

## Improved capsule endoscopy after bowel preparation CME

Ning Dai, MD, Christoph Gubler, MD, Peter Hengstler, MD, Christa Meyenberger, MD,  
Peter Bauerfeind, MD

Zurich, Switzerland; St. Gallen, Switzerland

**Background:** The diagnostic yield of capsule endoscopy depends on the quality of visualization of the small-bowel wall and complete passage through the small bowel. This study examined the effect of bowel preparation on the volume of intestinal content and on small-bowel transit.

**Methods:** Sixty-one consecutive patients (34 men, 27 women; mean age 56 years, range 17-88 years) were enrolled in the study. Although not randomized, 33 patients received a bowel preparation, and 28 had no preparation. Gastric emptying, small-bowel transit time, overall preparation assessment, and bowel-wall visualization were evaluated by 3 investigators who were unaware of whether the patient had undergone bowel preparation.

**Results:** Small-bowel transit time was significantly shorter in patients with bowel preparation (median 213 minutes: 95% CI[190, 267]) than in those without preparation (median 253 minutes: 95% CI[228, 307]) ( $p < 0.01$ ). The capsule reached the cecum in 97% of patients in the bowel-preparation group, compared with 76% in the nonpreparation group ( $p = 0.02$ ). Bowel preparation improved the quality of visualization significantly; this effect was more pronounced in the distal small bowel.

**Conclusions:** This study demonstrated that bowel preparation accelerates small-bowel capsule transit and leads to a higher rate of complete capsule endoscopy. Visualization of the small bowel was improved by bowel preparation. Bowel preparation before capsule endoscopy is recommended. (*Gastrointest Endosc* 2005;61:28-31.)

The development of capsule endoscopy (CE) has opened a new chapter in small-bowel examination.<sup>1-3</sup> CE has been used to investigate GI bleeding of obscure origin, polyposis syndromes, and inflammatory and infiltrative small-bowel disorders. Studies have found that CE has a higher diagnostic yield than barium contrast radiography of the small bowel and enteroscopy.<sup>4,5</sup> However, diagnostic yield may be limited by reduced visibility of the wall because of intestinal content and by incomplete small-bowel transit of the capsule. Some studies have found that bowel preparation results in higher-quality capsule images.<sup>6,7</sup> Despite this finding, bowel preparation as a standard before CE currently is not recommended. Slow transit may lead to incomplete examination of the small bowel. In a preliminary report, Gat et al.<sup>8</sup> claimed that colon preparation solutions may have a depressive effect on small-bowel motility and, therefore, increase small-bowel transit time (SBTT). Thus, the improvement in image quality obtained by bowel preparation may be counterbalanced by incomplete small-bowel transit.

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The aims of this study were to determine the effects of bowel preparation on SBTT to the ileocecal valve and the quality of capsule images.

### PATIENTS AND METHODS

Consecutive patients referred to two hospitals for CE over a period of 18 months were studied. In actual clinical practice, CE differs between the two hospitals with respect to bowel preparation. The study was nonrandomized: patients who had a bowel preparation (Group A) were recruited from the Department of Internal Medicine of the county hospital of St. Gallen, Switzerland; patients without bowel preparation (Group B) were recruited from the Department of Gastroenterology and Hepatology, University Hospital of Zurich, Zurich, Switzerland.

Patients in Group A received a standard colon preparation that consisted of a low-residue diet for 24 hours, fluid intake, and ingestion of 4 L polyethylene glycol-based electrolyte solution (3 L during the evening and 1 L 3 hours before CE). Group B fasted overnight for 12 hours before CE. No patient had a known neurologic or metabolic disorder that could affect small-bowel motility. No patient was taking medication affecting gut motility.

**TABLE 1. Patient characteristics**

	Group A*	Group B†	p Value
Male/female	17/16	18/11	.4
Age (y), mean (SD)	53.55 ± 16.80	55.93 ± 19.34	.8
Indication			
Bleeding	24	19	
Crohn's disease	2	1	
Abdominal pain	2	2	
Others	5	6	

SD, Standard deviation.

\*With bowel preparation.

