Techniques to Achieve Optimal Small Bowel Imaging for Capsule Endoscopy

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Small bowel video capsule endoscopy provides visualization of the gastrointestinal tract by transmitting images wirelessly from a disposable capsule to a data recorder worn by the patient. The capsule is activated by removal from a magnetic holder and provides image accrual and transmission at a frequency of 2 frames per second until the battery expires after 7+ 1 hour. FDA-approved systems are available to image the small bowel marketed as PillCam SB (Given Imaging, Yoqneam, Israel) and Endo Capsule (Olympus Medical Instruments, Tokyo, Japan).

Capsule endoscopy has been shown to be a useful tool to investigate obscure gastrointestinal bleeding, suspected small bowel Crohn’s disease, polyposis syndromes, small bowel tumors, and malabsorptive syndromes. However, its diagnostic value can be hampered by several limitations when diagnosing small bowel lesions. The presence of intestinal juice or air bubbles can influence the diagnosis by causing poor visualization of the intestinal mucosa. Intestinal transit times and battery life limitations can also prevent complete small bowel examinations. It has been reported that the capsule fails to reach the cecum in 21%-28% of examinations. This may be due to longer retention of the capsule in the stomach, slow transit in the small intestine, or technical failure of the capsule.

Currently, there is no consensus regarding bowel preparation prior to capsule endoscopy. Modifications in three influential factors such as bowel preparations, use of prokinetics, and postural maneuvers have been tried for the improvement of capsule endoscopy image quality. Fasting or clear liquids for 12 hours prior to capsule ingestion is standard practice in some centers. Data are conflicting, but several studies suggest that use of a bowel preparation the night before the study yields improved visualization of the small intestine and higher rates of capsules reaching the colon before the end of the recording period. Possible interventions to achieve optimal imaging can be discussed as those that influence transit time or visualization.
Transit Time

Capsule endoscopy has a battery life of 7+1 hour and studies have looked at ways to decrease transit time in an effort to increase the rate of complete exams. In one study, in abstract form, a maneuver shown to reduce gastric transit time involves instructing patients to lie on their right side for the first 2 hours of the procedure. However, a more recent randomized prospective study did not support this maneuver. In the study, one group stayed in the right lateral position for 30 minutes following ingestion and the other group was discharged upon ingestion. Both groups were encouraged to resume normal daily activities. The study showed that the gastric transit time (GTT) was similar: In the right position group, the median time was 14 minutes; in the group that was not positioned, the median was 13 minutes. No differences were found in the small bowel transit time (SBTT): the right positioned group, median time was 248 minutes, and in the other unpositioned group, median was 252 minutes. The procedures were complete in 73.2% of the positioned group versus 83% in the other group.

Several medications have also been studied regarding their effect on transit time. Caddy et al performed a study to determine whether erythromycin increased the completion rate of capsule endoscopy to the cecum. However, this study showed that erythromycin did not decrease gastric emptying time or SBTT. Lubiprostone, a type 2 chloride channel agonist, also has been studied and did not decrease the GTT or SBTT of small bowel capsule endoscopy. The GTT was actually increased with lubiprostone as compared to placebo.

Selby studied the effects of metoclopramide on complete small bowel transit. In the group which did not receive a prokinetic, 63/83 (76%) had a complete examination of the small bowel. The second group received metoclopramide 10mg by mouth 15 minutes before capsule ingestion. Complete small bowel examination was achieved in 65/67 (97%) of patients. Mean gastric transit time was longer in Group 1 compared to Group 2 (47.9 minutes vs. 30.8 minutes; p=0.025). Although mean small bowel transit time was similar (255.5 minutes vs. 230.9 minutes; p=0.35), the increased likelihood of complete examination was associated with decreased GTT as opposed to SBTT. Also, the first 26 patients in this study did not receive a bowel purgative. The remaining patients either received sodium phosphate or 1L of polyethylene glycol preparation the evening prior to the examination. When compared, there was no difference in SBTT between the purgative and non-purgative group. Other studies have shown improved transit and better completion rates with bowel purgatives. Endo et al compared clear liquids before capsule ingestion to 500 ml polyethylene glycol ingested 30 minutes after capsule ingestion. Completion rates were better in the latter group, 65.6% vs. 88.9% (p=0.038). Again, GTT times were better in the purgative group, but SBTT were not different (p=0.245).

