High Resolution Esophageal Manometry: 
How can it help me in my practice?

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Learning Objectives

• Review the new technology of high resolution manometry and its improvement on older tests
• Identify the primary motility disorders seen with HRM and better defined by the Chicago classification
• Discuss how this can improve our diagnosis and treatment of esophageal motility disorders
Principles of High Resolution Manometry

Black and White vs Color TV
UES Topography

Normal Peristalsis and LES Relaxation
EGJ Pressure Topography

Hiatus Hernia
**Integrated Relaxation Pressure (IRP)**

Normal < 15 mmHg

**Learners Favor High Resolution Manometry over Conventional Line Tracings**

<table>
<thead>
<tr>
<th>HRM</th>
<th>1st evaluation</th>
<th>2nd evaluation</th>
<th>Line tracings</th>
<th>1st evaluation</th>
<th>2nd evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aperistalsis</td>
<td>93.4</td>
<td>95.8</td>
<td>68.4</td>
<td>61.0</td>
<td></td>
</tr>
<tr>
<td>Hypermotility</td>
<td>90.9</td>
<td>83.2*</td>
<td>84.0</td>
<td>74.0*</td>
<td></td>
</tr>
<tr>
<td>Hypomotility</td>
<td>88.5</td>
<td>76.2*</td>
<td>60.7</td>
<td>53.0</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>82.7</td>
<td>76.5</td>
<td>74.4</td>
<td>84.7†</td>
<td></td>
</tr>
<tr>
<td>Body overall</td>
<td>87.9</td>
<td>82.0*</td>
<td>71.7</td>
<td>67.7</td>
<td></td>
</tr>
<tr>
<td>LES overall</td>
<td>73.1</td>
<td>69.3</td>
<td>60.5</td>
<td>54.8</td>
<td></td>
</tr>
<tr>
<td>Composite body and LES</td>
<td>60.6</td>
<td>57.0</td>
<td>42.3</td>
<td>36.0*</td>
<td></td>
</tr>
<tr>
<td>Achalasia</td>
<td>61.7</td>
<td>56.9</td>
<td>51.7</td>
<td>36.4*</td>
<td></td>
</tr>
</tbody>
</table>

Each comparison between HRM and line tracings was statistically significant at both evaluations.

*p<0.01 for decline in diagnostic accuracy compared with first evaluation.
†p<0.001 for increment in diagnostic accuracy compared with first evaluation.

HRM, high resolution manometry; LES, lower esophageal sphincter.

Soudagar AS et al Gut 2012
ACHALASIA

Achalasia Subtypes with High Resolution Manometry

Type I: achalasia with minimal pressurization
Type II: achalasia with esophageal compression
Type III: achalasia with spasm

Achalasia Type I

Achalasia Type II
Achalasia Type III

Demographic and Clinical Data Among Achalasia Subtypes

<table>
<thead>
<tr>
<th>Achalasia subtype</th>
<th>Type I (n = 21)</th>
<th>Type II (n = 49)</th>
<th>Type III (n = 29)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y) mean (SD)</td>
<td>58 (16.9)</td>
<td>53.4 (19.6)</td>
<td>63.5 (15.6)</td>
</tr>
<tr>
<td>Male/Female</td>
<td>12/9</td>
<td>15/34</td>
<td>19/10</td>
</tr>
<tr>
<td>Dilatation grade</td>
<td>1.5 (0.70)</td>
<td>0.6 (0.7)</td>
<td>0.4 (0.6)</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dysphagia (%)</td>
<td>100</td>
<td>100</td>
<td>97</td>
</tr>
<tr>
<td>Chest pain (%)</td>
<td>19</td>
<td>41</td>
<td>54</td>
</tr>
</tbody>
</table>

*P < .05 vs type I.

