The Dilemma of Incomplete Colonoscopy
What Next?

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Why Is Complete Colonoscopy Important?

- Multicenter trial of 1,994 patients undergoing screening colonoscopy found 50% with significant lesions in proximal colon.
- 2012 study found that the risk of proximal cancer increased twofold when colonoscopy was incomplete.
- Guidelines propose targets for successful intubation rates:
  - ≥90% for all colonoscopies
  - ≥95% for screening colonoscopies
- Rates of incomplete colonoscopy can range from 7% to 19%.
- Population-based study in Canada of 20,166 patients with incomplete colonoscopy:
  - Only 29.4% underwent complete exam one year later.

Completing Colonic Evaluation Is Important

- In a review of 25,451 colonoscopies, Ridolfi et al found that 242 were incomplete.
- 179 (74%) patients underwent a follow-up examination.
- Overall, follow-up examinations indicated clinically significant lesions in 21 patients (12%).

<table>
<thead>
<tr>
<th>Follow-up examination</th>
<th>Patients (n=179*)</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barium enema</td>
<td>74/179</td>
<td>New abnormalities in 11 patients</td>
</tr>
<tr>
<td>CT colonography</td>
<td>17/179</td>
<td></td>
</tr>
<tr>
<td>Repeat colonoscopy</td>
<td>71/179</td>
<td></td>
</tr>
<tr>
<td>Colonoscopy with anesthesia</td>
<td>9/179</td>
<td>27 lesions in 19 patients</td>
</tr>
</tbody>
</table>

*Remaining 8 patients underwent resection with intraoperative colonoscopy

Reasons for Incomplete Colonoscopy

**Patient Factors**
- Discomfort and intolerance
- Low body mass index
- Prior abdomino-pelvic surgery
- Suboptimal prep
- Female sex

**Technical Factors**
- Tortuosity and redundancy
- Angulated and fixed colon segments
- Extensive diverticulosis

**Endoscopist and Technician Expertise**

Approach to Difficult Colonoscopy

- Customize the bowel prep and educate
- Choose appropriate sedation
- Ensure expert endoscopist technique
- Train your technicians in abdominal pressure
- Consider the following
  - Water exchange
  - Magnetic imaging

Water Exchange Technique
Residual air produces an acute angle in the sigmoid colon making identification of the lumen difficult.

Water flows out easily and the sigmoid colon becomes "SHORT and STRAIGHT".


Water Exchange for Redundant Colons
- Benefit during insertion phase of colonoscopy in patients who are unsedated or receiving minimal sedation
- In a redundant colon, water immersion will keep a dilated colon collapsed and straighter
  Bourke MJ and Rax DK: Am J Gastro 2012;107:1467-72

Water Exchange in Difficult Colonoscopy
- Water and air methods compared in 44 unsedated patients with prior abdominal surgery
  - Water method: 19/22 (86%)
  - Air method: 11/22 (50%)

Water Exchange for Incomplete Colonoscopy
- 10 patients with prior failed cecal intubation referred for balloon colonoscopy
- All 10 patients underwent successful water exchange colonoscopy to the cecum
  Mann SK et al: Abstract
Magnetic coil signals are picked up by a small receiver dish and turned into a dynamic 3D image of the endoscope.
Magnetic Imaging for Difficult Colonoscopy

A hand coil enables precise placement for abdominal pressure in relation to the endoscope
Hand Coil for Loop Reduction

Magnetic Imaging

- Identify and mitigate loops
- Apply abdominal pressure to correct location
- Recognize difficult anatomy
- Educating fellows on loop reduction techniques
Magnetic Imaging Colonoscopy

296 patients
- No difference in sedation or pain scores
- Intubation times were shorter
- Colonoscopy completion rates were higher
- Abdominal hand pressure was more effective

Unsedated colonoscopy comparing magnetic imaging to standard colonoscopy
- Cecal intubation rate higher in imager group
  - 190/212 (90%) vs 153/207 (74%) (P<0.001)
- Pain-reducing effect in imager group noted with experienced colonoscopists: 7.3% vs 16% (P=0.03)

Tips for Difficult Colonoscopy
- Anticipate altered sigmoid anatomy
- Master the left colon
- Change solutions quickly
- Change instruments in the difficult sigmoid
- Be willing to quit


Bourke MJ and Rex DK: Am J Gastro 2012;107:1467-72
The Dilemma of Incomplete Colonoscopy

What Next?

Current options
- Double contrast barium enema
- Repeat colonoscopy with or without anesthesia or with different scope
- CT colonography
- Balloon assisted colonoscopy

Future technologies
- Colon capsule
- CheckCap

Patient factors
Institutional expertise
Available technologies

Double Contrast Barium Enema
- Adequate colon visualization in 77-94% after incomplete colonoscopy
- Main limitation – low sensitivity
  - All polyps 40%
  - Polyps >1cm 50%
  - CRC miss rate 22%
- A direct comparison of barium enema with repeat colonoscopy for completion of colonoscopy found that the polyp detection rate was significantly greater with colonoscopy compared with barium enema (34.3% vs 3.6%, P <0.0001)

Repeat Colonoscopy

• Routine colonoscopy in patients with prior incomplete exam, and repeat was successful in 117 of 119 patients

• Additional methods – applying abdominal pressure, manual reduction of abdominal wall hernia, changing the patient's position, and propofol sedation

• 59 of 119 patients were found to have a total of 126 adenomas <10 mm and 31 adenomas >10 mm

• Haq et al used push enteroscopy in obese or overweight patients with an 89% success rate

Haq T et al: Gastrointest Endosc 2010; 71(5):AB343

CT Colonography (CTC)

• Colonic imaging with multidetector scanners

• Requires bowel preparation and stool tagging, along with insufflation of the colon with CO²

• Colonic images are obtained using dual position scanning and analyzed using two-dimensional axial, multiplanar and three-dimensional endoluminal formats
CT Colonography After Incomplete Colonoscopy

546 patients after incomplete colonoscopy due to redundancy or tortuosity

- CTC detected an additional 88 polyps >6mm in size in 13.2% (72) of patients
- Repeat colonoscopy was completed in 63%
- CTC for mass lesions
  - Per-patient PPV 90.9%
  - Per-lesion PPV 91.7%
- CTC for large polyps
  - Per-patient PPV 64.7%
  - Per-lesion PPV 70.0%

CT Colonography After Incomplete Colonoscopy

- 65 patients with positive FOBT
- CTC performed in 42
- Results
  - 21/42 (50%) had polyps or mass lesions
    - 15 underwent repeat colonoscopy
    - 2 underwent surgery
  - CTC
    - Per-patient PPV polyps/masses >9mm: 87.5%
    - Per-lesion PPV polyps/masses: 83.3%
**CT Colonography**

**Advantages**
- Non-invasive
- Usually can perform on the same day
- Performed safely in anti-coagulated patients

**Disadvantages**
- Radiation
- Low sensitivity
- Air insufflation
- Purely diagnostic
- Extra-colonic findings

**Balloon Assisted Colonoscopy**
- Adjunctive technology that allows for diagnostic and therapeutic intervention
- **Choices**
  - Double balloon enteroscope
  - Single balloon enteroscope
  - Double balloon colonoscope
Double Balloon Colonoscopy

Cecal intubation rate (N)

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Cecal intubation rate (%)</th>
<th>Cecal intubation time (min)</th>
<th>Sedation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yamamoto 2005</td>
<td>50</td>
<td>98</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Kaltenbach 2006</td>
<td>20</td>
<td>95</td>
<td>28±20</td>
<td>moderate</td>
</tr>
<tr>
<td>Pasha 2007</td>
<td>16</td>
<td>88</td>
<td>27±9.5</td>
<td>moderate</td>
</tr>
<tr>
<td>Monkemuller 2007</td>
<td>7</td>
<td>100</td>
<td>15</td>
<td>?</td>
</tr>
<tr>
<td>Gay 2007</td>
<td>29</td>
<td>96</td>
<td>12±7</td>
<td>propofol</td>
</tr>
<tr>
<td>Moreels 2008</td>
<td>26</td>
<td>89</td>
<td>20±2</td>
<td>moderate</td>
</tr>
<tr>
<td>Moreels 2010</td>
<td>45</td>
<td>93</td>
<td>19±1</td>
<td>moderate</td>
</tr>
</tbody>
</table>


Double Balloon Enteroscopy for Incomplete Colonoscopy
Single Balloon Colonoscopy for Incomplete Colonoscopy

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Cecal intubation rate (%)</th>
<th>Total procedure time (min)</th>
<th>Sedation</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2006</td>
<td>14</td>
<td>100</td>
<td>50</td>
<td>Propofol</td>
</tr>
<tr>
<td>Teshima 2010</td>
<td>23</td>
<td>96</td>
<td>30</td>
<td>Moderate</td>
</tr>
<tr>
<td>Keswani 2011</td>
<td>30</td>
<td>93</td>
<td>22±18 (CI)</td>
<td>Moderate</td>
</tr>
<tr>
<td>Coppola 2011</td>
<td>79</td>
<td>94</td>
<td>12 (CI)</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

CI = cecal intubation

Single vs Double Balloon Enteroscopy for Incomplete Colonoscopy

- 53 patients
- SBC was successful in cecal intubation in 26/26
- DBC was successful in 25/27 (93%)
- No difference in cecal intubation times
- New polyp detection in both groups
Double Balloon Colonoscope for Incomplete Colonoscopy

- **Working length** – 152 cm; Overtube – 105 cm
- Overcomes limitations of enteroscope
- 29 patients
  - Cecal intubation rate of 98%
  - Shorter total procedure time
    - 18 min ± 14 vs 46 min ± 16
  - Majority of patients utilized moderate sedation
- 20 patients with incomplete colonoscopy – 70% due to looping
  - With DBC, 95% of procedures were completed beyond the splenic flexure
  - Cecal intubation rate was 80%; 4 cases were incomplete due to looping in 3 and angulation in 1

Colon Capsule

- Approved in Europe
- Cameras on both ends
- Takes images at a rate of 4 fps
- Measures 31x11mm
- Battery life is 9-10 hours
- Hibernates while capsule passes through small bowel
Colon Capsule Videos

Colon Polyps

Cecum – Single Polyp
Colon Capsule for Incomplete Colonoscopy

Prospective study of 34 patients with incomplete colonoscopy underwent colon capsule

- Bowel cleanliness good or excellent in 64.7%
- Capsule exceeded the most proximal point reached by colonoscopy in 29 patients (85.3%)
- Findings allowed formulation of a specific medical plan in 20 patients (58.8%)
  - 12 had no significant lesions
  - 7 underwent polypectomy or surgery for advanced colorectal neoplasia
  - 1 was treated for Crohn's disease
- Inconclusive studies were found in 14

Check-Cap

- Prep-Free Imaging
- Sonar-like technology for 3-D reconstruction of the colon
- Patient ingests a contrast agent that allows differentiation of stool from colon wall
- Capsule is sensitive to motion and does not scan when stationary
- When capsule moves, it emits low-dose radiation
Check-Cap

Capsule in Standby Mode

Capsule in Scan Mode

Approach to Difficult Colonoscopy

Difficult Colonoscopy

- Customize Prep
- Appropriate Sedation
- Expert Technique
- Magnetic Imaging
- Water Exchange

ACG Board of Governors/ASGE Best Practices Course - Las Vegas, NV
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Approach to Incomplete Colonoscopy

- Incomplete Colonoscopy
  - Low Risk Polyps
    - CT Colonography
  - High Risk Polyps
    - Repeat Colonoscopy
    - Balloon Assisted Colonoscopy

Future Technologies
- Colon Capsule
- CheckCap

Conclusions
- 7%-19% of all colonoscopies are incomplete, although clinical guidelines recommend that ≥90% of all colonoscopies should be complete.
- In addition to inadequate bowel preparation, incomplete colonoscopies occur most often as a result of technical problems such as looping scope, patient discomfort, adhesions and obstruction.
- The risk of colorectal cancer is increased twofold when colonoscopy is incomplete.
- For difficult colonoscopy, focus on prep, sedation, and expert techniques, including water immersion and magnetic imaging.
- For a history of incomplete colonoscopy but a high risk of polyps, consider repeat colonoscopy with adjustments vs balloon-assisted colonoscopy.
- For those patients with a low risk of polyps, one can consider CT Colonography.
- Future modalities include the Colon Capsule and CheckCap.