The Clinical Utility of High Resolution Pharyngeal Manometry

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Disclosures

• Consultant, Medtronic Inc.

• Advisory Board Member, Carolina Speech Services

• Salary from MUSC

• No compensation for this presentation
Outline

- Introduction to high resolution pharyngeal manometry (HRPM)

- Incorporation of HRPM into Clinical Practice
  - Adjuvant Diagnostic Tool
  - Therapeutically for Biofeedback
  - Assess Efficacy of Interventions
What is *High Resolution* Manometry?

- A catheter placed trans-nasally
- Sensors along catheter measure intraluminal pressures
- Solid state catheter
- At least 10 contiguous sensors, no more than 1 cm apart (pharynx)
  - Most catheters have 36 sensors
  - Sensors can be unidirectional or circumferential
- Can include impedance (but doesn’t have to)
Overview of the Procedure
High Resolution Pharyngeal Manometry

- **Pharyngeal muscle contraction**
  - Quantitative assessment of pharyngeal pressures
  - Composite information
  - Intrabolus pressures

- **Upper Esophageal Sphincter**
  - Quantitative assessment
  - Coordination & Timing
  - Relaxation duration
  - Relaxation pressures
Topographical Pressure Plots
Clouse et al AJP 1996
High Resolution Pharyngeal Manometry
High Resolution Pharyngeal Manometry
High Resolution Pharyngeal Manometry

Upper Esophageal Sphincter pressure band
High Resolution Pharyngeal Manometry

Opening of the UES
High Resolution Pharyngeal Manometry
Landmarks

A) Velopharynx Region
- Soft palate
- Superior pharyngeal constrictors

B) Mesopharynx Region
- Tongue base
- Inferior pharyngeal constrictors
- Middle pharyngeal constrictors

C) Hypopharynx Region
- Inferior pharyngeal constrictors

D) UES Region
- Pharyngoesophageal segment
### International HRPM Working Group

**Vision**

“To improve the quality of dysphagia care through the clinical implementation of high resolution pharyngeal manometry.”

**Mission**

“To create a standardization of high resolution pharyngeal manometry acquisition, measurement, reporting, education and training as well as advocate with payers and healthcare systems.”

<table>
<thead>
<tr>
<th>System to use</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Any solid state HRM system including a catheter configured with at least 10 pressure sensors at 1 cm spacing.</td>
</tr>
<tr>
<td>• If impedance included then electrodes at 2 cm spacing.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Catheter placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Requires education and training</td>
</tr>
<tr>
<td>• Apply lubricant gel to catheter</td>
</tr>
<tr>
<td>• May apply topical anesthesia to nasal passage</td>
</tr>
<tr>
<td>• Liquid sips via straw during placement</td>
</tr>
<tr>
<td>• Wait 5 minutes for catheter accommodation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test boluses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Position - seated with head neural</td>
</tr>
<tr>
<td>• Delivery - syringe preferred</td>
</tr>
<tr>
<td>• Volumes - 5 ml, 10 ml &amp; sometimes 20 ml (case by case)</td>
</tr>
<tr>
<td>• Minimum 3 repeats (case by case)</td>
</tr>
</tbody>
</table>

Omari et al...O’Rourke AK. Dysphagia 2019
An integral is a mathematical term that represents an area or a generalization of an area.
Illustrative Examples of PhCI
The Relationship Between Pharyngeal Contractile Integral and Pharyngeal Total Scores on Videofluoroscopy

\[ r = -0.44 \]
\[ p = 0.01 \]

O’Rourke, Humphries et al 2017 Neurogastroenterology & Motility
PhCI and PAS

- PAS scores for thin liquids were significantly different between groups (1.44 versus 3.78; p = 0.01)

<table>
<thead>
<tr>
<th></th>
<th>Overall</th>
<th>Thin</th>
<th>Nectar</th>
<th>Honey</th>
<th>Pudding</th>
<th>Solid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher PCI Group</td>
<td>1.21</td>
<td>1.44</td>
<td>1.28</td>
<td>1.11</td>
<td>1.11</td>
<td>1.11</td>
</tr>
<tr>
<td>Lower PCI Group</td>
<td>1.99</td>
<td>3.78</td>
<td>2.29</td>
<td>1.27</td>
<td>1.00</td>
<td>1.07</td>
</tr>
<tr>
<td>p value</td>
<td>0.03</td>
<td>0.01</td>
<td>0.06</td>
<td>0.05</td>
<td>0.80</td>
<td>0.97</td>
</tr>
</tbody>
</table>

O’Rourke, Humphries et al 2017 Neurogastroenterology & Motility
How much pressure is needed to clear bolus?

