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

<table>
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<tr>
<th>Year</th>
<th>F/U Visits</th>
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Motility Diagnostic Testing*

*Studies read by Dr. Wo
## Motility Training during Fellowship

- **VA 3rd GI fellow**

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<td>Read Motility with Wo</td>
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## Motility Training during Fellowship

- **DHC clinic fellow/Research/Elective**

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<tr>
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<td>Krueger or McClave</td>
<td>McClain or Dryden or Wo or Research</td>
<td>VA Fellow Clinic or Research</td>
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<td>UofL Fellow Clinic</td>
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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.

---

**Differences in the GI Tract**

<table>
<thead>
<tr>
<th>Region</th>
<th>Embryonic origin</th>
<th>ANS dependence</th>
<th>ENS dependence</th>
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<tbody>
<tr>
<td>Oropharynx to mid duod.</td>
<td>Foregut</td>
<td>+++</td>
<td>++</td>
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<tr>
<td>Small bowel to prox. colon</td>
<td>Midgut</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Colon to rectum</td>
<td>Hindgut</td>
<td>+</td>
<td>+++</td>
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</table>

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)

- Vagus Nerve
- Mesentery
- Perivascular Sympathetic Nerve
- Muscularis Externa (longitudinal)
- Muscularis Externa (circular)
- Submucosal Plexus
- Myenteric Plexus
- Subepithelial Plexus
- Muscularis Mucosa
- Submucosa
- Villus
- Intestinal Lumen
- Serosa
- Deep Muscular Plexus
Interstitial Cells of Cajal: The GI Pacemakers

Small Intestines

Gastric Fundus
Intrinsic Rhythm of Motility

- Food, vagal input, peptides, distension
- Spike Potentials
- Contraction
- Voltage
- Slow Waves (ICC)
- Time
- Action potential threshold
- 1 minute
“Slow Waves”: Intrinsic Electrical Activity is Pre-programmed by Enteric Nervous System

- Stomach (3/min)
- Small intestine (8-12/min)
- Colon (3-6/min)

30 sec
Enteric Nervous System: Peristalsis

Contraction

Ach, 5HT, SP

Excitatory Motor Neuron

5-HT<sub>4</sub> Receptors

Enterochromaffin Cells

5-HT

Sensory Neuron

VIP, NO

Inhibitory Motor Neuron

receptors (stretch, food, etc.)
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)

Intra-esophageal stimulus
Pathological  Physiological

Peripheral
Fat/nutrients/others?

Central
Anxiety
Stress
Sleep?

+ +

Heartburn
Chest pain
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

- LES resting pressure
- LES relaxation
- Proximal margin of LES
Esophageal Manometry: Esophageal Body

- Mean distal esophageal P
- % peristalsis
# Normal Esophageal Manometry

<table>
<thead>
<tr>
<th>Pressure*</th>
<th>mmHg (SD)</th>
<th>Normal</th>
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<tbody>
<tr>
<td>LES</td>
<td>15.2 (10.1)</td>
<td>15 - 45</td>
</tr>
<tr>
<td>Mean dist P</td>
<td>99 (40)</td>
<td>40 - 180</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motor patterns*</th>
<th>% wet swallows (SD)</th>
</tr>
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<tbody>
<tr>
<td>Double peaks</td>
<td>11 (19)</td>
</tr>
<tr>
<td>Simultaneous</td>
<td>4 (8)</td>
</tr>
<tr>
<td>Non-conducted</td>
<td>0.4 (2)</td>
</tr>
<tr>
<td>Retrograde</td>
<td>0</td>
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<table>
<thead>
<tr>
<th>Overall findings**</th>
<th>Normal</th>
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<tr>
<td>Mean distal peristaltic P</td>
<td>&gt; 40 mmHg</td>
</tr>
<tr>
<td>Peristalsis waves</td>
<td>&gt; 60%</td>
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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
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 ≠ 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 = \[
  \frac{\text{Duration of time where pH<4}}{\text{Duration of monitoring}}\]
  – 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

- Fixed 15-cm spacing
- 5 cm above LES
- Distance between UES and LES varies
Esophageal Length Varies Among Individuals

Triple-Sensor pH Monitoring

1 to 3 cm proximal to the UES

20 cm proximal to the LES

5 cm proximal to the LES

3, 6 or 9 cm

15 cm

Spacing between pH sensors

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

- Meal periods
- Simultaneous pH drop <4 with liquid swallows
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

Before test meal

After 2 hours

After 4 hours
Gastric Emptying Scan (GET)

Extrapolated GET

NL values: 4-hr GET (medians)

Abnl Values: 4-hr GET (95th%)

Scrambled eggs and toast

T 1/2: 90 min

% Remaining

0 1 2 3 4

Time (hours)

50% Remaining

100 90 80 70 60 50 40 30 20 10 0

% Remaining

10% 24% 60% 90% 69%
Gastric Scintigraphy to Diagnose Gastroparesis

SmartPill Study Group: 56 pts with gastroparesis
86 asymptomatic volunteers

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

Smartpill® Wireless Pressure and pH Tracing

From University of Louisville
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

3x / minute

Migratory Motor Complex

12x / minute
Abnormal Fasting Pattern
Abnormal Fed Pattern

↓ Test Meal
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

- **Stomach**
- **Small bowel**
- **Colon**

- **H2 content (ppm)**
- **Time (hrs)**
- **Lactulose given**

- **Bacteria overgrowth**
- **Normal**
- **Non-diagnostic**
Accuracy of Tests for Small Intestinal Bacteria Overgrowth

| Diagnostic test               | Abnormal test                      | Sensitive* | Specificity*
<table>
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<tbody>
<tr>
<td>Lactulose breath test</td>
<td>Double peaks of &gt;20 ppm H₂ above baseline</td>
<td>17 – 68%</td>
<td>70 – 100%</td>
</tr>
<tr>
<td>Glucose breath test</td>
<td>&gt;12 ppm H₂ above baseline</td>
<td>41 – 100%</td>
<td>67 – 98%</td>
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</table>

*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)
Anterior

Posterior

Rectum

• compliance
• sensation

Puborectalis muscle

• skeletal muscle

Internal anal sphincter

• smooth muscle

External anal sphincter

• skeletal muscle

Voluntary Squeeze
Anorectal Manometry

Internal anal sphincter

External anal sphincter

Station pull-through (1 cm interval)
Anorectal Manometry

Rectal balloon distension

Internal anal sphincter

External anal sphincter
Rectal balloon distension
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