†Without bowel preparation.

CE was performed with the M2A capsule (Given Imaging, Yögneam, Israel) according to manufacturer instructions. Informed consent was obtained from all patients. Gastric emptying time, SBTT, overall preparation assessment, and percentage of visualized bowel wall in each patient were determined independently by 3 investigators who were blinded as to whether the patient received bowel preparation. Criteria for evaluation of the CE studies were defined beforehand. Measurements of the gastric emptying time and SBTT were based on visualization of the capsule passing through the pylorus and the ileocecal valve, respectively. Visibility of the small intestine was determined by an overall assessment of the quality of small-bowel cleansing by using a 4-step scale: 1, large volume of residual ingested food or fecal material; 2, moderate volume of residual ingested food; 3, small volume of residual ingested food; 4, clear or colored liquid. Visibility also was assessed as the percentage of visualized bowel wall as determined during 10-minute video segments at 1-hour intervals after passage of the capsule through the pylorus: 1, less than 25%; 2, 25% to 49%; 3, 50% to 75%; and 4, greater than 75%.

### Statistical analysis

All data were analyzed statistically by using the computing environment "R".<sup>9</sup> Survival statistics were computed with the R add-on survival packages. Data are expressed as median. Differences in SBTT between the groups were compared by using survival models (Kaplan-Meier, Cox regression). Differences of the gastric emptying and overall preparation assessment were compared with the Non-parametric Wilcoxon test. The difference with respect to the capsule reaching the cecum was evaluated with the Fisher exact test. The unpaired exact Wilcoxon test was used to compare the percentage of bowel wall visualized. The Wilcoxon exact test and the chi-square test were used to compare age and gender, respectively, between the groups. A parametric survival

### Capsule Summary

#### What is already known on this topic

- Capsule enteroscopy has a higher diagnostic yield than barium radiography and push enteroscopy.
- Gastroparesis and slow intestinal transit with stasis of contents may reduce mucosal visibility.

#### What this study adds to our knowledge

- Use of PEG-based colon preparation before capsule endoscopy improves small bowel visualization and accelerates small bowel transit by about 15%, allowing the capsule to reach the cecum in about 20% more cases.

model was used to estimate age effects on main effects. A *p* value <0.05 was considered statistically significant.

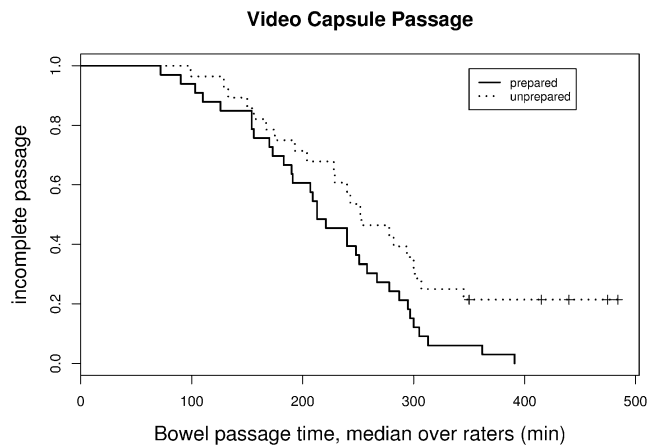
### RESULTS

A total of 65 consecutive patients underwent CE between March 2002 and September 2003. Four were excluded; 3 because of insufficient data from technical problems (2 data CDs not readable, 1 depleted battery). The third patient did not fast overnight, and massive amounts of residual food made assessment of the small-bowel impossible. The study, therefore, included 61 patients (34 men, 27 women; mean age 56 years, range 17-88 years). Without randomization, 33 patients received the bowel preparation (Group A) and 28 had no preparation (Group B). Baseline characteristics were similar between the groups (Table 1).

