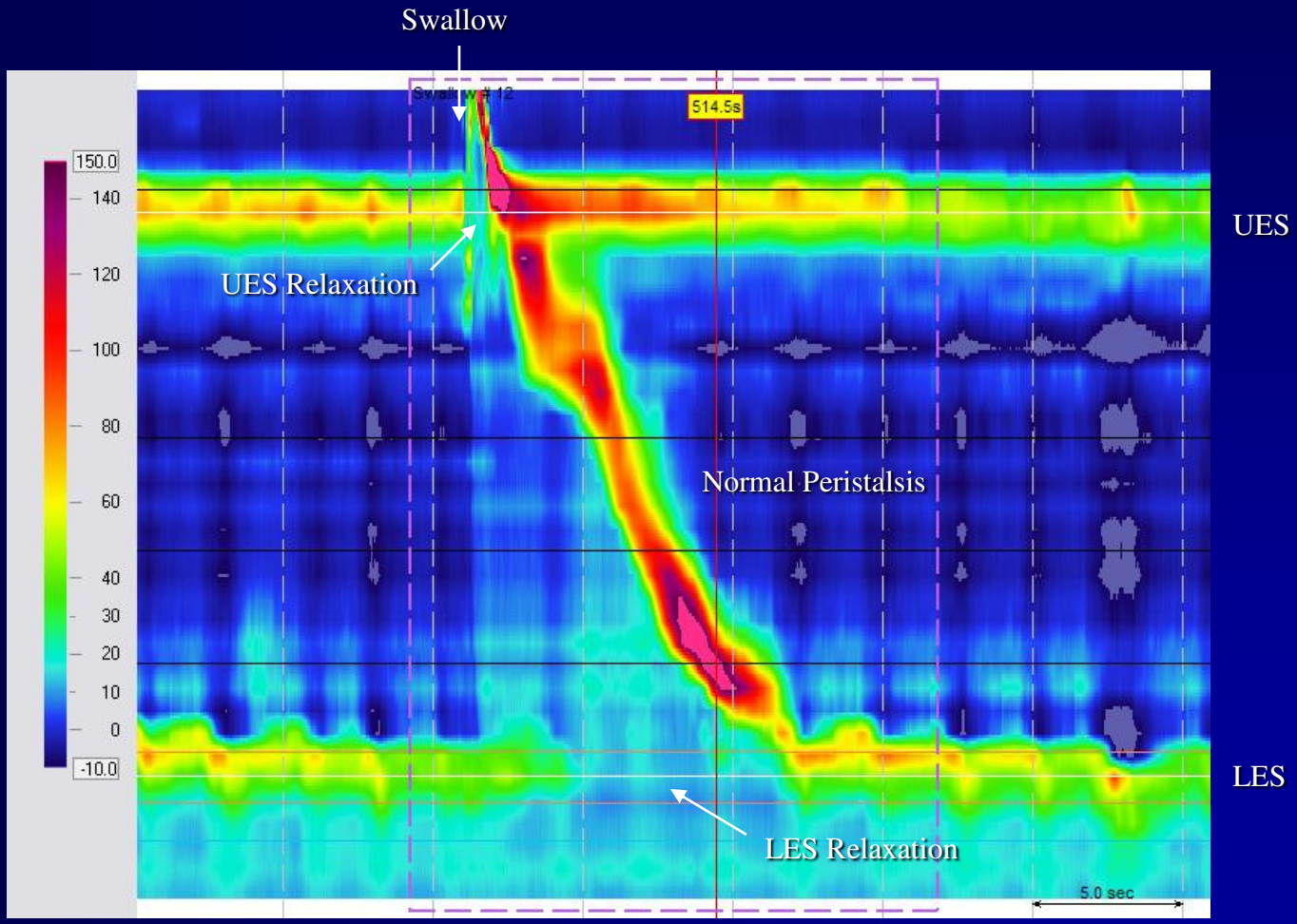
High-Resolution Manometry

Equipment:

- Recording device produces color-contour plot, with time on x-axis, esophageal length on y-axis, and pressure represented by a color scale

- Data between recording sites is interpolated to demonstrate pattern and pressure gradients

High Resolution Manometry
Normal Tracing



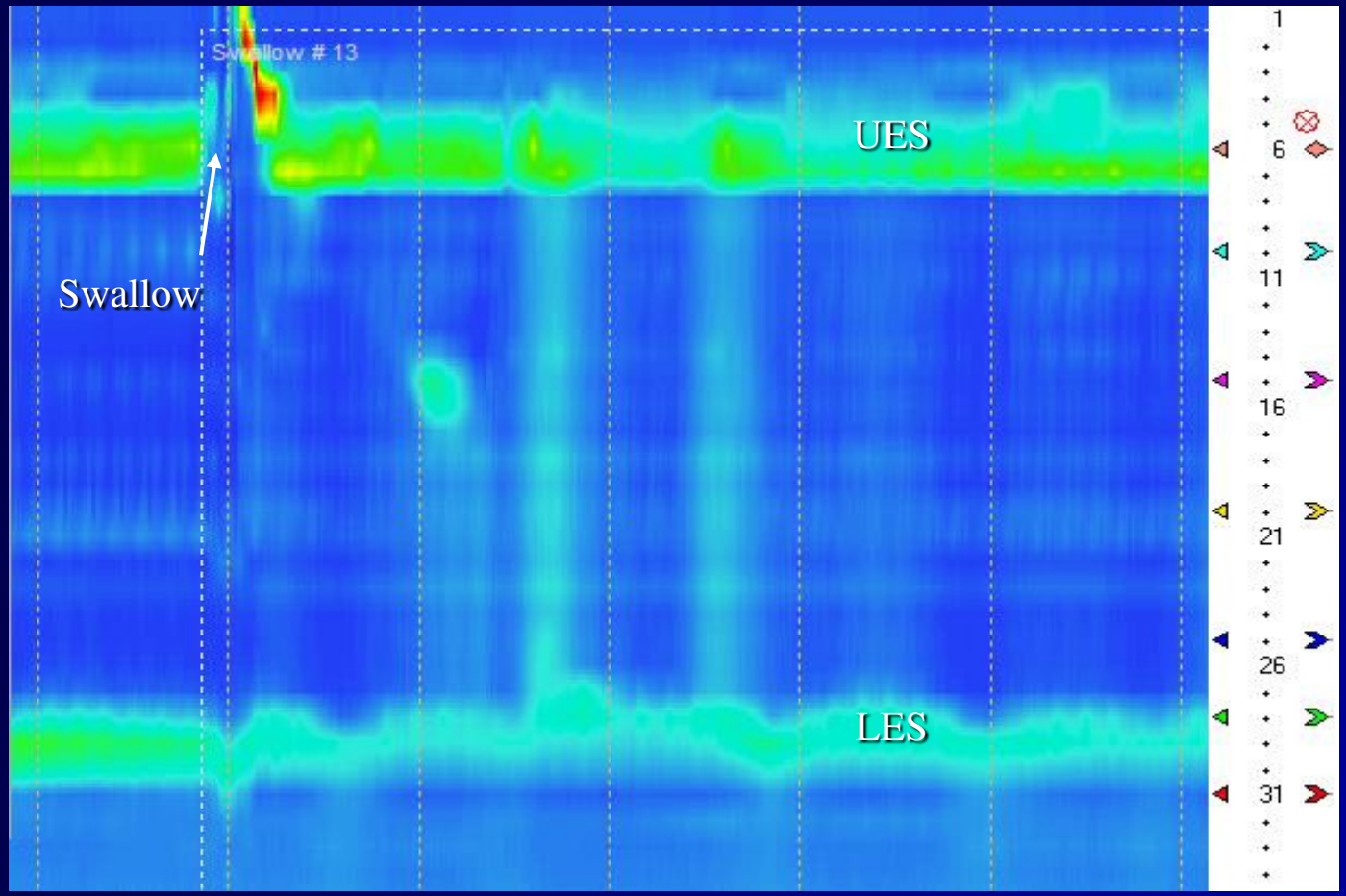
High-Resolution Manometry

Advantages over standard manometry:

- Technically easy to perform (catheter does not need to be repositioned during study)
- Visualize LES, esophageal body, and UES in detail simultaneously
- Visualize small and/or isolated segments of esophagus
- Compensates for esophageal shortening and movement of LES during swallows, using concept of “e-sleeve” (5-6 channels on distal catheter chosen to record LES)

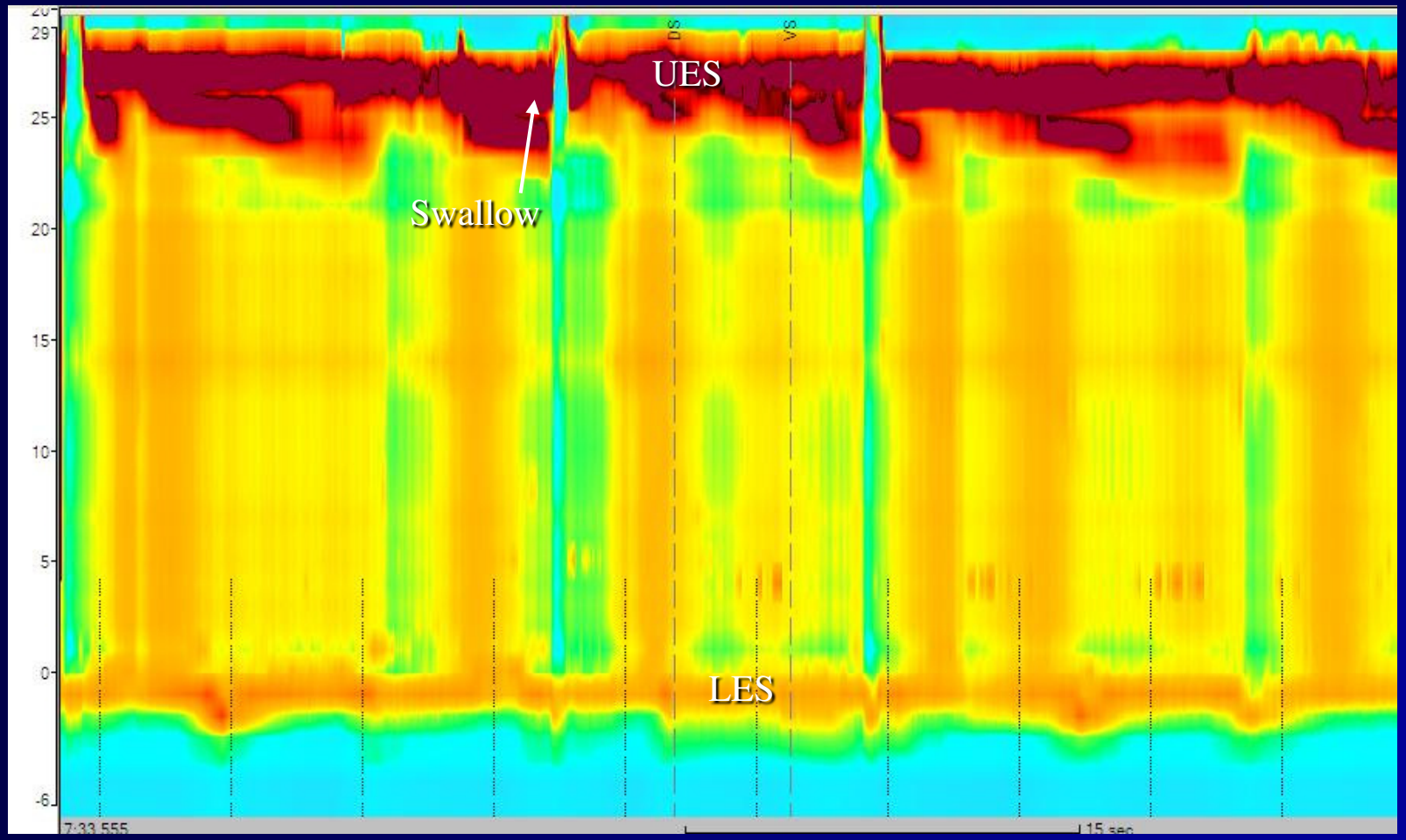
Specific Examples

Classic Achalasia:



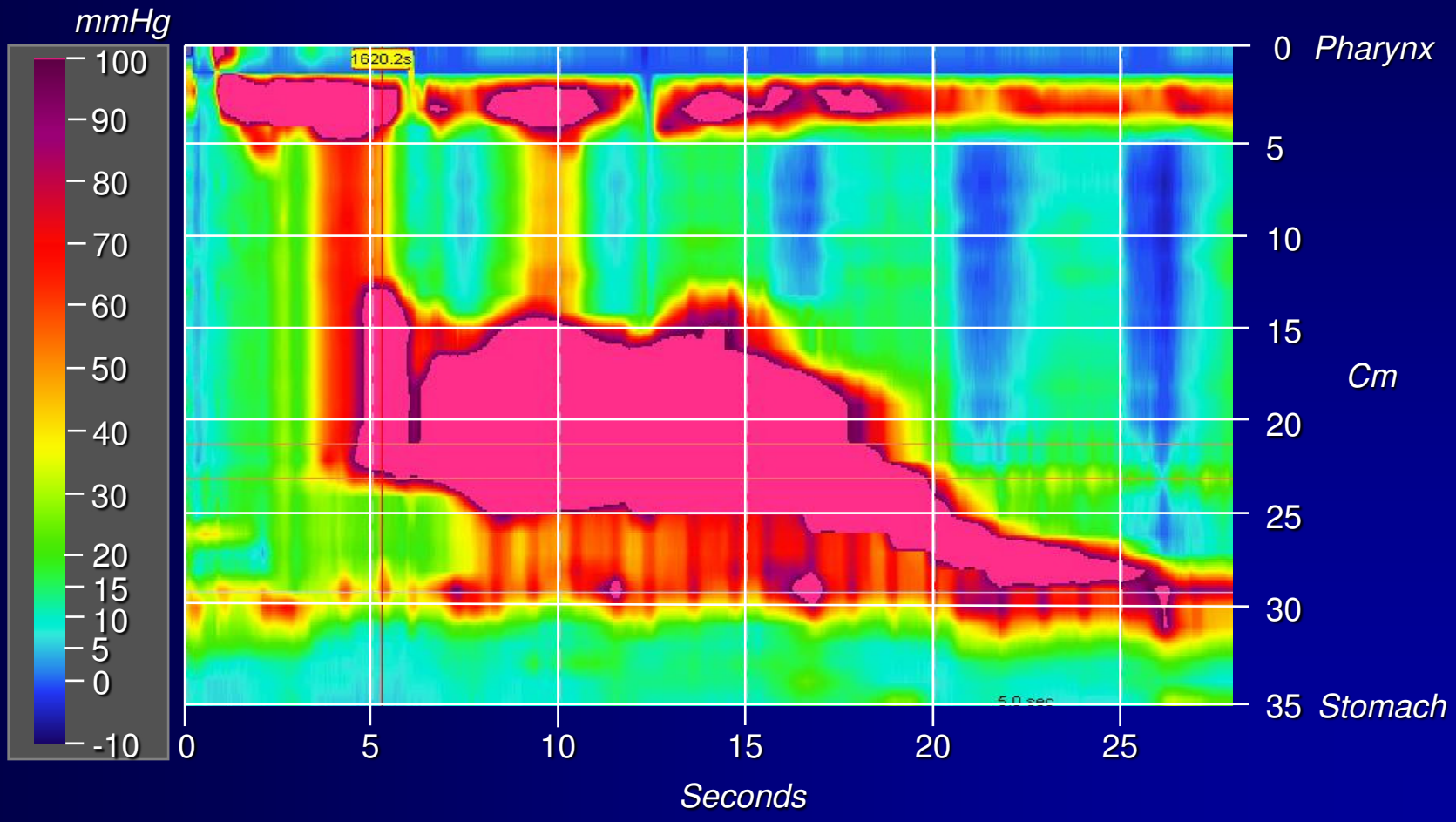
Specific Examples

Classic Achalasia:



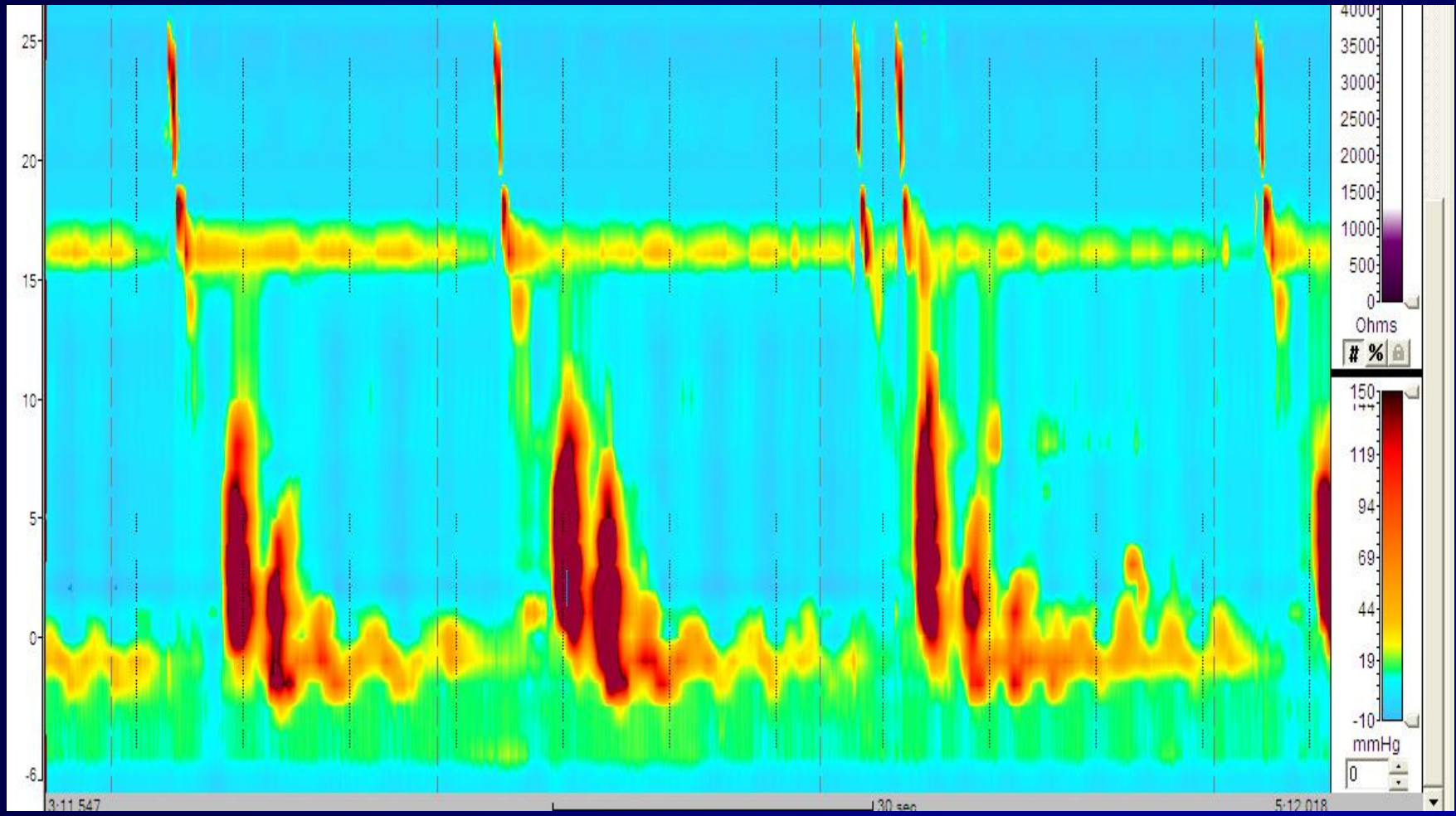
Specific Examples

Vigorous Achalasia:



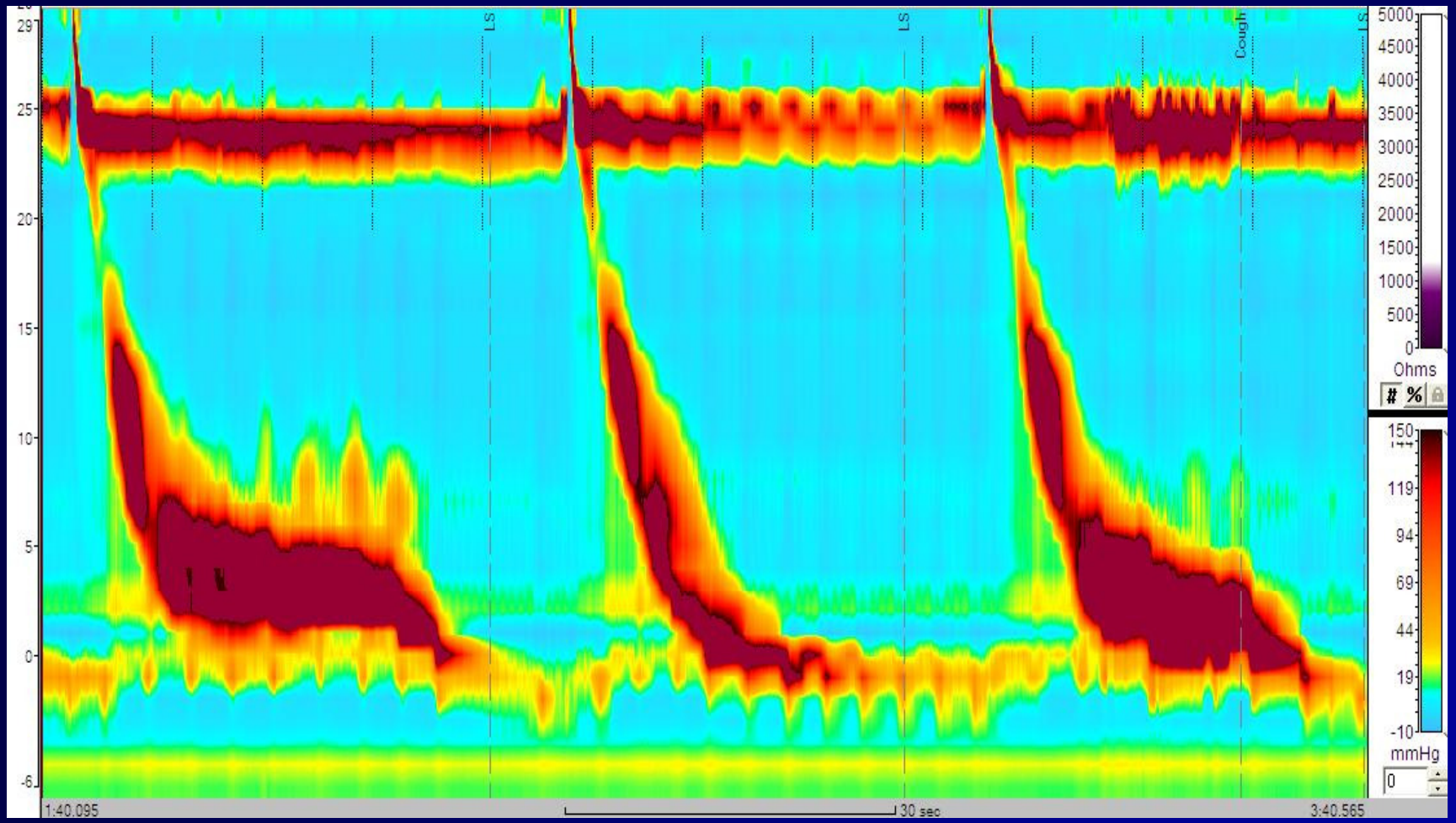
Specific Examples

Diffuse Esophageal Spasm:



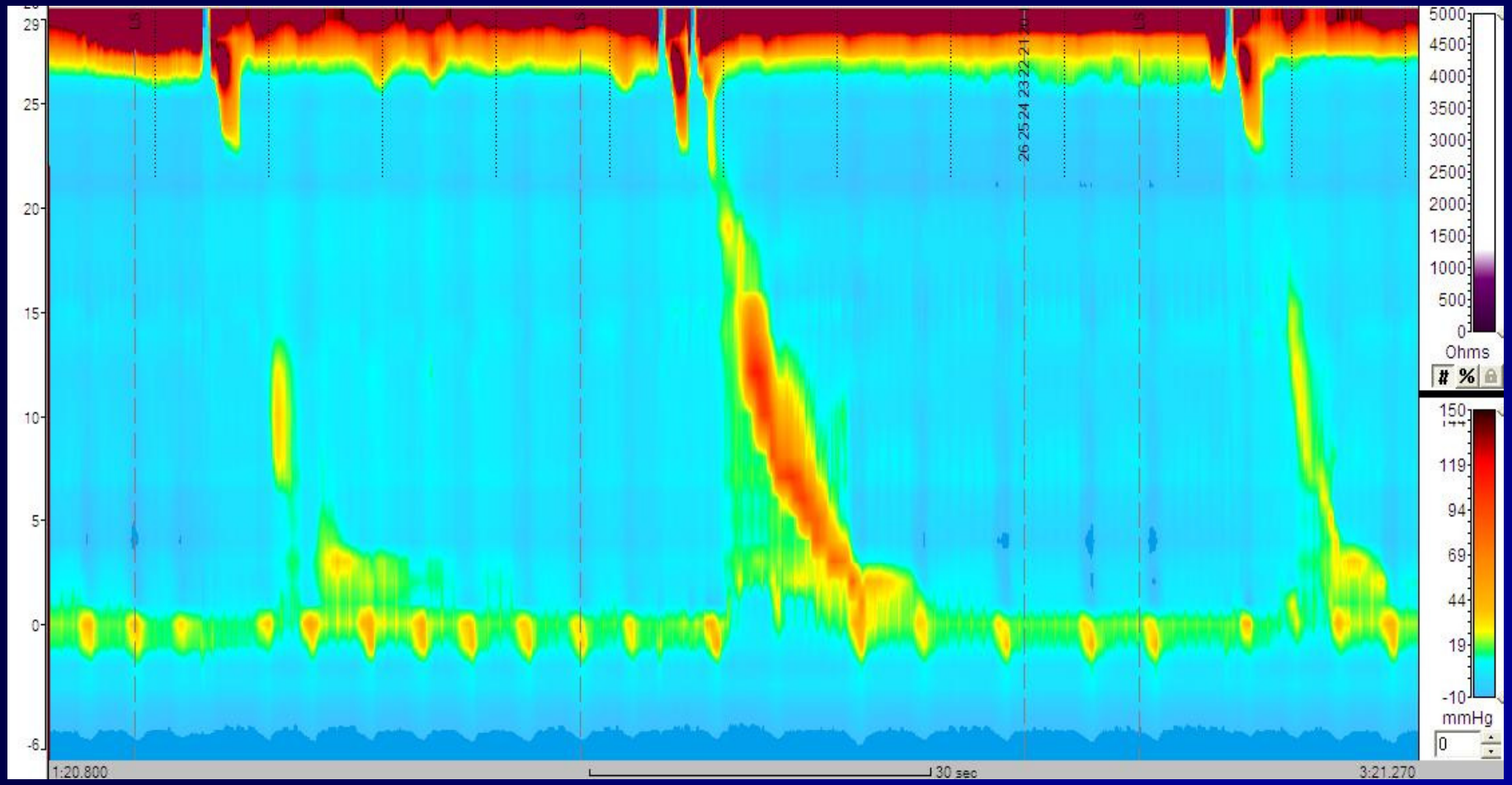
Specific Examples

Nutcracker Esophagus:



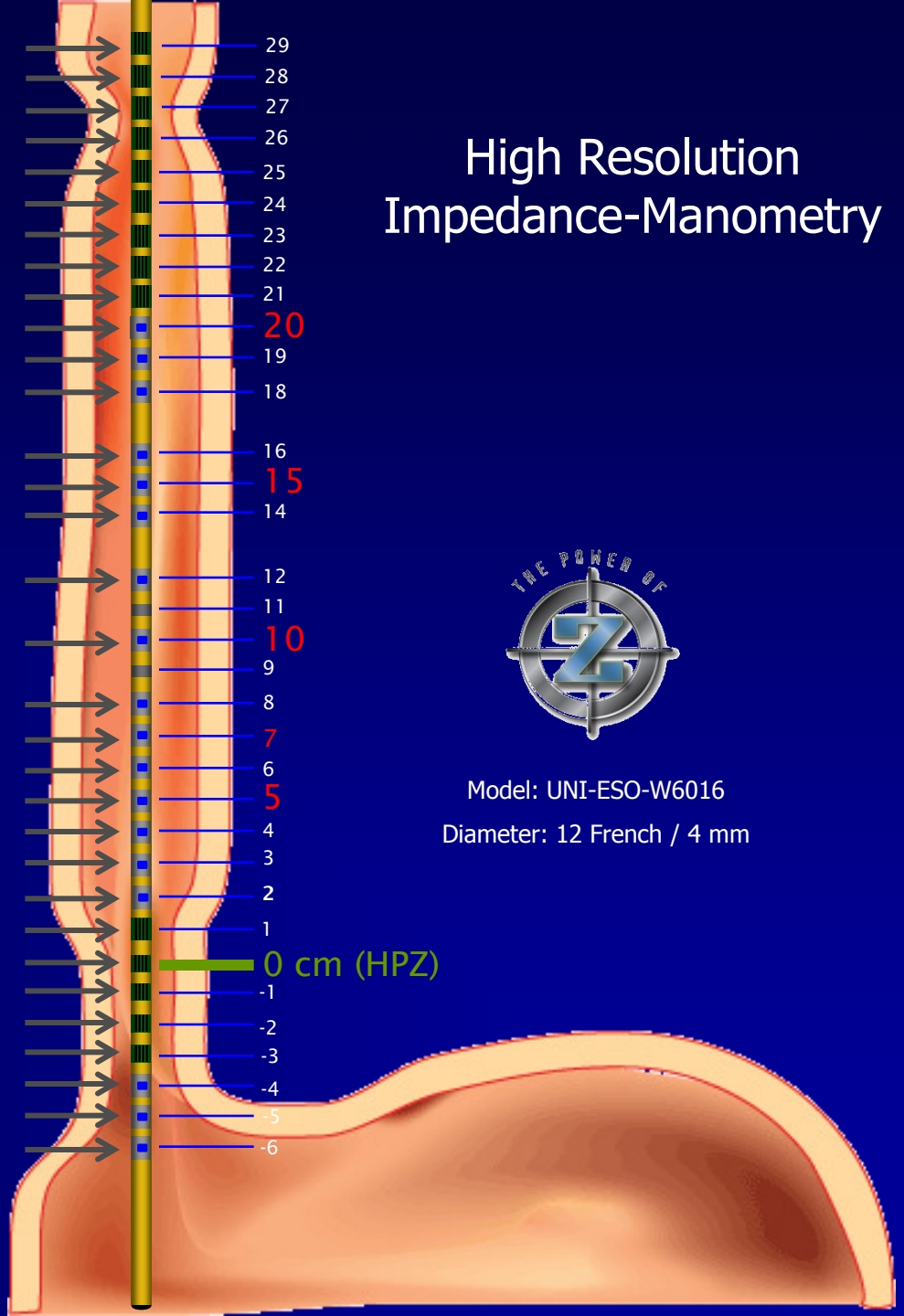
Specific Examples

Ineffective Esophageal Motility:



32 Pressure Channels

High Resolution Impedance-Manometry

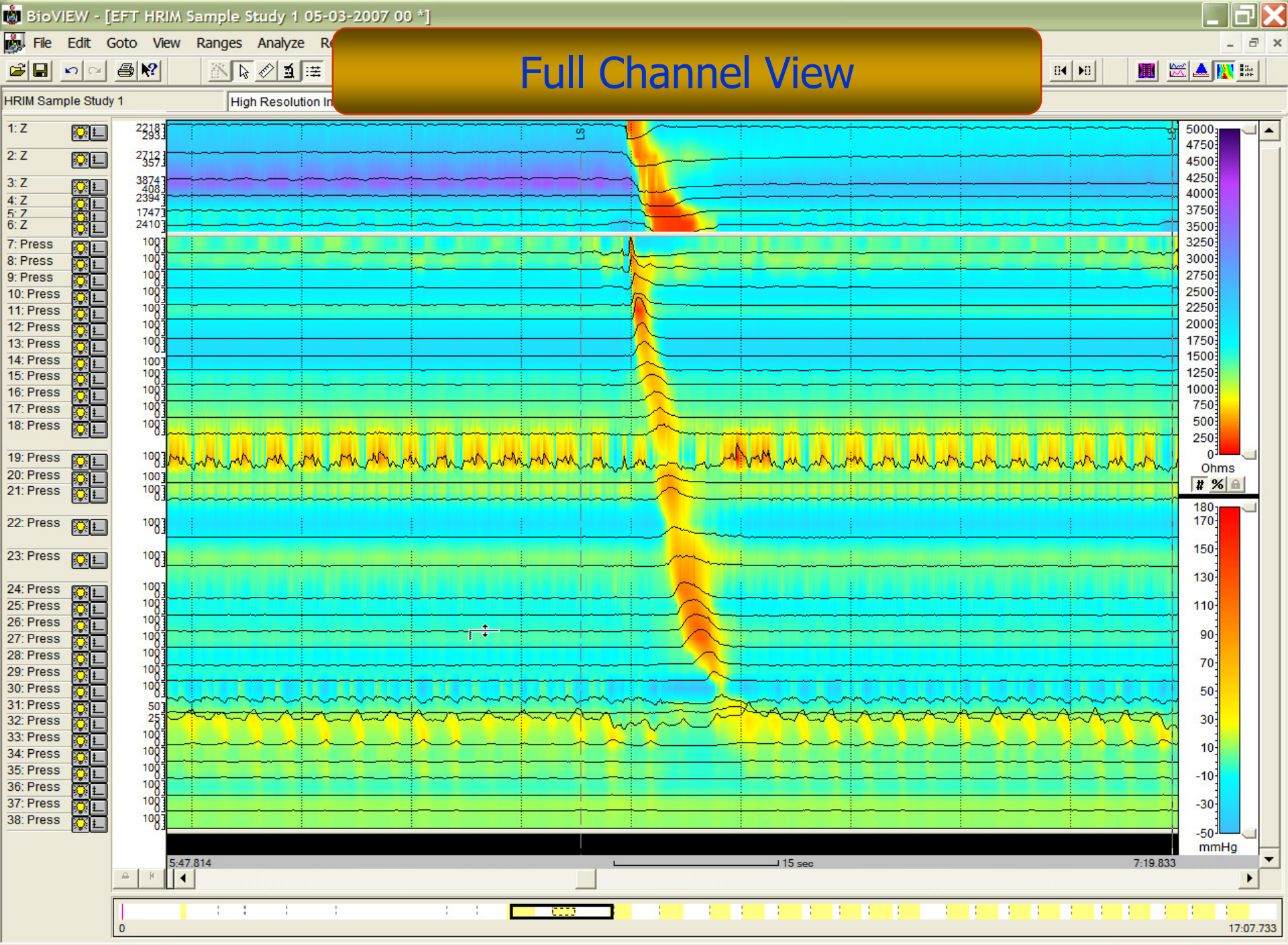


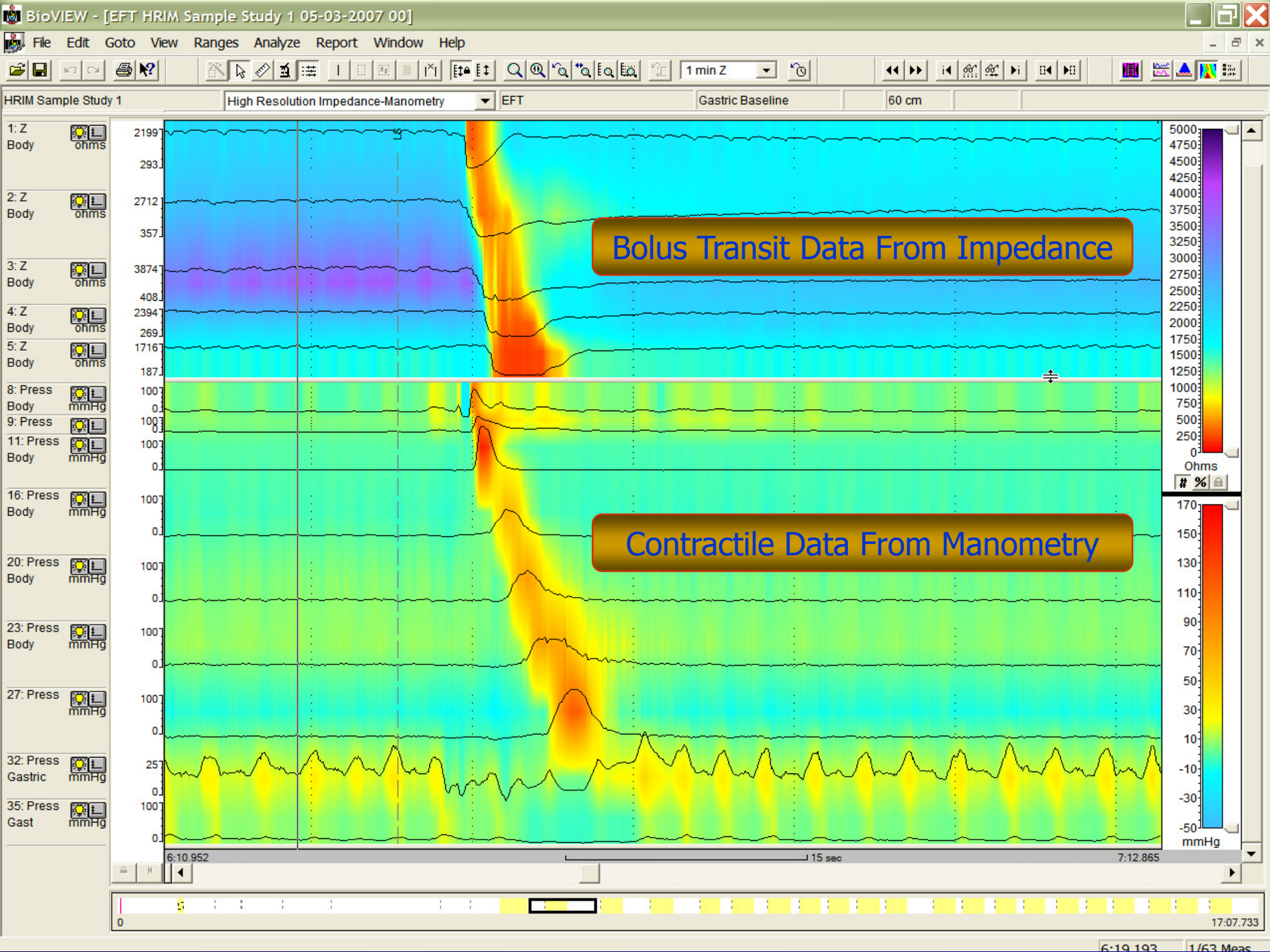
HRIM Probe Key

- Circumferential Pressure
- Impedance Ring / Directional Pressure
- Impedance Ring

Model: UNI-ESO-W6016

Diameter: 12 French / 4 mm

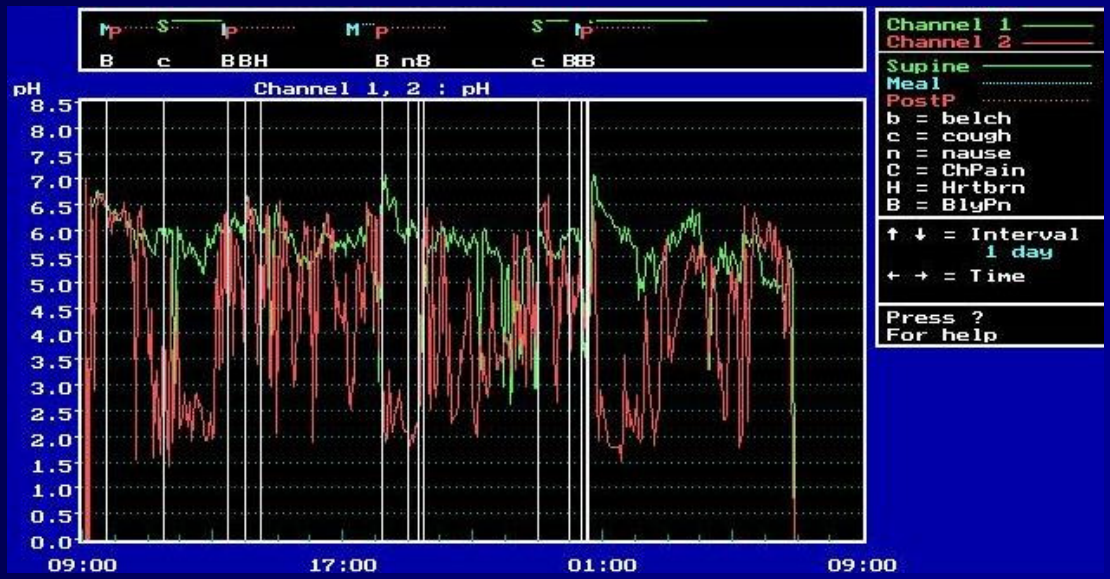

BioVIEW - [EFT HRIM Sample Study 1 05-03-2007 00 *]
File Edit Goto View Ranges Analyze
Full Channel View
HRIM Sample Study 1
High Resolution In
1: Z
2: Z
3: Z
4: Z
5: Z
6: Z
7: Press
8: Press
9: Press
10: Press
11: Press
12: Press
13: Press
14: Press
15: Press
16: Press
17: Press
18: Press
19: Press
20: Press
21: Press
22: Press
23: Press
24: Press
25: Press
26: Press
27: Press
28: Press
29: Press
30: Press
31: Press
32: Press
33: Press
34: Press
35: Press
36: Press
37: Press
38: Press
Ohms
mmHg
5:47.814
15 sec
7:19.833
0
17:07.733
Change maximum channel units
7:19.282
4/63 Meas.


BioVIEW - [EFT HRIM Sample Study 1 05-03-2007 00]
File Edit Goto View Ranges Analyze Report Window Help
HRIM Sample Study 1
High Resolution Impedance-Manometry
EFT
Gastric Baseline
60 cm
1 min Z
1: Z Body ohms
2: Z Body ohms
3: Z Body ohms
4: Z Body ohms
5: Z Body ohms
8: Press Body mmHg
9: Press
11: Press Body mmHg
16: Press Body mmHg
20: Press Body mmHg
23: Press Body mmHg
27: Press mmHg
32: Press Gastric mmHg
35: Press Gast mmHg
Bolus Transit Data From Impedance
Contractile Data From Manometry
Ohms
mmHg
6:10.952
15 sec
7:12.865
17:07.733

ESOPHAGEAL pH MONITORING

24hr pH Monitoring

- Technique (standard 2-channel):
  - Position distal channel 5cm above LES
  - Proximal sensor 15cm above
  - ALL norms based on this position
  - Exclude meals



24hr pH Monitoring

- Analysis:
  - DeMeester score (based on distal channel only)—a complex calculation which factors in:
    - Number of episodes
    - Number of episodes >5min
    - Longest episode
    - % time below pH 4 (total, supine, upright)
  - Correlate with symptoms (Symptom Index):

$$SI = \frac{\text{Number of symptoms reported that are associated with reflux events}}{\text{Total number of symptoms reported}} \times 100$$

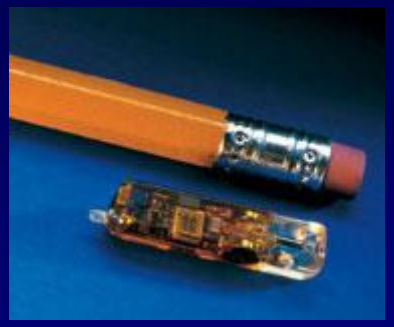
24hr pH Monitoring
Normal Values

- % Time pH < 4.0:
  - Distal Sensor:
    - Total < 4.2%
    - Upright < 6.3%
    - Supine < 1.2%
  - Proximal Sensor:
    - Upright < 1.3%
    - Supine = 0%
- DeMeester Score: < 14.72 (yes, 14.72!)

