Wireless Video Capsule Endoscopy: a Disruptive Technology

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Conflict of Interest Statement

• Olympus Corp: Consultant and recipient of research grant

• Covidien/ Medtronic/GivenImaging; consultant.

• Capsovision: Recipient of research funds
Objectives

- Evolution of imaging techniques for the small intestine
- Tools: pros and cons
- Indications and Contraindications
- Differential diagnosis
- Localization of a capsule
- The future
Evolution of Capsule Endoscopy

1999

Hardware

Software

Capsules

2000

2003

2007

2016

SB-3
EC-10
MiroCam
CapsoCam
Colon Capsule

*
Capsule Endoscopy Systems

PillCam SB3

Olympus EC-10

CapsoCam
## Comparative capsule characteristics

<table>
<thead>
<tr>
<th></th>
<th>IntroMedic MiroCam</th>
<th>Given Imaging SB3</th>
<th>Olympus EC-10</th>
<th>Capsocam</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
<td>11 x 24mm</td>
<td>11 x 26mm</td>
<td>11 x 26mm</td>
<td>11 x 31mm</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>3.4g</td>
<td>3.45g</td>
<td>--</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>320 x 320</td>
<td>256 x 256</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td><strong>Rate</strong></td>
<td>2-3 fps</td>
<td>2 fps</td>
<td>2 fps</td>
<td>3 fps</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>9-11 hours</td>
<td>8-12 hours</td>
<td>12-20 hours</td>
<td>12 hours</td>
</tr>
<tr>
<td><strong>Field of View</strong></td>
<td>150°</td>
<td>140° / 156°</td>
<td>145°</td>
<td>360°</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>HBC</td>
<td>RF</td>
<td>RF</td>
<td>Recover capsule</td>
</tr>
<tr>
<td><strong>Real Time Viewer</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
Other capsules

- Colon Capsule 2
  - Indication: Failed conventional colonoscopy
  - Double ended, variable frame rate.
  - Battery life >10 hrs 31 x 11mm

- PillCam Upper
  - Replaces PillCam Eso
  - double ended, 37 frames/sec
  - 90 min battery life 11 x 26mm

- Patency capsule
Indications for VCE

• Suspected small intestinal bleeding
• Suspected Crohn’s disease and management
• Small intestinal tumors
• Follow up of polyposis syndromes
• Lesser indications
  • Malabsorptive disorders e.g. celiac disease
  • Chronic diarrhea and abdominal pain
Contraindications to VCE

- Dysphagia – inability to swallow
- Pacemaker or ICD
- Pregnancy
- Intestinal obstruction
- Magnetic resonance imaging
Complications

• Capsule retention < 2 weeks

• True retention > 2 weeks

• NO deaths in > 3 million procedures

• Rare perforation
Tumbling of the capsule: incomplete view of mucosa
Small Intestinal Bleeding [OBSCURE GI bleeding]

- The source of bleeding remains unknown in 5-10% of patients with gastrointestinal bleeding after upper and lower endoscopy.

ACG guidelines on small intestinal bleeding. Am J Gastroenterology Sept 2015
Definitions

Small intestinal bleeding

Overt
- Hematochezia
- Melena

Occult
- FOBT
- Iron deficiency Anemia
<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>33%</td>
</tr>
<tr>
<td>Angioectasia</td>
<td>15%</td>
</tr>
<tr>
<td>Active bleeding source not identified</td>
<td>14%</td>
</tr>
<tr>
<td>Crohn’s disease</td>
<td>7%</td>
</tr>
<tr>
<td>Dieulafoy’s / punctate bleeding lesion</td>
<td>5%</td>
</tr>
<tr>
<td>Gastric antral venous ectasia</td>
<td>4%</td>
</tr>
<tr>
<td>Ulcers</td>
<td>4%</td>
</tr>
<tr>
<td>NSAID lesions</td>
<td>4%</td>
</tr>
<tr>
<td>Small intestinal tumors</td>
<td>2%</td>
</tr>
<tr>
<td>Small intestinal varices / enteropathy</td>
<td>1%</td>
</tr>
</tbody>
</table>
Normal small intestine
Angioectasia:
Punctate bleeding
Case 1: 65 yr. old WM with melena requiring transfusion: Dz. Dieulafoy lesion and lipoma
Small tumor
Video capsule in a patient with suspected Crohn’s Disease
Chronic stenosing enteritis

- Novel type of small bowel ulceration / stenosis
- Non transmural inflammation
- Presents in an older group of patients than Crohn’s disease, but occurs in children
- Typically present with iron deficiency and pain without diarrhea
- Similar to but not identical with CNSU / CMUSE
Index case

- VCE 2007
Index Case

• Repeat VCE in 2009
What to do when VCE is not diagnostic?

- Alternative diagnostic tools
  - Deep enteroscopy
  - CT or MRI enterography / angiography
  - Nuclear scans
  - Angiography
  - Intra-operative enteroscopy
  - Barium studies

- Repeat VCE
Localization of the capsule
The localization problem

• Diagnostic yield for outpatient VCE is approximately 40 to 60 %.

• Once a lesion or bleeding site is identified how does this help a surgeon or endoscopist?

• What is the current practice for localization?
Current practice

- Localization is based on time
- Percent progress between pylorus and cecum
- There is a problem with incomplete transit
- Early localization software was 2D
Purpose of study

• Primary objective
  – To validate a new 3-D localization system [3D Track Function] used for the new generation of capsules developed by Olympus: EC-10

• Secondary objectives
  – Use PA/lateral radiographs as a gold standard.
  – Examine the effect of changes in BMI
  – Test a decreased dose of radiation for X-rays while identifying the capsule and associated components.

Methods

• Subjects were fitted with a belt containing an antennae sensor array.
  – Six radio-opaque markers

• After swallowing capsule and real-time viewer showed that the capsule passed the pylorus subjects had a series of five PA/lateral X-rays
  – X-rays thirty minutes apart
  – 1/10th typical dose of x-rays

• Radiographs were compared to data obtained from sensor antennae.
Methods

• Subjects
  – Thirty volunteers were included in the study
  – Inclusion criteria
    • Able to consent
    • Volunteers paid $100
    • Age >45 years old
  – Exclusion criteria
    • History of GI pathology
    • Women capable of childbearing
  – Subjects were pre-identified to create a group representative of the BMI spectrum of the general population
Radiograph Analysis
Results

- Average error (SD) among the 3-dimensional coordinates was
  - X, 2.00 cm (1.64);
  - Y, 2.64 cm (2.39);
  - Z, 2.51 cm (1.83). T

- The mean total spatial error among all measurements was 13.26 cm(3) (22.72).

- There was a correlation between increased subject body mass index and the 3-dimensional software measurement error.
Conclusion

• Software and radiographic localization were closely related

• Remaining issues
  – 3D localization is better than 2D

• Real problem: distance from pylorus or cecum

Evolving and future concepts

• **Timing**
  – The sooner the better

• **Expansion of indications**
  – Acute GI bleeding

• **Robotic capsules**

• **Treatment**
  – Deep enteroscopy
    • Single and double balloons
    • Hand driven and powered spiral