Gastric emptying time was not significantly different: Group A, median 13 minutes: 95% CI[10, 23 minutes] vs. Group B, median 14 minutes: 95% CI[10, 23 minutes]. SBTT was significantly shorter for patients in Group A compared with those in group B (median 213 minutes: 95% CI[190, 267 minutes] vs. median 253 minutes: 95% CI[228, 307 minutes], respectively; *p* < 0.01). Therefore, the capsule reached the cecum more often in patients in group A (32/33; 97%) compared with those in Group B (22/29; 76%) (*p* < 0.01; Fig. 1). For unprepared patients, the SBTT increased significantly with age; there was no similar increase in prepared patients. For patients in Group A, overall preparation assessment scores were significantly higher than those for Group B (3.04 [0.17] vs. 2.41 [0.12]; *p* < 0.01). The visibility of small-bowel wall decreased during passage of the capsule in both groups (Fig. 2). However, for patients in Group B, visibility was significantly decreased compared with those in Group A (*p* = 0.001).

### DISCUSSION

CE has been shown to be the most effective non-invasive method for evaluation of the small bowel, with



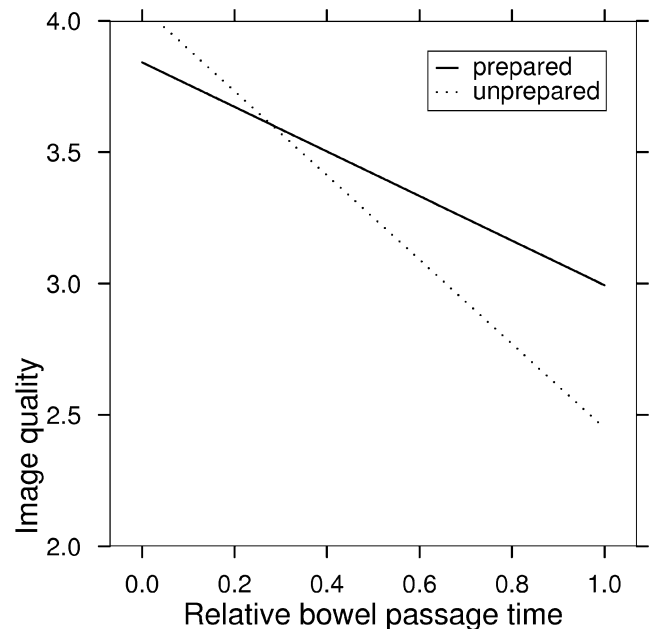
**Figure 1.** Kaplan-Meier plot of bowel transit time for prepared (*solid line*) and unprepared patients (*dotted line*). A step in the curve indicates that, for one patient in the group, the cecum was reached with a working battery. Censored cases (battery ceased to function before cecum observed) are shown with by an “+”. The y-axis represents the fraction of patients in whom the capsule has not reached the cecum. Bowel passage time was calculated as the median for 3 examiners.

a significantly higher diagnostic yield compared with push enteroscopy and conventional techniques.<sup>4,5</sup> It is safe, painless, well-tolerated, and has opened a new perspective in the diagnosis of recurrent GI bleeding of obscure origin, Crohn’s disease, small-bowel tumors, and polyps.<sup>3</sup>

Despite its obvious advantages, CE has some limitations. Image quality is not as good as that of flexible videoendoscopy.

Unlike the latter instruments, the intensity of the illumination provided by the capsule does not vary automatically with changing requirements. Moreover, a lesion cannot be washed or examined repeatedly. In some patients, CE fails to visualize the entire small bowel because of intestinal content.<sup>10</sup> During CE, progressive darkening of the images may be observed as the capsule moves toward the distal small bowel. This is probably because of the presence of bile and nonabsorbed food material. In patients prepared with a colonoscopy-type preparation, the images from the distal small intestine are significantly brighter, and the bowel contains less obscuring material. In addition, the image quality is improved.<sup>7</sup>

The present study evaluated the effect of bowel preparation on image quality and SBTT by taking advantage of differences in the performance of CE in two hospitals. Patients were not randomized to preparation vs. no preparation, but both study groups were comparable, and the CE readings were blindly analyzed by the same examiners according to predefined criteria. The results of the study show that bowel preparation improves image quality, especially in the distal small bowel. The diagnostic yield of CE is contingent upon several factors, including SBTT and image quality.<sup>7</sup> Because the capsule is transported passively through the GI tract, passage time