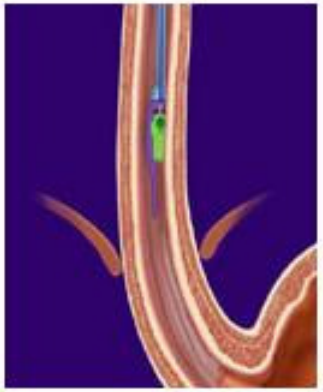
pH Testing—the Bravo Probe

Small radio transmitter device that transmits pH data to a recorder worn on patient's belt

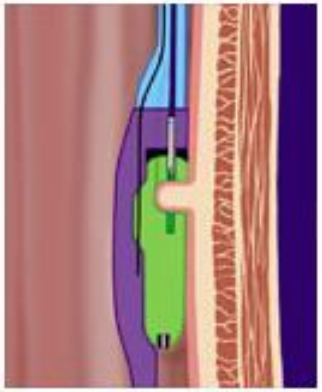
- 48 hours of data
- Typically only a single recording site
- Usually better tolerated than nasal catheter (although some patients experience chest pain)
- Probably gives a better picture of a more "typical" day



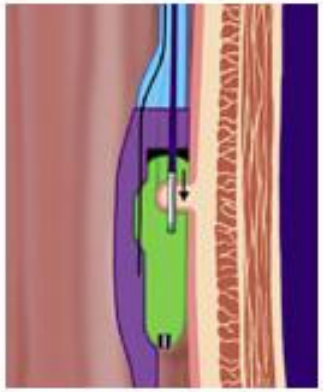
pH Testing—the Bravo Probe



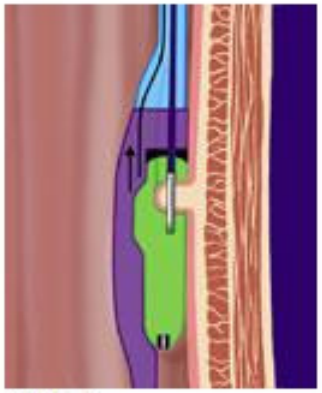
Step 1.
Position the capsule in the esophagus



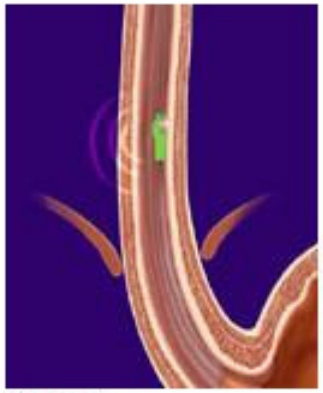
Step 2.
Apply suction



Step 3.
Attach capsule



Step 4.
Remove delivery system

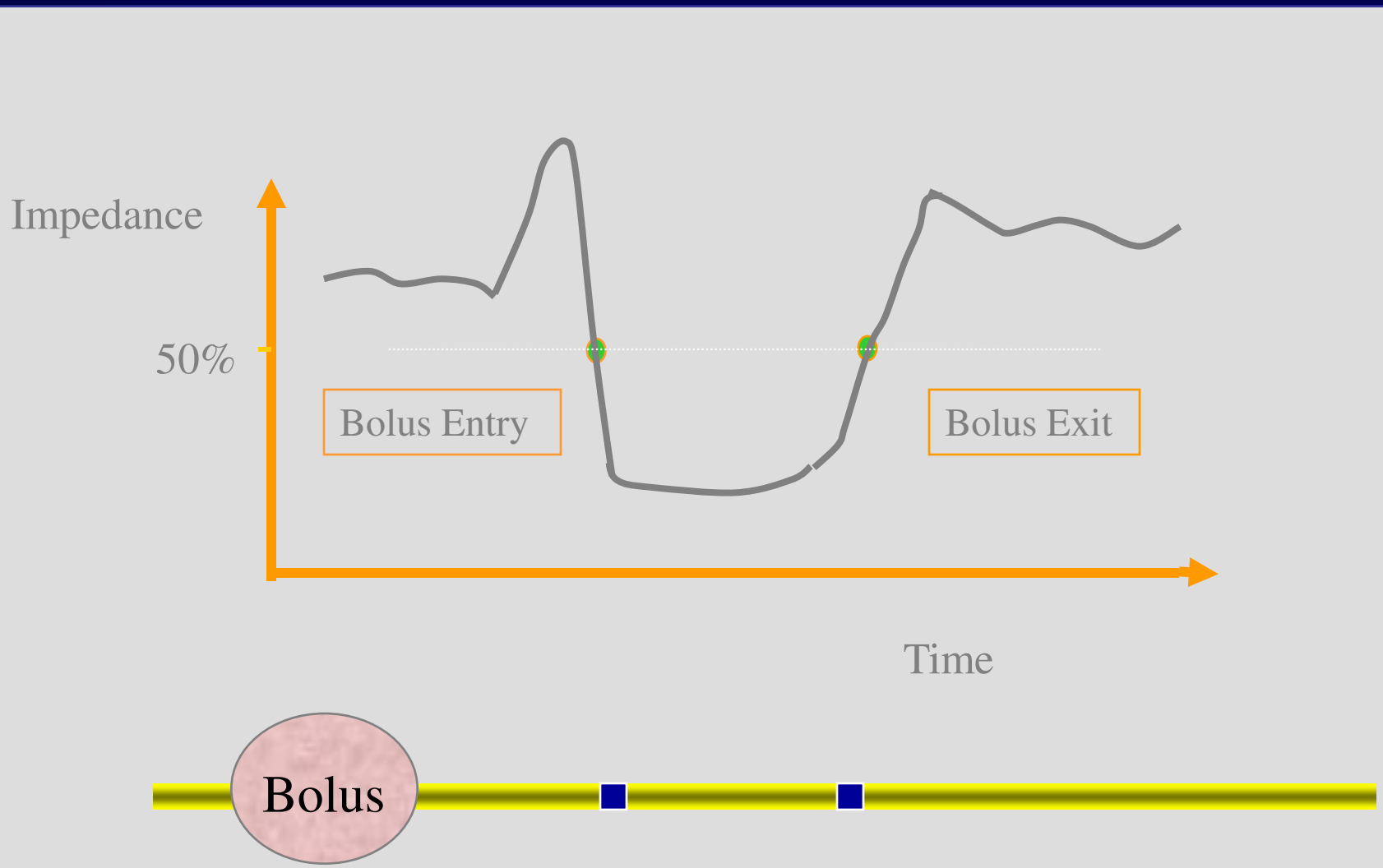


Step 5.
Begin transmitting pH data to receiver

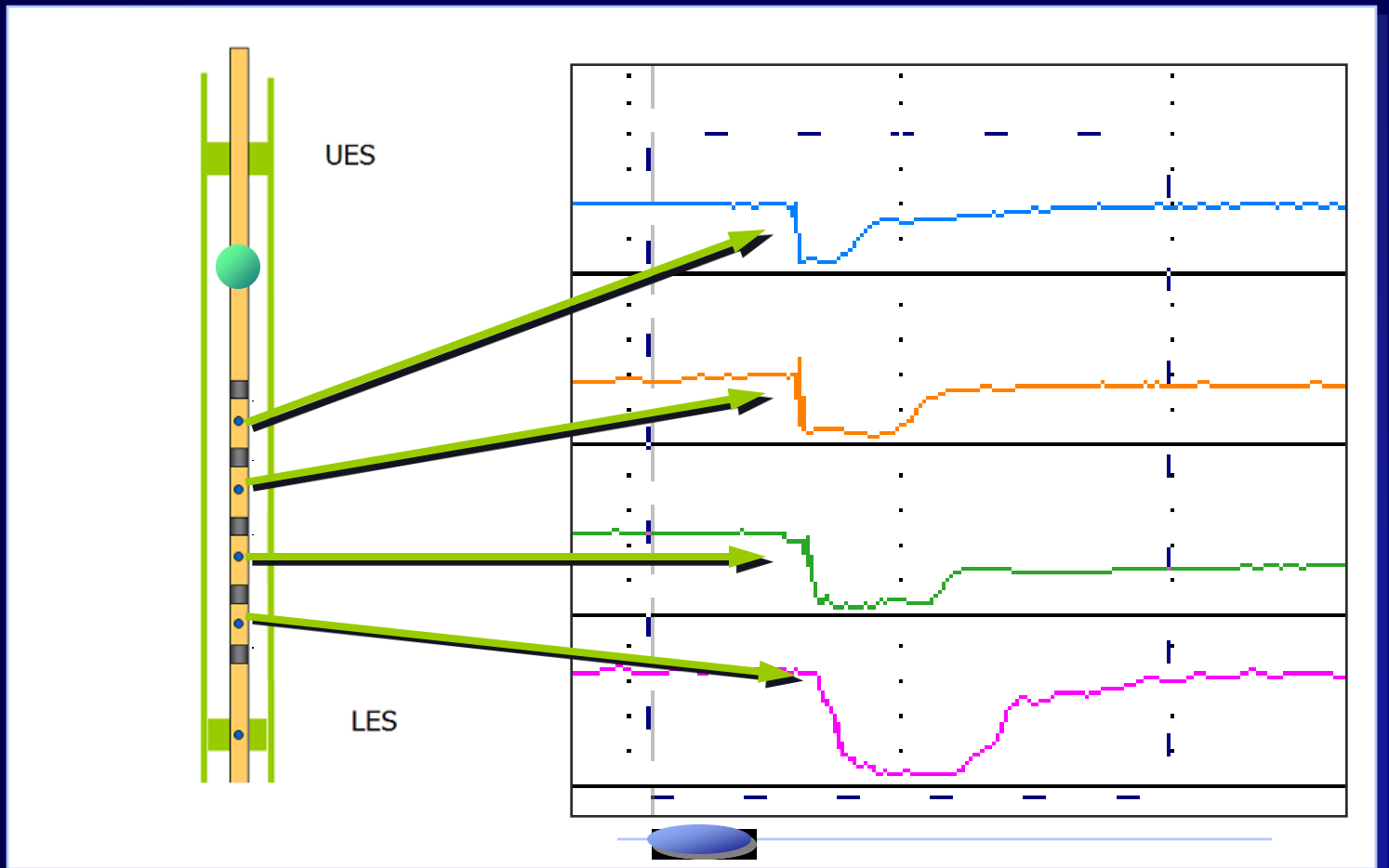
Impedance Monitoring

- Detects the presence of any material in the esophageal lumen
- Done concomitantly with manometry or pH study
- Gives information about:
  - Esophageal clearance
  - Non acid reflux

Impedance Tracing

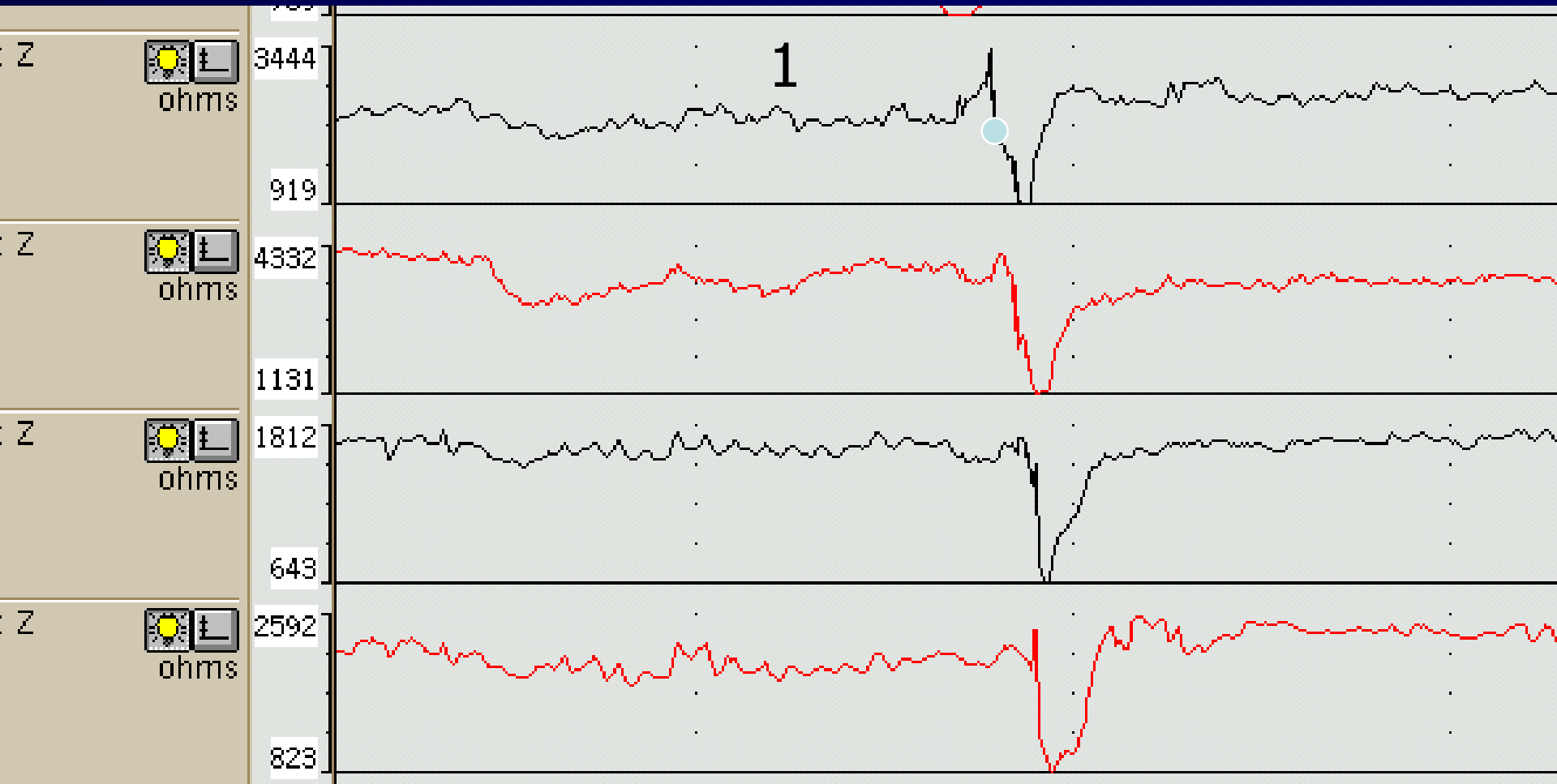


Impedance Tracing

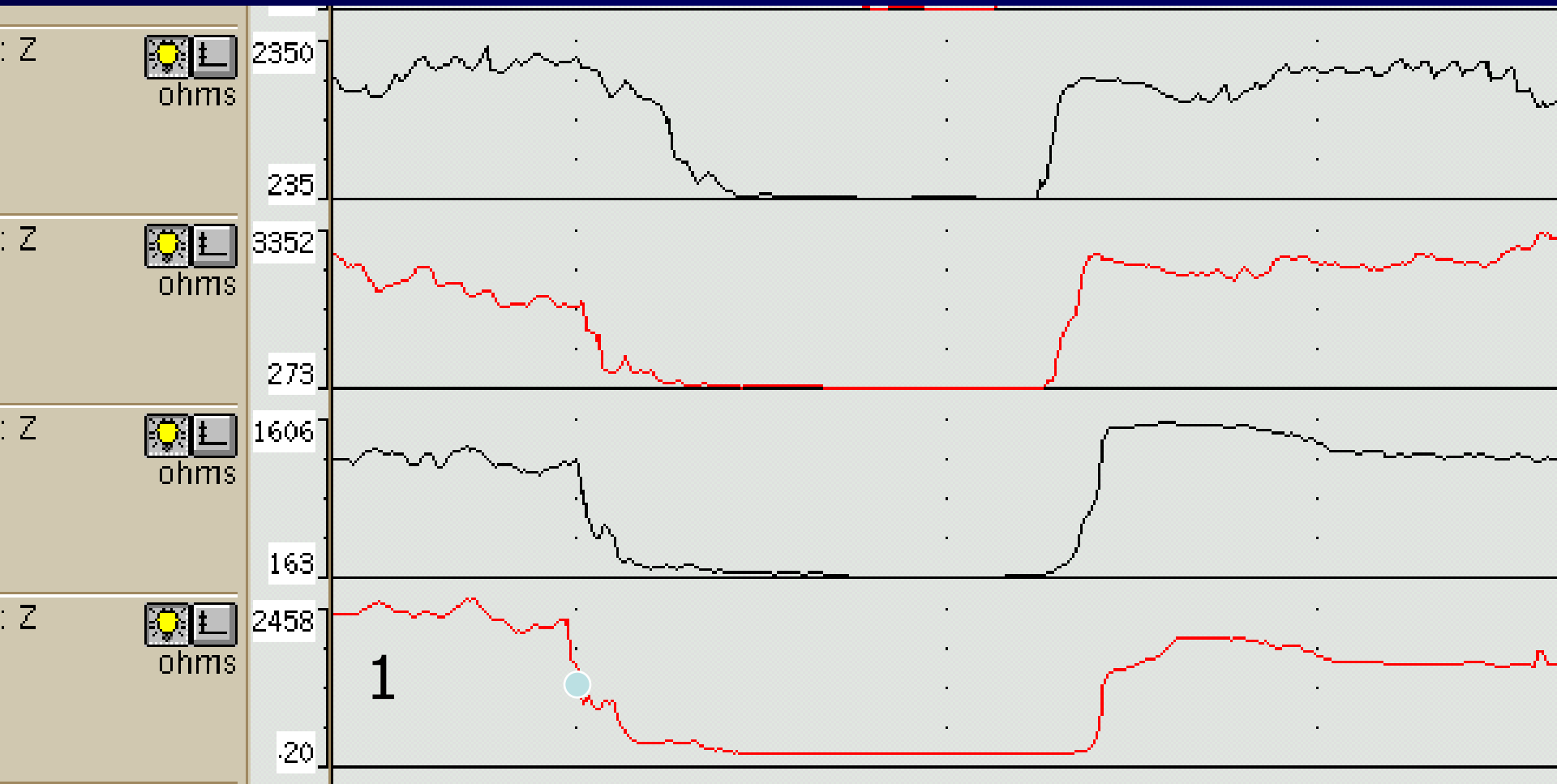


Waveform & Bolus Movement

Downward= Oral

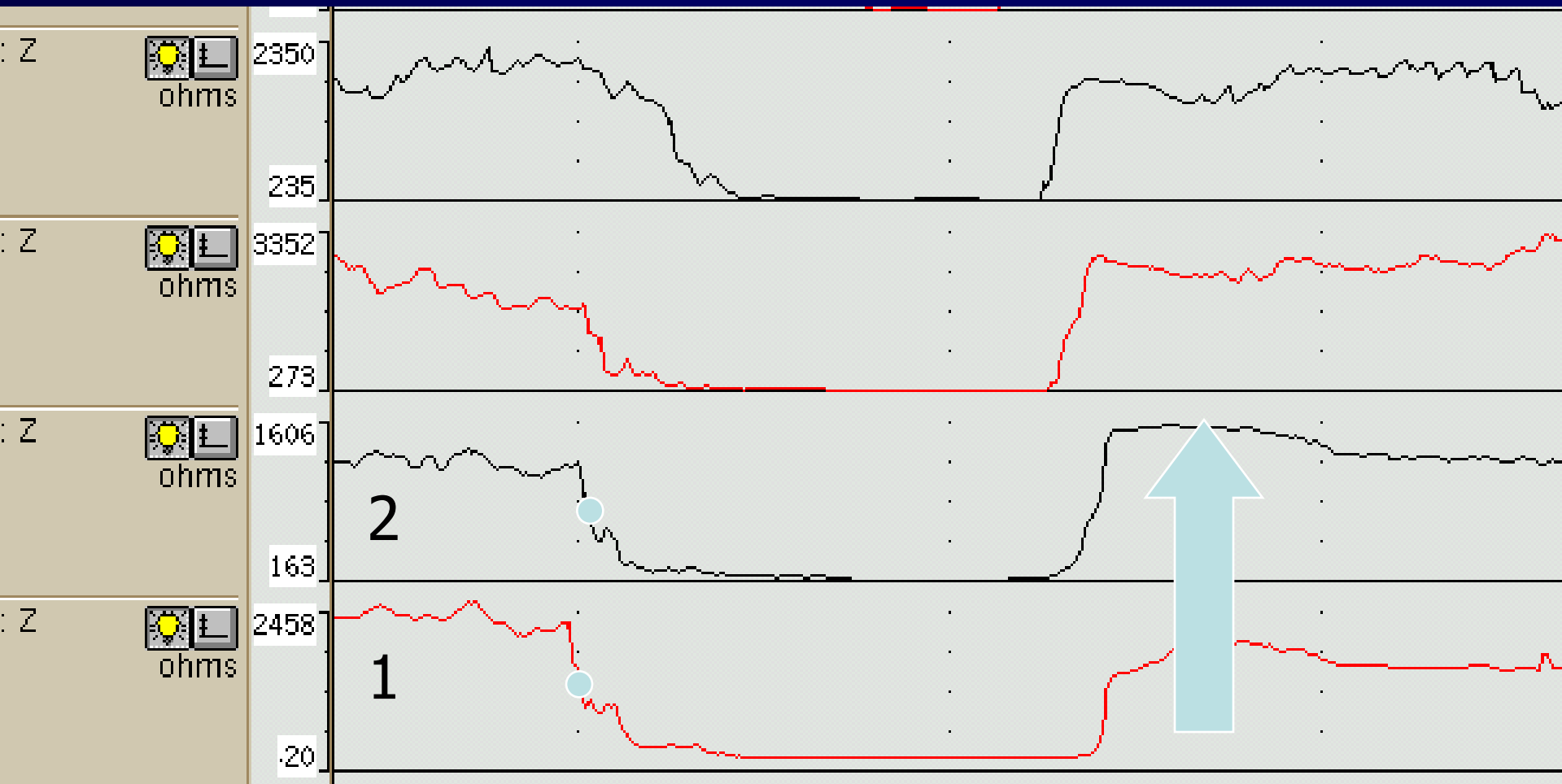


Aboral Bolus Movement



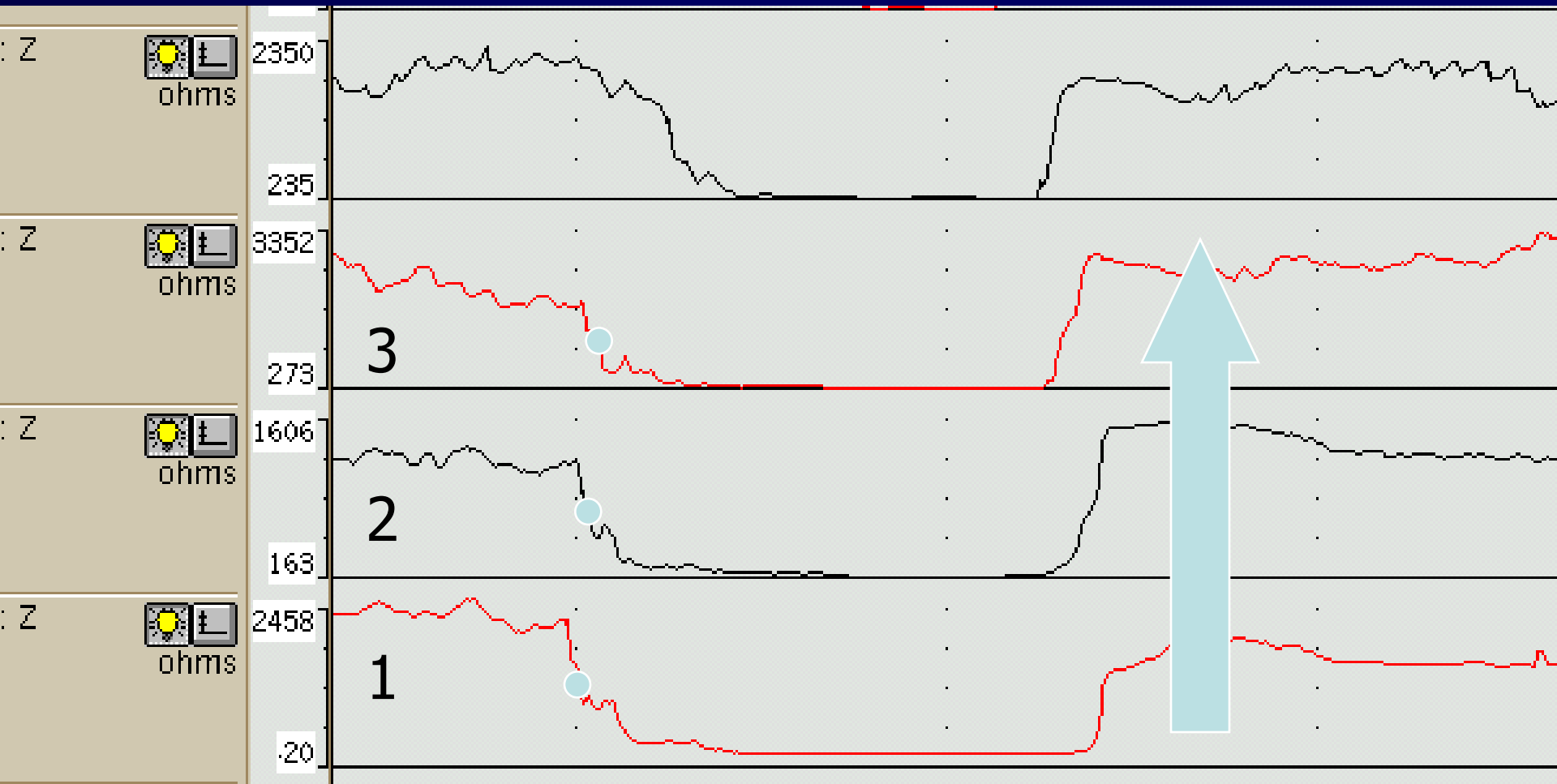
Aboral Bolus Movement

Upward= Aboral



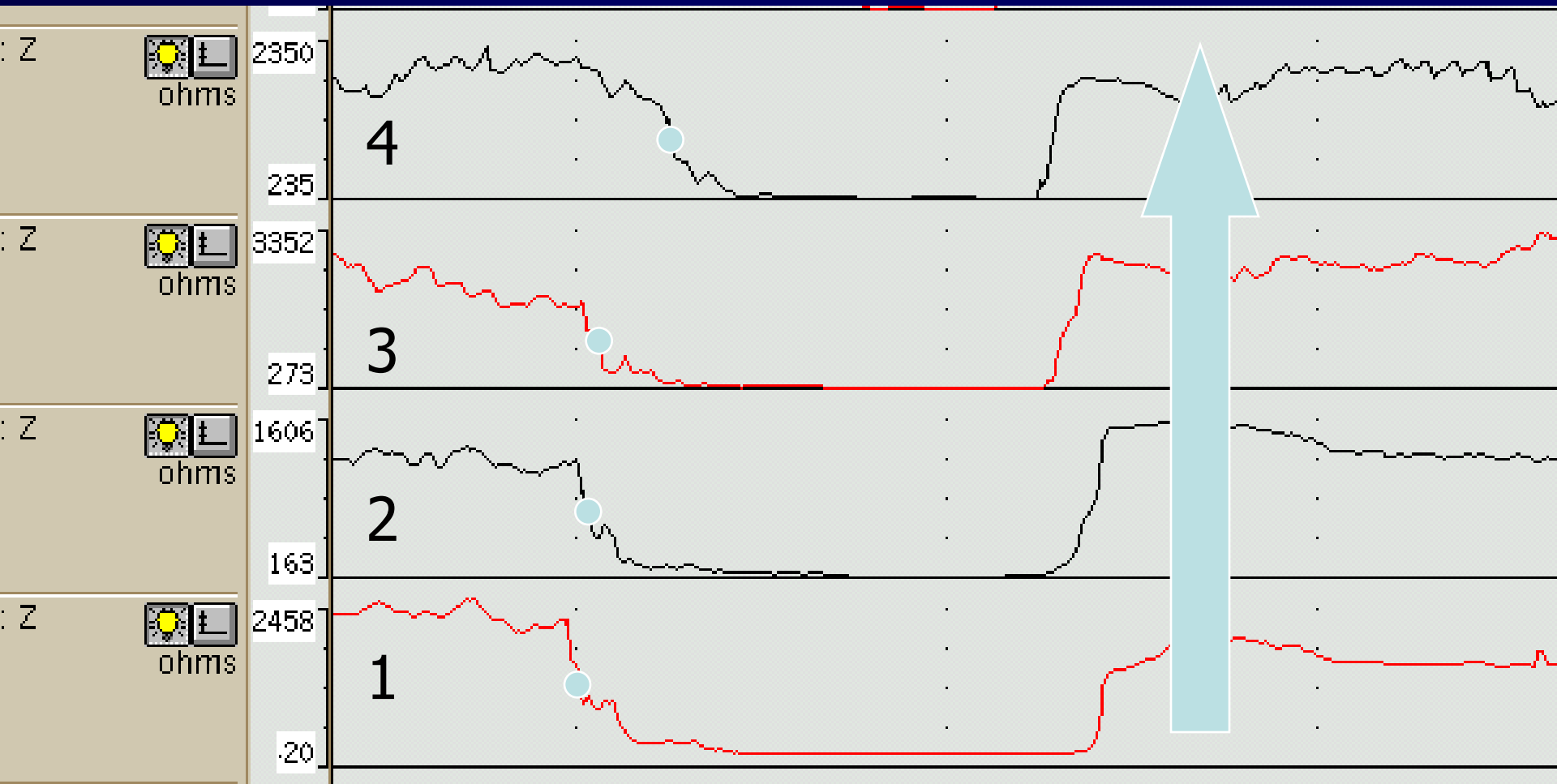
Aboral Bolus Movement

Upward= Aboral

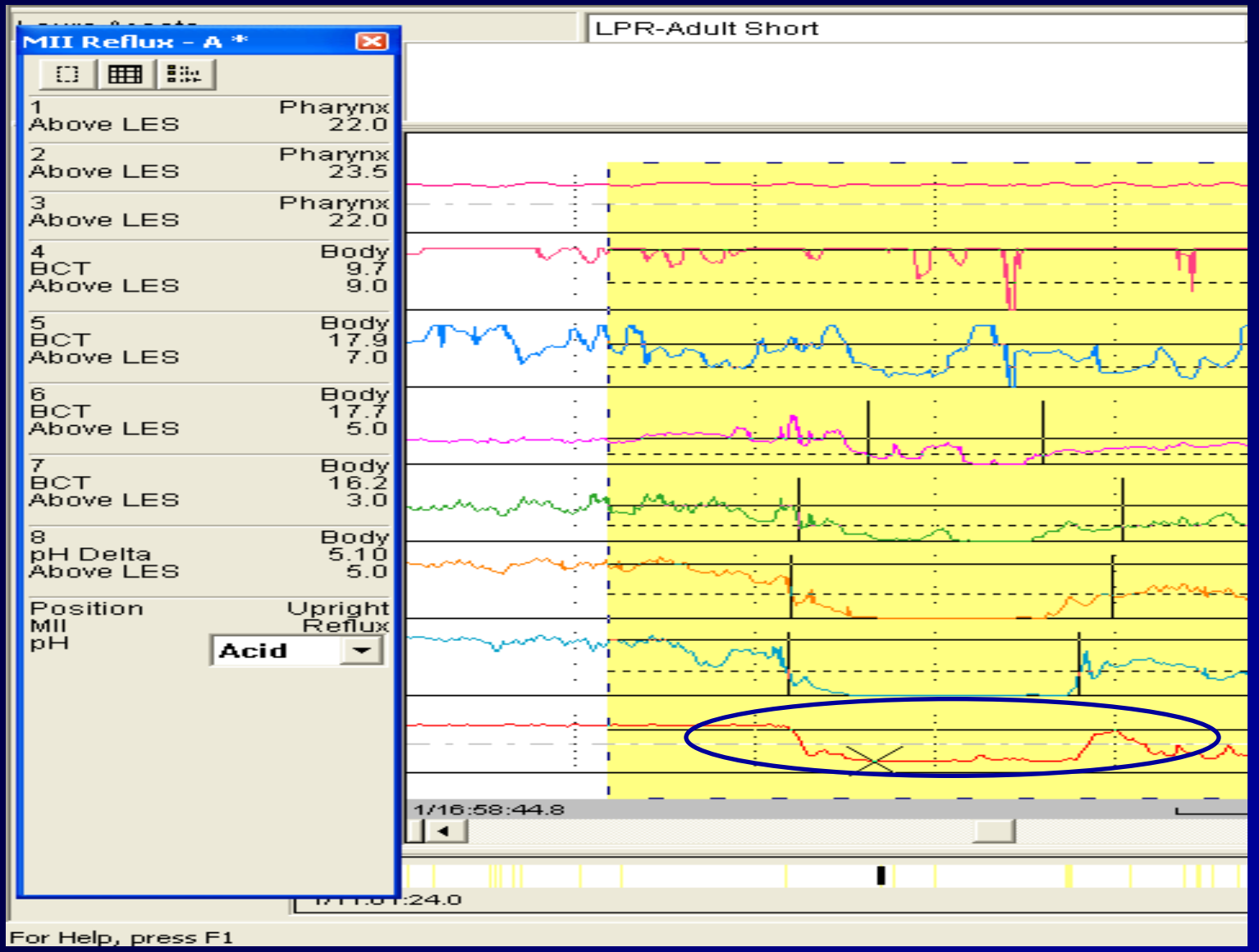


Aboral Bolus Movement

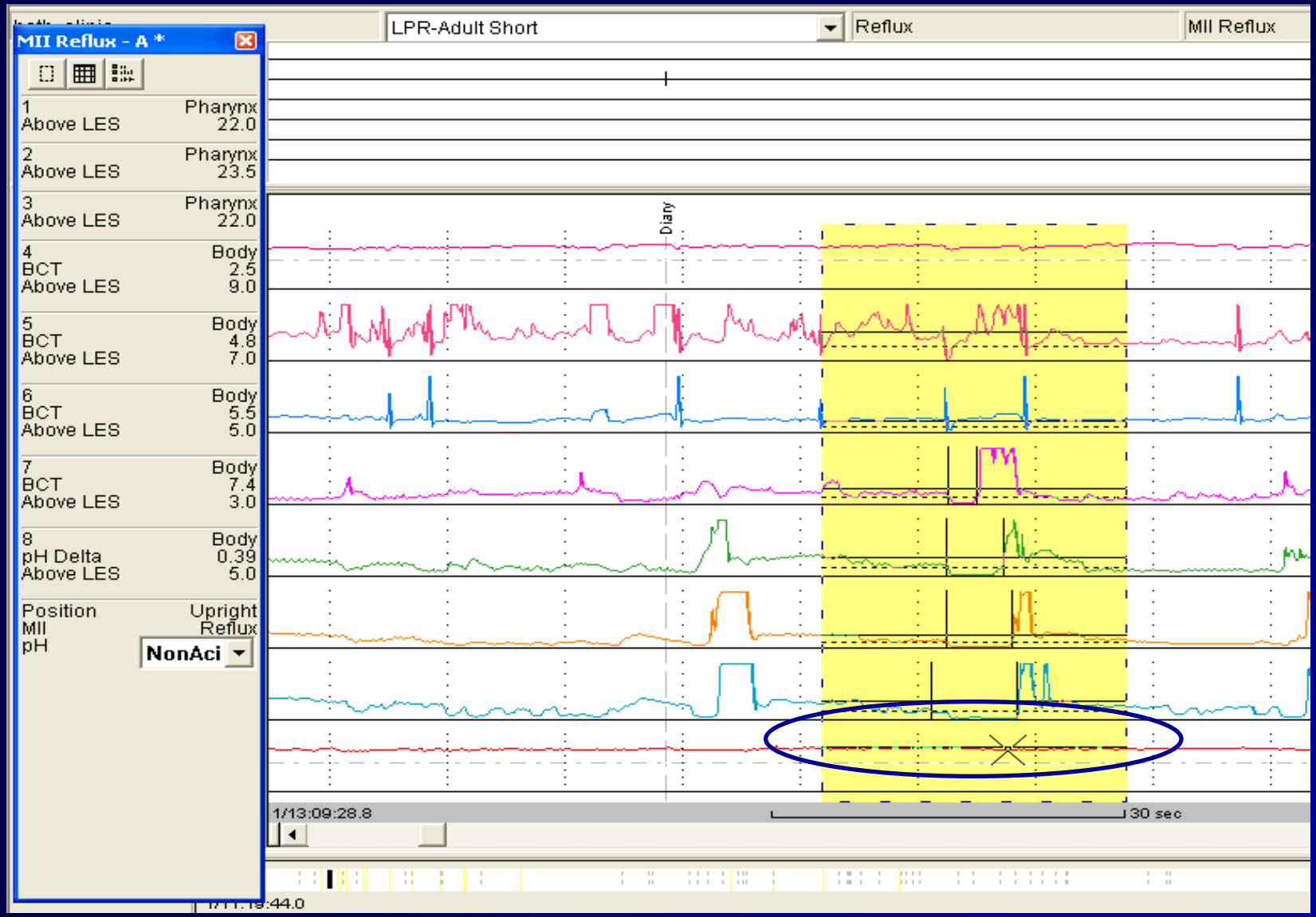
Upward= Aboral



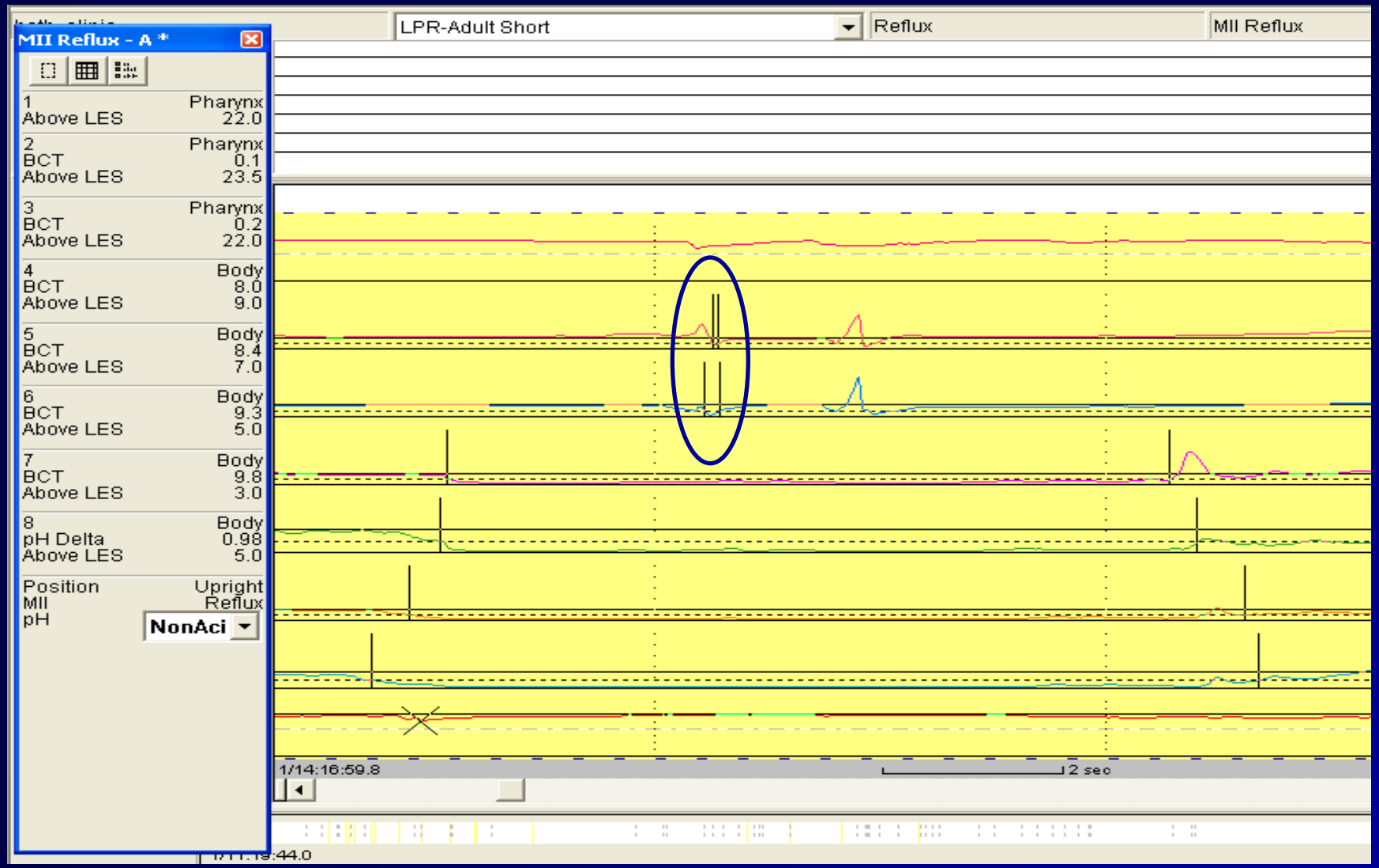
Acid Reflux


MII Reflux - A *
LPR-Adult Short
1
Above LES
Pharynx
22.0
2
Above LES
Pharynx
23.5
3
Above LES
Pharynx
22.0
4
BCT
Above LES
Body
9.7
9.0
5
BCT
Above LES
Body
17.9
7.0
6
BCT
Above LES
Body
17.7
5.0
7
BCT
Above LES
Body
16.2
3.0
8