Response to Therapeutic Interventions among Achalasia Subtypes

<table>
<thead>
<tr>
<th>Achalasia subtype</th>
<th>Type I (n = 18)</th>
<th>Type II (n = 46)</th>
<th>Type III (n = 21)</th>
<th>All (n = 83)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of interventions, mean (SD)</td>
<td>1.8 (SD, 0.7)</td>
<td>39 (7/18)</td>
<td>53 (24/48)</td>
<td></td>
</tr>
<tr>
<td>Success with Botox (first intervention) (%)</td>
<td></td>
<td>67 (4/8)</td>
<td>70 (13/13)</td>
<td>0 (0/1)</td>
</tr>
<tr>
<td>Success with dilation (first intervention with 30-mm balloon) (%)</td>
<td></td>
<td>44 (7/16)</td>
<td>83 (38/46)</td>
<td>9 (2/21)</td>
</tr>
<tr>
<td>Success with myotomy (first intervention) (%)</td>
<td>56 (8/16)</td>
<td>100 (13/13)</td>
<td>0 (0/1)</td>
<td>85 (17/20)</td>
</tr>
<tr>
<td>Success with first intervention (total) (%)</td>
<td></td>
<td>56 (8/16)</td>
<td>83 (38/46)</td>
<td>9 (2/21)</td>
</tr>
<tr>
<td>Success with last intervention (%)</td>
<td></td>
<td>96 (8/16, P&lt;0.05)</td>
<td>29 (8/16, P&lt;0.05)</td>
<td>71 (14, P&lt;0.05)</td>
</tr>
</tbody>
</table>

NOTE: Pneumatic dilation was initially done with a 30-mm Microvasive balloon in all instances. If this failed, it was usually followed by a 35-mm dilation accounting for the difference in success rate for pneumatic dilation when applied as an initial or as the last intervention. Overall, type II patients exhibited better response to all therapies: Botox (B), pneumatic dilation (P), or surgical myotomy (M).

99 < .05 vs type I.
99 < .05 vs type II.
Pseudoachalasia

Functional Esophageal Obstruction

Eosinophilic esophagitis, esophageal stricture, variant achalasia
Tight fundoplication, large hiatal hernia, gastroparesis
Functional Outlet Obstruction
Variants of Spasm
New Terminology in Chicago Classification

- Distal contractile integral
  volume representation of esophageal squeeze
- Distal latency—premature contractions
  peristaltic timing—old simultaneous contraction
- Contraction Front Velocity—rapid contractions
  velocity of the wave front
- Pan esophageal pressurization
- Failed peristalsis
- Large and small breaks

Distal Contractile Index

Distal Contractile Index < 5000 mmHg*sec*cm
Distal Latency and Contraction Front Velocity

DL < 4.5 sec
CFV > 7 cm/sec

Pandolfino, et al. Gastroenterology 2011

Reduced Distal Latency

Pandolfino, et al. Gastroenterology 2011
Short Latency Describes a Homogenous Group of EMDs

Pandolfino, et al. Gastroenterology 2011

Nutcrackers Esophagus
Diffuse Esophageal Spasm

Jackhammer Esophagus with Very High Distal Contractile Index
Weak Esophageal Pump

High Resolution and Impedance Manometry
Bolus Transit and Breaks in Peristalsis

Roman, et al. Am J Gastroenterol 2010

Bolus Transit as Function of Isobaric Bars (20 vs 30 mmHg) and Breaks (2-5 cm)

Roman, et al. Am J Gastroenterol 2010
Ineffective Esophageal Peristalsis

HRM Criteria for Ineffective Esophageal Peristalsis

• 50% or more of swallows with any combination of:
  --failed peristalsis
  --weak contractions with small breaks
  --weak peristalsis with large breaks in middle/distal esophagus