- 47 dysphagic patients; 25 females, 22 males; mean age of 62 (range 28-86)

### Table 1. Differences in Pharyngeal Contractile Integral based on Residue Presence

<table>
<thead>
<tr>
<th>Residue</th>
<th>No Residue</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median [IQR]</td>
<td>Median [IQR]</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
</tr>
</tbody>
</table>

**Thin**
- Valleculae: 80.4 [57.3-176.8] vs 159 [104.2-236.4], 0.013
- Pyriforms: 78.7 [54.5-137.4] vs 189.0 ± 163.4, 0.013

**Nectar**
- Valleculae: 137.2 [85.0-184.2] vs 183.3 [129.7-219.9], 0.007
- Pyriforms: 164.9 [119.8-217.7] vs 185.3 ± 132.6, 0.052

**Pudding**
- Valleculae: 195.8 [132.0-258.3] vs 118.4 [68.8-181.6], 0.016
- Pyriforms: 123.3 ± 34.2 vs 185.2 [141.5-236.5], 0.012

### Table 2. Threshold Pharyngeal Contractile Integral (PhCl) for residue clearance

<table>
<thead>
<tr>
<th>Residue</th>
<th>Threshold PhCl (mmHg·s·cm)</th>
<th>R²</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valleculae</td>
<td>173.3</td>
<td>0.0020</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Pyriforms</td>
<td>177.9</td>
<td>0.0224</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Nectar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valleculae</td>
<td>162.0</td>
<td>0.0279</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Pyriforms</td>
<td>175.9</td>
<td>0.0466</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Pudding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valleculae</td>
<td>186.6</td>
<td>0.1023</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Pyriforms</td>
<td>185.9</td>
<td>0.0751</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Hamberis A, Davidson K, Zhao E, O’Rourke, unpublished data, presented at AAO 2019
Outline

• Introduction to high resolution pharyngeal manometry (HRPM)

• Incorporation of HRPM into Clinical Practice
  – Adjuvant Diagnostic Tool
  – Therapeutically for Biofeedback - tomorrow
  – Assess Efficacy of Interventions - tomorrow
Diagnostic Applications of HRPM

- Characterize PES/UES function
- Timing & Coordination
- Pressure chamber formation – fluid dynamics
- Addition to VFSS in evaluation of subtle contractility deficits
- Evaluation of the entire swallowing process
Diagnostic Applications of HRPM

Characterize PES/UES function

Timing & Coordination

Pressure chamber formation – fluid dynamics

Addition to VFSS in evaluation of subtle contractility deficits

Evaluation of the entire swallowing process
Cricopharyngeal Dysfunction

Esophagram

HRM
Cricopharyngeal Dysfunction

Before

After

CP Myotomy
Are our interventions improving swallowing?

Swallowing outcomes after cricopharyngeal myotomy: A systematic review.
Knigge MA¹, Thibeault SL².

Abstract

BACKGROUND: No practice guidelines have been established for swallowing outcomes after cricopharyngeal myotomy (CPM). The purpose of this systematic review was to summarize evidence for swallowing outcomes in patients undergoing CPM to treat symptomatic cricopharyngeal dysfunction, in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) protocol.

METHODS: Swallowing outcomes examined included penetration/aspiration ratings, manometric measures, patient-rated dysphagia scales, clinician-rated dysphagia scales, diet level, and weight.

RESULTS: Three databases were queried for studies published between January 1995 and July 2015, resulting in a total of 122 full-text eligible records. Studies were screened and reviewed, culminating in 10 studies meeting inclusion criteria. Critical appraisal of study design, swallowing outcomes measures, and statistical analysis were summarized.

CONCLUSION: This systematic review revealed insufficient evidence for guiding clinical practice. Future investigations should use validated patient-rated and clinician-rated instruments as well as detailed high-resolution manometry measures to optimally capture postoperative swallowing outcomes.
Targeted interventions can lead to better outcomes.

Targeted intervention requires appropriate diagnostics.
After 6 Weeks HRPM
Biofeedback Assisted Therapy

Pre-Therapy

Post-Therapy

PhCl: 154 mmHg-cm-s
UES Opening Duration: 140 ms
UES Nadir Relaxation Pressure: 27

PhCl: 334 mmHg-cm-s
UES Opening Duration: 350 ms
UES Nadir Relaxation Pressure: -3
Diagnostic Applications of HRPM

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Temporal Coordination
Pharyngeal Mis-sequencing

Huckabee et al., 2014
Temporal Coordination
Pharyngeal Mis-sequencing

a. Pre-treatment

b. Post-treatment

Huckabee et al., 2014
Temporal Coordination
Simultaneous Contraction
Temporal Coordination
Simultaneous Contraction

Post-HPRM Assisted Therapy
Diagnostic Applications of HRPM

- Characterize PES/UES function
- Timing & Coordination
- Pressure chamber formation – fluid dynamics
- Addition to VFSS in evaluation of subtle contractility deficits
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Why does the UES show increased pressure just before relaxing?
Pressure Chamber Formation

Pressure Formation Issue - VPI
Diagnostic Applications of HRPM

- Characterize PES/UES function
- Timing & Coordination
- Pressure chamber formation – fluid dynamics
- Addition to VFSS in evaluation of subtle contractility deficits
- Evaluation of the entire swallowing process
Quantifying Subtle Changes
Status Post UPPP

Thin Liquid

Puree
Oropharyngeal Dysphagia
Mesopharyngeal Deficits

Thin Liquid

Puree
Diagnostic Applications of HRPM

- Characterize PES/UES function
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Why is our understanding of esophageal dysphagia important?

- Swallowing involves bolus transfer from the lips to the stomach.
- Swallowing mechanism is interrelated in timing and function.
- Dysfunction in one area can affect the other.
- We need to understand, evaluate, and treat the swallowing mechanism as a whole.
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The Charleston Pharyngoesophageal Manometry Training Program

January 10 - 11, 2020
Hyatt House Mount Pleasant - Midtown
www.musc.edu/ent/cme