Conventional pH monitoring and Bravo test

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GERD is a condition which develops when the reflux of stomach content causes troublesome symptoms and/or complications.

**Esophageal Syndromes**
- Symptomatic Syndromes
  - Typical reflux syndrome
  - Reflux chest pain syndrome
- Syndromes with Esophageal Injury
  - Reflux esophagitis
  - Reflux stricture
  - Barrett's esophagus
  - Adenocarcinoma

**Extra-esophageal Syndromes**
- Established Association
  - Reflux cough
    - Reflux laryngitis
    - Reflux asthma
    - Reflux dental erosions
- Proposed Association
  - Sinusitis
  - Pulmonary fibrosis
  - Pharyngitis
  - Recurrent otitis media

Vakil N et al, Am J Gastroenterol 2006;101:1900-1920
Asia-Pacific consensus on the management of gastroesophageal reflux disease: Update

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- **Statement 1:** GERD is defined as a disorder in which gastric contents reflux recurrently into the esophagus, causing troublesome symptoms and/or complications.

- **Statement 2:** Typical symptoms of reflux are **heartburn** (retrosternal burning sensation) and **acid regurgitation**, which are commonly experienced by Asian patients.

Fock KM et al, J Gastroenterol Hepatol 2008;23:8-22
Persistent symptoms on PPI therapy
- 19 primary care and community studies

Etiology of PPI failure

- Compliance and adherence
- Residual acid, weakly acidic, and weakly alkaline reflux
- Functional heartburn
- Psychological comorbidity, delayed gastric emptying, eosinophilic esophagitis, and concomitant functional bowel disorder
- Nocturnal acid breakthrough

PPI efficacy for potential manifestations of GERD - estimates based on available RCT data

Kahrilas PJ and Boeckxstaens G. Gut 2012;61:1501-1509
Key questions:

1. Do these patients have GERD?
2. If they have GERD, what is the explanation for the lack of response?

GERD assessment tools

- Endoscopy
- Esophageal pH monitoring
- Combined pH-impedance monitoring
- Manometry
NERD is more common than ERD

Esophageal pH monitoring

- **Indications**

1. Patients with typical GERD symptoms who fail 4 weeks of PPI therapy
2. Patients with atypical GERD symptoms who fail 6 to 8 weeks of PPI therapy
3. Patients being considered for endoscopic or surgical reflux therapy
4. Patients who have undergone endoscopic or surgical reflux therapy who continue to have GERD symptoms
Ambulatory 24 hour pH monitoring
pH parameters

1. Percentage of total time pH < 4
2. Percentage of supine time pH < 4
3. Percentage of upright time pH < 4
4. Total number of reflux episodes
5. Number of reflux episodes > 5 minutes
6. Duration of the longest reflux episode

pH < 4
- Pepsinogen is converted to its active form pepsin.
- Heartburn often occur.
- Normal subjects show pH ≥ 4 about 98.5% of the time.
Normal values for 24h pH monitoring

<table>
<thead>
<tr>
<th></th>
<th>Johnson/DeMeester&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Richter et al&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of total time pH &lt; 4</td>
<td>&lt; 4.2</td>
<td>&lt; 5.78</td>
</tr>
<tr>
<td>Percentage of supine time pH &lt; 4</td>
<td>&lt; 1.2</td>
<td>&lt; 3.45</td>
</tr>
<tr>
<td>Percentage of upright time pH &lt; 4</td>
<td>&lt; 6.3</td>
<td>&lt; 8.15</td>
</tr>
<tr>
<td>Total number of reflux episodes</td>
<td>&lt; 50</td>
<td>&lt; 46</td>
</tr>
<tr>
<td>Number of reflux episodes &gt; 5 minutes</td>
<td>≤ 3</td>
<td>&lt; 4</td>
</tr>
<tr>
<td>Duration of the longest reflux episode (min)</td>
<td>&lt; 9.2</td>
<td>&lt; 18.45</td>
</tr>
</tbody>
</table>

<sup>1</sup> Johnson and Demeester. Am J Gastroenterol 1974;62:325-332

DeMeester score

- Composite score
- Weighted based on the parameters that were most sensitive and the least sensitive to reflux
- Normal score < 14.7
- Not demonstrated clinical utility
Update of the Porto consensus

Pathological GERD

Upper gastrointestinal endoscopy

Grade C or D esophagitis and/or peptic stricture and/or Barrett’s esophagus

or

Normal esophagus grade A or B esophagitis

or

24-h esophageal pH ± impedance monitoring (off or on therapy)

AET >6%

AET 4-6%

AET <4%

Consider additional evidence:
number of reflux events, baseline impedance, microscopic esophagitis

Symptom indices

If a patient’s symptom is actually related to acid reflux episodes during pH monitoring.