**Figure 2.** Visibility of small-bowel wall during passage of capsule. Image quality is rated as percentage of visualized wall: 1, <25%; 2, 25%-49%; 3, 50%-75%; 4, >75%. Relative bowel passage time was defined as 1 if the end of small bowel or end of recording was reached. *Dashed line*, group without preparation; *solid line*, group with preparation.

varies considerably, depending on bowel motility. However, the transmission time of the capsule is limited by the capacity of its battery. If the capsule is transported too slowly and does not reach the cecum, CE is incomplete. Incomplete CE has considerable implications: significant lesions may be missed or incorrectly localized, a second examination may be necessary (inconvenient for patients), and costs increase. Studies have found that in 28% to 50% of patients who prepare for CE by fasting alone, the capsule battery ceased to function before the device reached the cecum.<sup>7,11</sup> A similar observation was made in the present study: 24% of patients in the group without bowel preparation had an incomplete CE. Therefore, some investigators routinely administer prokinetic drugs for the examination.<sup>12</sup> However, the present study found that bowel preparation had an accelerating effect on small-bowel transit and was associated with a high rate (97%) of complete CE. This finding confirms that of Sgouros et al.<sup>13</sup> concerning the improvement of complete examination of the small bowel by bowel preparation but is contrary to the data of Gat et al.<sup>8</sup>

Some studies in animals and humans have shown that a full cecum causes intestinal flow to be seriously retarded in the ileum.<sup>14,15</sup> Colon cleansing has been stressed for enteroclysis as a means of accelerating passage of barium through the small bowel.<sup>16</sup> A polyethylene glycol-based electrolyte solution was used for bowel preparation in the present study. Basit et al.<sup>17</sup> found that polyethylene glycol significantly accelerated small-intestinal transit. This effect

is probably because of the fact that polyethylene glycol is not absorbed from the GI tract, and, thus, its osmotic effect within the intestine stimulates peristalsis and thereby hastens small-intestine transit. It, therefore, is reasonable that the decrease in SBTT with bowel preparation is caused by the empty cecum and the osmotic effect of the polyethylene glycol.

Although some studies of the effect of aging on small-bowel transit have found no age-related differences,<sup>18,19</sup> the present study found a trend toward a longer SBTT in older patients. This suggests that bowel preparation, by accelerating small-bowel transit, may be especially useful in older patients.

The main disadvantage of bowel preparation is that it is not well accepted by patients.<sup>20</sup> It frequently is considered the major source of discomfort by patients who undergo colonoscopy. However, CE is not a screening procedure. Thus, it usually is easier to motivate patients referred for CE to accept bowel preparation. In addition, CE is costly and time consuming and, therefore, should be performed under optimal conditions to obtain the best possible diagnostic yield.

The present study is limited by the fact that measurements of visibility were subjective; interobserver agreement was only fair (kappa statistic = 0.56). However, the absence of a true criterion standard, such as intraoperative endoscopy or double-balloon enteroscopy, makes it impossible to compare diagnostic yield with or without bowel preparation. Incomplete CE or poor visualization obviously reduces diagnostic yield. Whether acceleration of capsule transit also results in missed pathologic findings is unknown.

In conclusion, the results of the present study suggest that bowel preparation accelerates small-bowel emptying and results in a high rate of complete CE. With bowel preparation, visualization of the small intestine seems to be improved in the distal segments. Therefore, we recommend bowel preparation before CE.

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Current affiliations: Division of Gastroenterology, Sir Run Run Shaw Hospital, Clinical Research Institute, Zhejiang University, Zhejiang, China, Department of Internal Medicine, Gastroenterology and Hepatology, University Hospital of Zurich, Zurich, Switzerland, Department of Internal Medicine, Gastroenterology and Hepatology, Kantons Hospital of St. Gallen, St. Gallen, Switzerland.

Ning Dai and Christoph Gubler contributed equally to this work.

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Reprint requests: Peter Bauerfeind, MD, Department of Gastroenterology/Hepatology, University Hospital Zurich, Raemistrasse 100, 8091 Zurich, Switzerland.