• 50% or more of swallows associated with a DCI< 450 mm Hg-s-cm

Xial Y et al. Am J Gastroenterol 2012
Scleroderma

Proposed Classification of Peristaltic Integrity with High Resolution Manometry

<table>
<thead>
<tr>
<th>Diagnostic</th>
<th>Diagnostic criteria (all with normal esophageo-gastric junction relaxation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent peristalsis</td>
<td>100% of swallows with failed peristalsis</td>
</tr>
<tr>
<td>Frequent failed peristals*</td>
<td>&gt;30%, but &lt;100% of swallows with failed peristals</td>
</tr>
<tr>
<td>Weak peristalsis with large peristaltic defects</td>
<td>&gt;20% of swallows with &gt;5cm breaks in the 20mm Hg isobaric contour</td>
</tr>
<tr>
<td>Weak peristalsis with small peristaltic defects</td>
<td>&gt;30% of swallows with 2–5cm breaks in the 20mm Hg isobaric contour</td>
</tr>
</tbody>
</table>

EPT, esophageal pressure topography.
*Although statistically exceeding the 95th percentile of normal, this finding has not been shown to correlate with non-obstructive dysphagia. Isobaric contour pressure is referenced to atmospheric. Note that an individual may have more than one diagnosis.

Roman, et al. Am J Gastroenterol 2010
All the Trees in the Forest
What does it mean??

Swallow composite
Computer analysis with impedance

Proposed Classification of Esophageal Peristalsis
for Anti-reflux Surgery

<table>
<thead>
<tr>
<th>Esophageal body*</th>
<th>Failed sequences</th>
<th>Implications for Anti-reflux Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal peristalsis</td>
<td>adequate</td>
<td>≤30%</td>
</tr>
<tr>
<td>Mild hypomotility</td>
<td>adequate</td>
<td>30-50%</td>
</tr>
<tr>
<td>Moderate hypomotility</td>
<td>adequate</td>
<td>50-70%</td>
</tr>
<tr>
<td>Moderate hypomotility</td>
<td>inadequate</td>
<td>50-70%</td>
</tr>
<tr>
<td>Severe hypomotility</td>
<td>any</td>
<td>≥80%</td>
</tr>
</tbody>
</table>

*adequate: >30 mmHg averaged amplitudes in the smooth muscle esophagus, or averaged distal contractile integral >450 mmHg.cm.s for transmitted sequences

**presence of preoperative dysphagia and lack of contraction response to provocative measures may modify this recommendation

Gyawaki CP GI Clinics of North America 2013
Multiple Swallows as Test for Weak Esophageal Pump

A—Normal
B—Abnormal-no recovery

Hierarchial Analysis of Esophageal Motility by Chicago Classification

1. IRP > upper limit of normal AND absent peristalsis
   - Yes
   - Achalasia
     - Type I: classic
     - Type II: with esophageal compression
     - Type III: peristaltic fragments or spastic

2. IRP > upper limit of normal AND some instances of intact or weak peristalsis
   - No
   - EGG Outflow Obstruction
     - Achalasia variant
     - Mechanical obstruction
     - May have 1st or 2nd hypercontractility

3. IRP normal AND absent peristalsis
   - OR reduced distal latency
   - OR DGl > 8000 mmHg-s-cm
   - Yes
   - Absent Peristalsis
     - Distal Esophageal Spasm (DES)
     - > 20% of swallows with reduced latency
     - Hypercontractile (Jackhammer) Esophagus
     - Any swallow with DGl > 8000 mmHg-s-cm

4. IRP normal AND Peristaltic abnormalities
   - No
   - Weak Peristalsis
     - Large or small breaks in the 20-mmHg isobaric contour
   - Frequent Failed Peristalsis
   - Hypertensive Peristalsis (Nutcracker Esophagus)
   - Rapid Contraction
     - > 20% of swallows with rapid contraction

Neurogastroenterology and Motility Supplement 2012
Rumination

Amplitude of Gastric Pressure Peak During Proximal Reflux Events Distinguishes Rumination from GERD

Kessing BF et al Am J Gastroenterol 2014
Summary

• Advantages of high resolution manometry
  --easy to learn
  --shorter study and more patient friendly
  --sees the entire esophagus
  --better assessment of LES and peristalsis
  --defines new treatable diseases

• Disadvantages
  --expensive—catheters $10 to $12 K
    lasts for about 200 studies
  --may be information overload for the non-
esophagologist