NUOVI STRUMENTI DIAGNOSTICI IN ENDOSCOPIA DIGESTIVA PEDIATRICA

Massimo Martinelli,
Dipartimento di Pediatría,
Università di Napoli “Federico II”
From the Sword to Schindler: A Saga of Gastroscopy

Leon Morgenstern, MD, FACS

Figure 1. The Schindlers performing a gastroscopy (circa 1939-1940). The “sword swallowler’s position” of the head is held by Gabriele.
Flexible endoscopes

• The advent of flexible fiberoptic endoscopes transformed the diagnosis and management of the 90% gastrointestinal disorders in adults and children, allowing direct visualization with targeted mucosal biopsies.

• Furthermore, endo-therapeutic procedures have been possible throughout the upper GI tract and ileo-colon.

The dream to pursue an entire enteroscopy...

✓ The small bowel has historically been considered as an inaccessible area because of its anatomy, location, and relative tortuosity
Capsule endoscopy

A capsule fitted with a disposable mini video camera can examine parts of the small intestine that standard scopes can’t reach for diagnosing unexplained bleeding or other abnormalities. The video data is transmitted and stored in a recorder worn on a belt, and is later downloaded to a computer that the doctor can study.

**THE PROCEDURE**

1. Fasting necessary prior to swallowing capsule
2. Capsule glides smoothly through digestive tract
3. Wireless recorder worn on a belt around waist receives signals transmitted by capsule through sensors placed on patient’s body
4. Capsule naturally excreted

**THE CAPSULE**

- What it can show
- Stomach
- Colon
- Small intestine disorders
- Rectum
- Small intestine

**Advantages:**
- Painless
- No sedation
- Provides 3-D, color images of small intestines without surgery
- Allows doctors to make early, accurate diagnosis of problems so they can recommend most appropriate treatment

**Size:**

- Side: 27 mm (1.2 inches)
- Front: 11 mm (0.4 inches)

*SOURCE: GIVEN IMAGING*
Nei bambini piccoli, incapaci di deglutire, la capsula viene trasportata endoscopicamente oltre il Piloro.
Pediatric Indications

✓ OBSCURE GI BLEEDING

✓ SMALL BOWEL CROHN’S DISEASE

✓ MANAGEMENT OF HEREDITARY POLYPOSIS SYNDROMES (PEUTZ-JEGHERS)

✓ MUCOSAL INJURY (drugs, chemotherapy, graft versus host disease)

✓ OTHER (malignances, intestinal lymphangiectasia, etc)

# Wireless Capsule Endoscopy for Pediatric Small-Bowel Diseases

Gian Luigi de’ Angelis, Prof., Fabiola Fornaroli, M.D., Nicola de’ Angelis, M.D., Barbara Magiteri, M.D., and Barbara Bizzarri, M.D.

*Pediatric Gastroenterologic Unit, University of Parma, Parma, Italy*

<table>
<thead>
<tr>
<th>Indications</th>
<th>Findings</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Known IBD (21 Crohn’s disease, 1 indeterminate colitis)</td>
<td>Small-bowel Crohn’s disease lesions (macro/micro fistulization, clubbing) Giant ileal lymphoid nodular hyperplasia Severe distal duodenitis (IC) Negative Delayed capsule endoscopy passage from the stomach Crohn’s disease-related small-bowel lesions Negative Nonspecific possibly postinfectious diffuse small-bowel lesions Delayed capsule endoscopy passage from the stomach Multiple Peutz-jeghers syndrome-related small-bowel polyps</td>
<td>16</td>
</tr>
<tr>
<td>Suspected IBD (10 patients)</td>
<td>Multiple familial adenomatous polyposis-related small-bowel polyps Multiple Bannayan-Riley-Ruvalcaba syndrome-related small-bowel polyps Giant ileal lymphoid nodular hyperplasia Negative Multiple ileal sessile polyps Isolated ileal sessile polyp Small-bowel Crohn’s disease lesions Giant ileal lymphoid nodular hyperplasia Negative Nonspecific hemorrhagic ileal lesions Small-bowel polyposis Ileal bleeding lesions Angiodysplasia Small-bowel NSAID-induced mucosal lesions Ileal bleeding ulcer Delayed capsule endoscopy passage from the stomach Negative</td>
<td>4</td>
</tr>
<tr>
<td>Known polyposis (20 Peutz-Jeghers syndrome, 5 familial adenomatous polyposis, 2 multiple juvenile colonic polyps, 1 Bannayan-Riley-Ruvalcaba syndrome)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspected small-bowel polyposis (5 patients)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspected obscure gastrointestinal bleeding (21 patients)</td>
<td></td>
<td></td>
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<tr>
<td>Chronic malabsorption (1 patient)</td>
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</tbody>
</table>
Management of obscure GI bleeding

OGIB with negative EGD and colonoscopy

- Meckel’s scan (if clinically suggestive)
  - If negative (could be repeated with high index of suspicion)

- Repeat EGD and Colonoscopy
  - If negative

  CE (if the age is suitable)
  - (If not available or can’t be done consider PE)*

- Specific treatment
  - Occult
    - Close monitoring
      - If continued: assess for repeat investigation and consider
  - Overt
    - Laparoscopy/ctomy and/or intraoperative enterostomy

*If PE and CE are not available and bleeding is active, consider RBC radioisotope scan or mesenteric angiography

Usefulness of wireless capsule endoscopy in paediatric inflammatory bowel disease

Giovanni Di Nardo, Salvatore Oliva, Federica Ferrari, Maria Elena Riccioni, Annamaria Staiano, Giuliano Lombardi, Guido Costamagna, Salvatore Cucchiara, Laura Stronati

1 Pediatric Gastroenterology and Liver Unit, Sapienza University of Rome, Italy
2 Gastrointestinal Endoscopy Unit, Catholic University of Rome, Italy
3 Pediatric Gastroenterology Unit, University of Naples Federico II, Italy
4 Pediatric Gastroenterology Unit, Hospital of Pescara, Italy

Fig. 1. Algorithm showing patient population investigated with the wireless capsule endoscopy and the diagnostic outcome. SB, small bowel; WCE, wireless capsule endoscopy; SICUS, small intestine contrast ultrasonography; MRI, magnetic resonance imaging.
**TABLE 2. A summary of the studies looking at the diagnostic yield of capsule endoscopy versus other diagnostic modalities in CD**

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Patient no.</th>
<th>CE</th>
<th>PE</th>
<th>SBFT/EN</th>
<th>CTE</th>
<th>MRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eliakim et al (39)</td>
<td>Prospective</td>
<td>20</td>
<td>70</td>
<td></td>
<td>35</td>
<td>35</td>
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</tr>
<tr>
<td>Fireman et al (40)</td>
<td>Prospective</td>
<td>17</td>
<td>71</td>
<td></td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ge et al (41)</td>
<td>Prospective</td>
<td>20</td>
<td>65</td>
<td></td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mow et al (42)</td>
<td>Prospective</td>
<td>50</td>
<td>40</td>
<td></td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buchman et al (43)</td>
<td>Prospective</td>
<td>23</td>
<td>68</td>
<td></td>
<td>88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heigh et al (44)</td>
<td>Prospective</td>
<td>8</td>
<td>86</td>
<td></td>
<td>88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chong et al (45)</td>
<td>Prospective</td>
<td>21</td>
<td>80</td>
<td>14</td>
<td>88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herreiras et al (46)</td>
<td>Prospective</td>
<td>21</td>
<td>43</td>
<td></td>
<td>88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voderholzer et al (47)</td>
<td>Prospective</td>
<td>13</td>
<td>62</td>
<td></td>
<td>88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marmo et al (48)</td>
<td>Prospective</td>
<td>16 (TI)</td>
<td>89</td>
<td></td>
<td>88</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 (PI)</td>
<td>46</td>
<td></td>
<td>88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Golder et al (23)</td>
<td>Prospective</td>
<td>18</td>
<td>39</td>
<td></td>
<td>88</td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>

**CE** = capsule endoscopy; **PE** = push enteroscopy; **SBFT** = small bowel follow-through; **EN** = enteroclysis; **CTE** = computerized tomographic enteroclysis; **MRE** = magnetic resonance enteroclysis; **TI** = terminal ileum; **PI** = proximal ileum; --- = not compared.

FIGURE 1. Algorithm for approaching suspected small bowel Crohn’s disease. The absence of any mucosal lesions, shown by a complete assessment of the small bowel by capsule endoscopy, essentially excludes active CD of the small bowel. Patients with symptoms suggestive of or known to have a stenosis should either undergo a patency capsule exam or evaluation by CTE or MRE prior to capsule endoscopy (CD, small bowel Crohn’s disease; CTE, CT enterography; MRE, MR enterography; SB, small bowel; SBFT, small bowel follow-through). [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]
Diagnosis of Inflammatory Bowel Disease in Children and Adolescents: The Revised Porto Criteria

Wireless capsule endoscopy is useful to identify small bowel mucosal lesions in children with suspected Crohn’s disease, in whom conventional endoscopy and imaging tools have been non-diagnostic (EL3b; RG C) or in whom MRE can not be performed due to young age or in settings where MRI is not available or not feasible.

A normal WCE study has a high negative predictive value for active SB CD (EL4, RG D)
Evaluation of Child / Adolescent with intestinal or extraintestinal symptoms suggestive of IBD based on history, physical and laboratory examination or abd. sonography

Strong Suspicion IBD

Tests unhelpful or Isolated extraintestinal symptoms

Fecal Markers (FM)
Calprotectin/ Lactoferrin

Ileocolonoscopy & EGD (with biopsies all segments)

Typical UC

Atypical UC

Clear CD

Normal

IBDU

Consider further w/u for immune deficiency depending on age, clinical signs and laboratory results

Consider Imaging

Serologic Markers

MRI-Enterography/ VCE

Suggest UC

Suggest CD

Negative

Consider VCE or Enteroscopy. if FM+

positive

Negative

UC

CD

no IBD

CD

IBDU
Wireless Capsule Endoscopy

✓ **Main advantages**: possibility to visualize the entire small bowel with a relative non invasive procedure, with a good diagnostic yield

✓ **Main disadvantages**: inability to perform air insufflations, rinsing of tissue, taking biopsies or undertaking endotherapeutic procedures - and thus the major utility is limited to diagnostic input alone

Risk of Capsule Endoscope Retention in Pediatric Patients: A Large Single-center Experience and Review of the Literature

Orhan Atay, Lori Mahajan, Marsha Kay, Franziska Mohr, Barbara Kaplan, and Robert Wyllie

Department of Pediatric Gastroenterology, Cleveland Clinic Children’s Hospital, Cleveland, Ohio

<table>
<thead>
<tr>
<th>References</th>
<th>No. patients</th>
<th>Mean age, y</th>
<th>Age range, y</th>
<th>No. retained capsules</th>
<th>Surgical intervention required</th>
<th>Endoscopic removal required</th>
</tr>
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<tbody>
<tr>
<td>Present study</td>
<td>207</td>
<td>14.7</td>
<td>8–21</td>
<td>3 (1.4%)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>de’ Angelis et al (1)</td>
<td>87</td>
<td>12.8</td>
<td>1.5–18</td>
<td>2 (2.3%)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Moy and Levine (5)</td>
<td>45</td>
<td>14.9</td>
<td>5.6–22.4</td>
<td>9 (20%)*</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sant’anna et al (6)</td>
<td>30</td>
<td>14.1</td>
<td>10–18</td>
<td>1 (3.3%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Thomson et al (7)</td>
<td>28</td>
<td>12.5</td>
<td>9.4–15.9</td>
<td>1 (3.6%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cohen et al (11)</td>
<td>28</td>
<td>15.8</td>
<td>Not reported</td>
<td>1 (3.6%)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Urbain et al (8)</td>
<td>17</td>
<td>11.9</td>
<td>5–18</td>
<td>0 (0%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ge et al (9)</td>
<td>16</td>
<td>11</td>
<td>3–18</td>
<td>0 (0%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Barth et al (12)</td>
<td>11</td>
<td>9 (median)</td>
<td>3–18</td>
<td>0 (0%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Shamir et al (10)</td>
<td>10</td>
<td>13</td>
<td>10–17.5</td>
<td>0 (0%)</td>
<td>0</td>
<td>0</td>
</tr>
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</table>