1. Symptom index (SI)
2. Symptom sensitivity index (SSI)
3. Symptom association probability (SAP)

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
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<tbody>
<tr>
<td>SI</td>
<td>34.8%</td>
<td>80%</td>
</tr>
<tr>
<td>SSI</td>
<td>73.9%</td>
<td>73.3%</td>
</tr>
<tr>
<td>SAP</td>
<td>65.2%</td>
<td>73.3%</td>
</tr>
</tbody>
</table>
**Symptom-reflux association analysis**

1. **Symptom index (SI)**
   - \[ SI = \left( \frac{\text{number of symptom events with pH < 4}}{\text{total number of symptom events}} \right) \times 100 \]
   - Positive ≥ 50%

2. **Symptom sensitivity index (SSI)**
   - \[ SSI = \left( \frac{\text{number of symptom events with pH < 4}}{\text{total number of reflux episodes}} \right) \times 100 \]
   - Positive ≥ 10%
   - Limited added value to SI and SAP
Symptom association probability

<table>
<thead>
<tr>
<th>Positive Symptom</th>
<th>Positive Symptom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Reflux</td>
<td>Negative Reflux</td>
</tr>
<tr>
<td>Negative Symptom</td>
<td>Negative Symptom</td>
</tr>
<tr>
<td>Positive Reflux</td>
<td>Negative Reflux</td>
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</table>

• Probability (association between reflux and symptoms) calculated using the Fisher’s exact test

• SAP = (1-\(\text{probability}\)) \times 100

• Positive \(\geq 95\%\)
Recording of Imp-pH monitoring
Refractory GERD management

- incomplete PPI response
  - revisit symptoms
    - origin of symptoms uncertain
      - (repeat) endoscopy, with biopsies in case of dysphagia
        - pill, infectious, or eosinophilic esophagitis
      - negative or consistent with GERD but symptoms not necessarily related to reflux
        - achalasia
        - esophageal manometry
          - no relevant findings

Refractory GERD for 1 year, M/29

Final Diagnosis: Achalasia type II
pH (impedance) monitoring off PPI

are the patient’s symptoms reflux-related?

- positive symptom association
  pathological reflux
    - GERD symptoms reflux-related
      - double-dose PPI alginate, baclofen?
        - insufficient response?
          - pH/imp monitoring on PPI
            - acid exposure sufficiently reduced?
              - symptoms related to weakly acidic reflux?
                - surgery
              - continue PPI
            - low-dose antidepressant?
        - add low-dose antidepressant
      - GERD hypersensitive esophagus
  physiological reflux
    - negative symptom association
      pathological reflux
        - GERD symptoms probably due to other mechanisms
          - continue PPI
        - no GERD but functional disorder
          - low-dose antidepressant?
Wireless pH monitoring

- The Bravo capsule
- Main advantages
  - Reducing discomfort and improving adherence with daily activity
  - Longer monitoring (usually 48 hours) thus taking into account the day-to-day variation of reflux
- Disadvantages
  - Early capsule detachment and foreign body/pain sensation
Bravo pH System
Catheter-Free pH Monitoring System

- pH capsule이 식도 점막에 부착되어 신호를 Receiver에 전달
- 샤워를 포함한 정상 생활 가능
- 수면을 방해하지 않음

pH Monitoring without Strings
Bravo® 장비
입, 혹은 코를 통해 Bravo pH Capsule을 위치시킴

입을 통한 삽입:
내시경을 통해 squamo-columnar junction (Z-line)을 확인. 6cm 상방.

코를 통한 삽입:
식도내압검사를 통해 LES 근위부 경계를 확인하고 위치시킴. 9cm 상방.
Capsule 부착

Step 1
Position Bravo Capsule

Step 2
Apply Suction

Step 3
Advance Pin

Step 4
Release Capsule

Step 5
Begin pH Recording
Digital Radio-Telemetry

- Digital Radio-Telemetry를 이용
- Capsule은 6초마다 pH를 측정하며 12초에 한 번씩 receiver에 자료를 전송
- 자료 소실의 예방을 위해 1 m 이내에 receiver 위치시킴 (range up to 3m)
Bravo pH Receiver & Analysis Software

DataLink
정상 소견

DeMester score = 0.3
Data interpretation

• Same parameters to a pH catheter
• Percentage of total time pH <4: <5.3%
위식도 역류

DeMester score = 49.7
병적역류(+) , 증상지수(-)

DeMester score = 39.5
병적역류(-), 증상지수(+)
DeMester score = 59.4
Capsule 탈락

DeMester score = 105.3
Summary & conclusion

1) 전형적/비전형적 역류증상 환자에서 pH monitoring은 GERD를 진단하거나 배제할 수 있다.
2) 전형적 역류증상 환자에서 양성의 결과가 나오면 더 강력한 위산억제 치료 또는 항역류 치료를 고려할 수 있는 근거가 된다.
3) 비전형적 역류증상 환자에서 음성의 결과가 나오면 증상의 다른 가능성을 고려해야 하겠으며 추가 검사로 impedance-pH monitoring을 시행해 볼 수 있다.
4) 기능검사 특정상 기술적 문제로 인한 비정상적 결과가 나올 수 도 있으므로 이를 인지할 수 있는 경험을 쌓는 것이 필요하며 특히 예기치 못한 결과가 나왔을 때 적절한 해석을 할 수 있는 능력을 갖추는 것이 중요하다.