Several studies of various bowel preparations have shown no effect on GTT or SBTT. Kalantzis et al showed no difference in GTT or SBTT between patients given clear liquids, 45 ml of phosphate, or 2L of polyethylene glycol the night before the procedure. Postgate et al did not show any statistically significant difference between GTT, SBTT, or completion rates when comparing three different bowel preparations to clear liquids plus simethicone. Rondonotti et al performed a review of 733 cases of capsule endoscopy. They evaluated the incidence and type of technical and clinical problems with capsule endoscopy. The capsule reached the cecum in 83% of patients. Two centers were included in the study. In one center, 92% of patients received a bowel preparation with 2-4L of polyethylene glycol the night before, and no preparation was given in 97% of patients at the other center. Incomplete examination of the small bowel occurred significantly more often in patients who had undergone bowel preparation (21.9%) than in those who had not (7.5%), (p=0.0001).

Metoclopramide did show significant benefit when considering completion rates of capsule endoscopy. The use of other medications, including erythromycin and lubiprostone were not beneficial. The use of bowel purgatives have conflicting data on completion rates. Whether discussing prokinetics or bowel purgatives, a decrease in GTT seems to be more important in completion rate as opposed to SBTT. However, bowel purgatives have an alternate role in capsule endoscopy and may improve visualization.
Visualization

Poor bowel preparation for endoscopic procedures interferes with the diagnosis of neoplasia and may necessitate repeat colonoscopy. Cleansing is of similar importance for capsule endoscopy and there is no possibility of flushing or suctioning. Optimal small-bowel cleansing is critical for the evolution of capsule endoscopy. A capsule endoscopy report should include an assessment of small-bowel cleansing and an adequate, validated grading system must also be used. Brotz et al performed a study to validate three new scales that grade small-bowel cleansing. They compared a quantitative index, qualitative evaluation, and overall adequacy assessment. On a 3 point scale, the quantitative index assessed 5 elements: (1) mucosal visualization, (2) fluid and debris, (3) bubbles, (4) bile/chyme staining, and (5) brightness. The qualitative evaluation of the small-bowel preparation was scored as poor, fair, good, or excellent. The overall adequacy assessment grading system graded small-bowel cleansing as “adequate” or “inadequate”. For each scoring system, intra-reader reliability exceeded inter-reader reliability. The quantitative index had the greatest reliability, while the qualitative evaluation performed poorly. However, its reliability improved when dichotomized as excellent and good vs. fair and poor. Reliability for the overall adequacy assessment was in the moderate range. Regardless of what grading scale is used, a graded system of small-bowel cleansing and incorporation into the standard capsule endoscopy report is an important quality measure.

As with transit time, multiple medications and bowel purgatives have been studied and used to improve small bowel visualization. Visibility of the small bowel mucosa is significantly limited in some cases, either because of the presence of intraluminal gas bubbles, turbid intestinal fluid, or food debris. Simethicone (80 mg) orally, given 20 minutes before capsule ingestion, has been evaluated and shown to improve the visibility of small bowel mucosa. Simethicone resulted in significantly better visibility because of fewer intraluminal bubbles compared to patients not given simethicone (p < 0.01). No adverse effect of simethicone was observed.

Simethicone has been compared to magnesium citrate as a bowel preparation for capsule endoscopy. In this retrospective review of capsule endoscopy images from 75 patients, fluid transparency was better with magnesium citrate, but mucosal invisibility and transit times did not differ. Diagnostic yield correlated significantly with fluid transparency but not with mucosal invisibility. The authors concluded that magnesium citrate may be a better preparation for capsule endoscopy than simethicone alone. Wei et al showed that simethicone in combination with a bowel purgative (1L PEG) improved the quality of imaging of the entire small bowel as well as the visualization of the mucosa in the proximal and distal small intestine. The combination of simethicone plus split dose PEG has been shown to be superior to an overnight fast alone in achieving satisfactory visualization of the small bowel for capsule endoscopy.

Polyethylene glycol 500ml taken 30 minutes after capsule ingestion resulted in improved image quality (p<0.01) and increased completion rates and decreased GGT. This may be due to the flushing and motility stimulation effects of the PEG solution after capsule ingestion.
Other studies have failed to show the benefit of bowel purgatives for capsule endoscopy preparation. Karagiannis et al compared 4L of PEG (3L the night before and 1L 3 hours before capsule ingestion) vs. clear liquids only 24 hours prior to capsule ingestion. Image quality, transit time and completion rates did not differ. Postgate et al compared four different bowel preparations and failed to show a significant difference in view quality among the groups.