pH Delta
Above LES
Body
5.10
5.0
Position
MII
pH
Upright
Reflux
Acid
1/16:58:44.8
For Help, press F1

Non-Acid Reflux



Non-Acid Pharyngeal Reflux



Impedance-pH Monitoring
Normal Values

- Number of Reflux Episodes:
  - Total < 73
  - Acid < 55
  - Weakly Acid or Non-acid < 27
- Duration of Episodes < 44 sec.

Shay S, et al., Am J Gastroenterol 2004

Conclusion

- Standard esophageal manometry uses either water-perfused or solid-state catheter assemblies to measure changes in pressure of the esophagus, including measurement of the LES, esophageal body (peristalsis), and UES

- This represents circular muscle contraction

- Patterns of abnormal motility such as achalasia, diffuse esophageal spasm, and hypercontractile (nutcracker) esophagus are distinguished by specific defects in LES relaxation, peristalsis, or both

Conclusion

- High-resolution esophageal manometry increases the information produced and displayed in each study, facilitating interpretation and potentially yielding new findings

- Standard pH monitoring involves measurement of pH changes at two sites in the esophageal body (5 and 15 cm above the LES) over a 24-hour period

- Results of pH monitoring are expressed in time during which pH is below 4.0 and a the complex calculation of the DeMeester score

Conclusion

- Bravo-probe pH monitoring involves a single sensor without a transnasal wire, and a 48-hour recording period

- Impedance pH monitoring adds the ability to evaluate non-acid reflux in addition to acid reflux events, which may be beneficial in evaluating atypical reflux symptoms (such as respiratory symptoms)