* Duration of retention not specified.
<table>
<thead>
<tr>
<th>Indications</th>
<th>No. patients (% of total)</th>
<th>No. with retained capsule (% with retained capsule)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspected IBD</td>
<td>73 (35.3)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Abdominal pain</td>
<td>54 (26.1)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Evaluation of known CD</td>
<td>41 (19.8)</td>
<td>3 (7.3)</td>
</tr>
<tr>
<td>Differentiating CD vs UC</td>
<td>17 (8.2)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Patients with known IBD before study (total)</td>
<td>58 (28)</td>
<td>3 (5.2)</td>
</tr>
<tr>
<td>Hematochezia</td>
<td>15 (7.2)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>4 (1.9)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Juvenile polyposis syndrome</td>
<td>2 (1)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Protein losing enteropathy</td>
<td>1 (0.5)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Total number of patients in study</td>
<td>207 (100)</td>
<td>3 (1.4)</td>
</tr>
</tbody>
</table>
NEW REVISED PORTO CRITERIA: Practical points

- Imaging tools or a patency capsule should generally precede wireless capsule endoscopy (WCE) to reduce the risk of retention. The choice depends on local availability and expertise.

- A diagnosis of CD should not be based on the WCE features alone, due to the high number of false-positives and not validated diagnostic criteria. False positive features are found in 10 – 21% of healthy persons, particularly with NSAIDs use.
A piece of the puzzle..
Videocapsula endoscopica

✓ La videocapsula endoscopica è una procedura relativamente sicura in età pediatrica

✓ Permette di diagnosticare patologie del piccolo intestino, ed è particolarmente utile nell’inquadramento di un sospetto Crohn

✓ Permette di fare diagnosi ed orientare le scelte terapeutiche nei casi più dubbi
Total enteroscopy with a nonsurgical steerable double-balloon method

Hironori Yamamoto, MD, Yutaka Sekine, MD, Yukihiro Sato, MD, Toshihiko Higashizawa, MD, Tomohiko Miyata, MD, Satoru Iino, MD, Kenichi Ido, MD, Kentaro Sugano, MD
DBE TATTOO

World J Gastroenterol 2010 January 7; 16(1): 000-000
# Pediatric Indications

<table>
<thead>
<tr>
<th>Diagnostic Indication</th>
<th>Therapeutic Indications</th>
</tr>
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<tbody>
<tr>
<td>Obscure GI bleeding</td>
<td>Hemostasis</td>
</tr>
<tr>
<td>Crohn’s disease</td>
<td>Polypectomy</td>
</tr>
<tr>
<td>Intestinal Lymphangectasia</td>
<td>Stenosis</td>
</tr>
<tr>
<td>Hereditary polyposis</td>
<td>Retrieval of foreign bodies</td>
</tr>
<tr>
<td>ERCP in patients with altered anatomy</td>
<td>ERCP in patients with Billroth type II stomach or Roux-en Y anastomosis</td>
</tr>
<tr>
<td>Malignancies</td>
<td>Gastrostomy in abnormal bowel anatomy</td>
</tr>
<tr>
<td></td>
<td>Early post-operative small bowel obstruction</td>
</tr>
</tbody>
</table>
A total of 92 procedures were performed on 48 patients (27 males, 21 females) with a median age of 12.2 years (range 4-18 years).

The mean duration of all procedures was 96.0 minutes (range 30-220 minutes) and was 103 minutes for the oral route, 76 minutes for the anal route.

The overall diagnostic yield was 65% (31/48 patients)

Observation of the entire small intestine was attempted in 9 patients and succeeded in 5 (56%) of them with a combination of the 2 approaches (antegrade and retrograde)
18 patients with a diagnosis of Peutz-Jehers syndrome underwent a total of 80 DBE examinations, 34 FE examinations, 38 WCE examinations, 30 of which were done for follow-up after DBE and 8 of which were done for surveillance before the first DBE.

WCE is noninvasive and useful for the detection of small-bowel polyps in PJS, and DBE is relatively safe and useful for polyp resection without laparotomy. Therefore, these two techniques are preferable for the management of patients with PJS.
Complications

✓ **Minor complications:**
  - Abdominal pain
  - Sore throat
  - Minimal bleeding due to a polipectomy

✓ **Major complications**
  - Acute pancreatitis
  - Perforation
  - Massive bleeding

There were no major complications related to the insertion of the double-balloon endoscope, such as perforation, bowel obstruction, pneumonia, and pancreatitis.

Ten patients experienced abdominal pain that was self-limited and resolved within 24 hours without any further interventions.

Among patients who underwent therapeutic interventions, there was only 1 major complication. Postpolypectomy bleeding occurred in 1 patient, and endoscopic hemostasis was successfully performed by using DBE. The patient did not require a transfusion.
Balloon by balloon, inch by inch

Petar Mamula, MD
Division of Gastroenterology; Hepatology and Nutrition
The Children's Hospital of Philadelphia
Philadelphia, Pennsylvania, USA

Several important aspects of double-balloon endoscopy that are unique to the pediatric population—training; type of sedation used; comparison to experience in adults in terms of safety, technical difficulties, and procedure time and success; and the lack of instruments designed specifically for children, a factor that is very often the case in pediatric endoscopy—deserve further analysis.
Single Balloon Enteroscopy

Prospective Multicenter Trial Comparing Push-and-Pull Enteroscopy With the Single- and Double-Balloon Techniques in Patients With Small-Bowel Disorders

Andrea May, MD, PhD1, Michael Förber, MD2, Insa Aschmoneit, MD1, Jürgen Pohl, MD, PhD3, Hendrik Manner, MD1, Erich Lotterer, MD, PhD1, Oliver Moschler, MD1, Johannes Kunz, MD1, Liebwin Gossner, MD, PhD4, Klaus Monkemüller, MD, PhD5 and Christian Ell, MD, PhD5

Number of enrolled patients
$n=123$

Randomization DBE or SBE

Oral balloon enteroscopy (DBE or SBE)

Drop-out after oral balloon enteroscopy due to exclusion criteria according to the study protocol:
$n=23$ (12 DBE and 11 SBE)

100 Patients finished the study (50 DBE, 50 SBE)

Prospective Multicenter Trial Comparing Push-and-Pull Enteroscopy With the Single- and Double-Balloon Techniques in Patients With Small-Bowel Disorders

<table>
<thead>
<tr>
<th>Preparation time for the instruments (min)</th>
<th>DBE</th>
<th>SBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±s.d.</td>
<td>9.7±2.4</td>
<td>10.0±3.2</td>
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</table>

<table>
<thead>
<tr>
<th>Investigation time (min) Procedure</th>
<th>DBE</th>
<th>SBE</th>
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<tr>
<td>Mean±s.d.</td>
<td>66.5±17.7</td>
<td>62.0±22.7</td>
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<tr>
<td>Minimum–maximum</td>
<td>38–100</td>
<td>22–115</td>
</tr>
<tr>
<td>Total</td>
<td>88.5±21.8</td>
<td>80.5±25.7</td>
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<table>
<thead>
<tr>
<th>Complete enteroscopy (n, %)</th>
<th>DBE</th>
<th>SBE</th>
</tr>
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<tbody>
<tr>
<td>Mean±s.d.</td>
<td>33/60 (66%)</td>
<td>11/60 (22%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diagnostic yield</th>
<th>DBE</th>
<th>SBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate of negative complete enteroscopies influencing the further therapy</td>
<td>25/60 (52%)</td>
<td>21/60 (42%)</td>
</tr>
<tr>
<td>Therapeutic yield (n, %)</td>
<td>DBE</td>
<td>SBE</td>
</tr>
<tr>
<td>-----------------------------</td>
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</tr>
<tr>
<td>Mean±s.d.</td>
<td>36/60 (72%)</td>
<td>24/60 (48%)</td>
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</tbody>
</table>

*χ²-Test.
**Student's t-test.

DBE, double-balloon enteroscopy; SBE, single-balloon enteroscopy.
Double balloon enteroscopy has become established throughout the world for diagnostic and therapeutic examinations of the small bowel, and is now used universally in clinical routine work. The recently introduced technique of single balloon endoscopy represents a simplification of the method. This prospective randomized trial showed that the rate of complete enteroscopy with DBE was three times higher than with SBE and that DBE was associated with a higher diagnostic yield. On the basis of these results, DBE must continue to be regarded as the nonsurgical gold standard procedure for deep small-bowel endoscopy at present.

Single balloon advantages

- It is useful for proximal small bowel lesions

- Using an Olympus platform and standard push enteroscope or pediatric-size colonoscope, it has the advantage of a lack of requirement for a totally new endoscopic system

- The preparation and the procedure time is significantly reduced

Spiral Enteroscopy

VERY FEW KIDS DREAM OF BEING A GASTRONAUT.