A recent meta-analysis of 12 studies (six prospective, six retrospective) explored the role of bowel preparation and diagnostic yield. Pooled data showed that in comparison to clear liquids, purgative bowel cleansing before capsule endoscopy improves the small bowel visualization quality (p=0.005) and diagnostic yield (p=0.002), but did not affect completion rate.

Simethicone does improve mucosal visibility and is safe and well tolerated. The data on bowel purgatives is less clear, with conflicting data. Based on the meta-analysis, bowel purgatives seem to improve visual image quality and thus increase diagnostic yield. Further studies will be needed to help clarify if bowel purgatives should be routinely used in preparation for capsule endoscopy.

### Table 1. Comparison of Various Capsule Endoscopy Preparation Techniques

<table>
<thead>
<tr>
<th></th>
<th>GGT (min)</th>
<th>SBTT (min)</th>
<th>Passage to Cecum</th>
<th>Visibility</th>
</tr>
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<tbody>
<tr>
<td>Control</td>
<td>13</td>
<td>252</td>
<td>83%</td>
<td>NA</td>
</tr>
<tr>
<td>Right Position</td>
<td>14</td>
<td>248</td>
<td>73.2%</td>
<td>NA</td>
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<tr>
<td>Control</td>
<td>38.4</td>
<td>302.6</td>
<td>78%</td>
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<tr>
<td>Erythromycin</td>
<td>50.5</td>
<td>304.4</td>
<td>68%</td>
<td>No difference</td>
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<tr>
<td>Control</td>
<td>47.9</td>
<td>255.5</td>
<td>76%</td>
<td></td>
</tr>
<tr>
<td>Metoclopramide</td>
<td>30.8</td>
<td>230.9</td>
<td>97%</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>42.7</td>
<td>218.9</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>Lubiprostone</td>
<td>125.91</td>
<td>188.1</td>
<td>95%</td>
<td>No difference</td>
</tr>
<tr>
<td>Control</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>50% limited</td>
</tr>
<tr>
<td>Simethicone</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>20% limited</td>
</tr>
<tr>
<td>Simethicone</td>
<td>16.8</td>
<td>278</td>
<td>89%</td>
<td>37/44*</td>
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<tr>
<td>Metoclopramide</td>
<td>17.3</td>
<td>260</td>
<td>85%</td>
<td>38/44</td>
</tr>
<tr>
<td>Mag citrate + Senna</td>
<td>24.7</td>
<td>241</td>
<td>85%</td>
<td>37/44</td>
</tr>
<tr>
<td>Mag citrate + Senna + Metoclopramide</td>
<td>15.1</td>
<td>201</td>
<td>88%</td>
<td>40/44</td>
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</tbody>
</table>

NA - data are not available
*Scoring system - no difference

### Conclusion

To optimize imaging techniques for capsule endoscopy, the regimen and timing for bowel preparation must be considered. The ideal preparation should be well tolerated, safe, with minimal side effects and provide adequate cleansing. Since capsule endoscopy first entered the market, the ideal preparation has yet to be determined. The first colonoscopy was performed in 1969 and the ideal preparation is still being studied.

Several medications seem to be beneficial with minimal side effects. Simethicone 80 mg orally 20 minutes prior to capsule ingestion does improve mucosal visibility. Metoclopramide 10 mg orally given prior to capsule ingestion also decreases transit time. Studies have shown that improved GTT seems to be a more important factor in overall transit time than SBTT.
In a study reviewing the use of preparation and prokinetic adjuncts used in our practice, we found, in over 200 patients, that a full bowel preparation or the use of prokinetics (metoclopramide or tegaserod) improved the visualization of the distal bowel and the likelihood of a complete small bowel examination. We routinely use bowel purgative in conjunction with simethicone 80 mg orally and metoclopramide 10 mg orally 20 minutes prior to capsule ingestion.

Many patients undergoing capsule endoscopy for obscure gastrointestinal bleeding or suspected Crohn’s disease have already undergone colonoscopy and underwent a bowel purge. Some are reluctant to have another bowel preparation. We try to anticipate the need for capsule enteroscopy so it can be coordinated to follow a planned colonoscopy utilizing the same cleansing preparation. After the endoscopic procedure, clear liquids are advised and further purgative preparation is avoided.

The ideal interventions for optimal imaging are yet to be achieved. Simethicone and metoclopramide have purported superior mucosal visibility and decreased transit time. Data from our group supports the use of bowel preparation and we advise split-dose cleansing regimens.

References:


