



Effect of Oral Purgatives on Gastric and Small Bowel Transit Time in Capsule Endoscopy

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Abstract

Background: During ingestible capsule endoscopy, video images are recorded throughout the device's natural propulsion through the digestive system. Shortening the transit time of the wireless video capsule through the stomach and small bowel could reduce the time needed to read and analyze the resultant images, utilize more effectively the short life of the capsule battery (7 ± 1 hours) and make it possible to image the entire small bowel.

Objective: To measure gastric and small bowel transit times, with and without preparation, using capsule endoscopy.

Methods: Capsule transit times through the stomach, small bowel and colon were evaluated by analysis of the videos generated during the capsule's passage. The study group included 62 patients with small and large bowel pathologies (e.g., iron deficiency anemia, Crohn's disease). The patients were divided into three groups: prepared with polyethylene glycol (Group A, $n = 9$), prepared with sodium phosphate (Group B, $n = 13$), and with no preparation (Group C, $n = 40$).

Results: The gastric emptying times were 20.4 ± 15.2 minutes in group A, 55.7 ± 45.1 in group B, and 48.3 ± 28.7 in group C ($P = 0.01$). The capsule produced views of the cecum in only 49 of the 62 patients. The mean small bowel transit time for these 49 patients was 238.8 ± 82.1 minutes, making the mean times for the groups (A,B,C) 148.9 ± 32.6 , 289.4 ± 77.2 and 249.3 ± 73.9 minutes respectively ($P = 0.0001$).

Conclusion: Compared to both SP and no preparation, preparation of the colon with PEG significantly shortened the transit time of the capsule through the stomach and small bowel.

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For Editorial see page 560

The factors involved in both emptying the stomach and small bowel motility include the composition of the food and fluid in the gastrointestinal tract. The transit time differs in the fed or fasted states. Existing diagnostic tests are inadequate for evaluating intestinal motility and are mainly regarded as research tools [1].

The recently developed Given Diagnostic Imaging System (M2A Capsule, Given Imaging Ltd, Yoqneam, Israel) is a new modality for evaluating the pathology of the small bowel [2-4]. This revolutionary technology allows direct visualization of the gastrointestinal tract while providing information on transit time in the digestive tract. From the initial M2A Capsule experience we learned that in

approximately 10% of the study population the capsule did not reach the cecum (the view, not the capsule), for several reasons: short battery life, the capsule remaining in the stomach more than 60 minutes, and others.

Colonic preparation was required for subjects needing gastrointestinal evaluation (e.g., patients with unexplained iron deficiency anemia) who underwent colonoscopic examination on the same day. We compared standard colonoscopy with wireless colonoscopy (unpublished data). Also, since our initial experience with the capsule demonstrated that the distal part of the ileum is not clean enough for visualization, we therefore decided that two groups be given colonic preparation. Another problem is that the short battery life of the capsule (approximately 7 hours) may not be sufficient to image the entire small bowel. We hypothesized that some colonic preparation might accelerate the movement of the capsule and also provide a better view of the entire small bowel.

There is a lack of data on the effect of colonic preparation on the stomach and the small bowel. Recently, Basit et al. [5] demonstrated that polyethylene glycol 400 has a marked accelerating effect on small intestinal liquid transit, which in turn has implications with PEG 400. Also sodium phosphate effectively shortens small bowel transit time [6]. On the other hand, Sood et al. [7] found no significant difference in the mean transit time in the stomach, duodenum and small bowel between PEG 400 and plain water. For these reasons we decided to evaluate the gastric and small bowel transit times of the M2A Capsule with and without colonic preparation.

Patients and Methods

Study population

The current retrospective study was carried out from November 2000 until March 2002, and represents our initial experience with the M2A Capsule in diagnosing small bowel disease in patients who had previously undergone conventional investigations in which no characteristic abnormalities were detected.

The 62 patients participating in the study were divided into three groups: Groups A and B underwent complete colon preparation and were required to have a low residual diet for 48 hours before swallowing the capsule. Group A comprised nine patients prepared with 3 L of polyethylene-glycol divided into two doses: 1.5 L 12 hours before swallowing the capsule and 1.5 L one hour after swallowing the capsule. Group B comprised 13 patients prepared

SP = sodium phosphate
PEG = polyethylene glycol

with 90 ml of sodium phosphate divided into two doses: 45 ml 12 hours before swallowing the capsule and 45 ml one hour after swallowing the capsule. Group C included 40 patients without colonic preparation. All patients fasted for 12 hours before swallowing the capsule and were allowed to drink water 2 hours after swallowing the capsule. The group C patients ate a light meal 3 hours after swallowing the capsule. The patients in groups A and B (with the colonic preparation) fasted for a further 8 hours at least because they were then scheduled for colonoscopy. All the participants found eligible for the study were 18–75 years of age, suffering from unexplained gastrointestinal tract bleeding or suspected disease of the small bowel of an unclear nature. Each patient had a small bowel X-ray. Excluded from the study were pregnant women, diabetics, those in whom there was a suspicion of intestinal obstruction and those who had undergone major surgery.

The study was conducted in one medical center (Hillel Yaffe Medical Center) [Table 1]. Of the 62 patients, 32 males and 30 females (mean age 49.1 years), most had undergone total colonoscopy, gastroscopy, and small bowel X-ray series before entering the study, some more than once. All patients signed an informed consent agreement as approved by the local and governmental Helsinki and ethical committees.

Wireless capsule

After an overnight fast of 12 hours the patients ingested the wireless video capsule (Given M2A Capsule), and an array of 8 sensors was attached to the abdominal wall and a recorder with a battery placed in a belt worn around the waist. After ingesting the capsule with a small amount of water, patients were free to go about their normal activities. Seven to eight hours after ingestion the recorder was disconnected and the sensors were removed. The recorded digital information was downloaded into the computer and images from the stomach and all along the small bowel were analyzed, using the proprietary RAPID software. Patients were asked to look for the capsule in the feces. All patients were contacted 1 month after completing the study for a late complication survey.

The transit time from the first view of the gastric mucosa up to the pyloric region, and small bowel transit time were calculated from the first view of the duodenum up to the ileo-cecal regions. Those cases without views of the target organ were regarded as not having reached the target area. The results from the video produced from the data recorded by each capsule were reviewed independently by two experts (Z.F. and E.S.) who were blinded to the clinical data. There was 100% agreement between the two readers.

Table 1. Characteristics of the study group

	With colonic preparation		Without colonic preparation Group C
	Group A (PEG)	Group B (SP)	
No. of patients	9	13	40
Mean age (yrs)	40.0 ± 10.1	52.3 ± 14.1	49.1 ± 19.2
Gender (M/F)	4/5	9/4	19/21
Pathologic finding (no. of patients)	2	2	13
The capsule did not reach the cecum (no. of patients)	2	1	9

Statistical analysis

A comparison between the three groups (not prepared and two types of preparation) with regard to demographic and clinical factors was performed using analysis of variance, Kruskal-Wallis and Fisher's exact tests as applicable. The Gabriel and Games-Howell multiple comparison tests were used to determine significant differences between pairs of groups [8,9]. The statistical significance level was set at 0.05 and the SPSS Windows software, version 10.0, was used for the analysis.

Results

The 32 male and 30 female patients (mean age 48.6 years, range 18–75) were divided into three groups: Group A with 4 males and 5 females, mean age 40.0 ± 10.1 years; Group B with 9 males and 4 females, mean age 52.3 ± 14.1; and group C with 19 males and 21 females, mean age 49.1 ± 19.2 years. There were no significant age and gender differences between the three groups [Table 2]. Pathologic findings were noted in 2 of the 9 patients in group A, in 2 of 13 in group B, and in 13 of 40 in group C. These findings were as follows: arteriovenous malformation and Crohn's disease in group A; 2 cases of Crohn's disease in group B; and 5 cases of arteriovenous malformation, 3 cases of Crohn's, 2 cases each of small bowel polyps and erosions and one case of celiac disease in group C. In only one case (group A) did the capsule remain in the stomach (496 min), and in 13 (20.9%) cases the capsule did not reach the cecum – 2 of 9 patients (22.2%) in group A, 2 of 13 (15.4%) in group B and 9 of 40 (22.5%) in group C. Age, gender, pathologic findings or normal examinations had no influence on the resultant transit times.

The mean transit time of the capsule in the stomach was 59.4 ± 82.4 minutes. In only 17 of the 62 patients was the gastric emptying time more than 60 minutes (60 min was used arbitrarily as the cutoff), none in group A, 4 (30.7%) in group B, and 13 (32.5%) patients in group C ($P = 0.01$).

The mean gastric emptying times were: 20.4 ± 15.2, 55.7 ± 45.1 and 48.3 ± 28.7 minutes in group A, B and C respectively ($P = 0.01$). The mean small bowel transit time in 49 patients in whom the capsule reached the cecum was 238.8 ± 82.1 minutes, and in the three groups 148.9 ± 32.6, 289.4 ± 77.2 and 249.3 ± 73.9 respectively ($P = 0.0001$).

A comparison of the combined A and B groups (with colonic preparation) to group C (no preparation) showed no significant

Table 2. Comparison of the transit time between the three groups

	With colonic preparation		Without colonic preparation Group C
	Group A (PEG)	Group B (SP)	
No. of patients	9	13	40
Mean age (yrs)	40.0 ± 10.1	52.3 ± 14.1	49.1 ± 19.2
Gender (M/F)	4/5	9/4	19/21
Mean gastric emptying (min)	20.4 ± 15.2*	55.7 ± 45.1	48.3 ± 28.7
Mean small bowel emptying (min)	148.9 ± 32.6**	289.4 ± 77.2	249.3 ± 73.9

* $P = 0.01$, ** $P = 0.0001$

Table 3. Comparison of transit time with or without colonic preparation

	With colonic preparation	Without colonic preparation
	Group A and B (PEG or SP)	Group C
No. of patients	22	40
Mean age (yrs)	47.7 ± 13.9	49.1 ± 19.2
Gender (M/F)	13/9	19/21
Mean gastric emptying (min)	41.3 ± 38.7	48.3 ± 28.7
Mean small bowel emptying (min)	222.8 ± 93.0	249.3 ± 73.9

No significant difference between the groups

differences. The mean gastric emptying times were 41.3 ± 38.7, 48.3 ± 28.7 minutes respectively, and mean small bowel transit times 222.8 ± 93.0, 249.3 ± 73.9 minutes respectively [Table 3]. In most of the prepared patients the capsule remained in the cecum for a long period, until the battery died. There was partial imaging of the colon in only two patients: in one we were able to view a few diverticuloses in the left colon and the other patient presented a normal "capsule colonoscopy." All patients ingested the capsule smoothly and with no side effects.

Discussion

The Given Diagnostic Imaging System (M2A™ Capsule) [2–4] is a novel system designed to aid the gastroenterologist in diagnosing small bowel diseases and provide information on transit time in the digestive tract.

The ingestible capsule records video images during natural propulsion through the digestive system. In preliminary results obtained from clinical studies performed to evaluate the safety and effectiveness of the system as a tool in aiding the diagnosis of small bowel diseases, the M2A Capsule provided good views from mouth to colon and successfully-imaged small bowel pathologies.

The usual tests for evaluating gastric emptying time and small bowel transit time can be determined by different techniques: the radio-isotopic technique considered the "gold standard," radiographic examination, ultrasound, etc. On average, in healthy subjects, stomach emptying time is 1–3 hours and small bowel transit time 4 hours [10]. The revolutionary technology with the capsule gives us the opportunity for direct visualization of the gastrointestinal tract while providing information on transit time in the digestive tract. To the best of our knowledge, this is the first time that this technique was used to measure transit time in the digestive tract and to compare different colonic preparations.

PEG 400 reduced the transit time in the small bowel by 35% [5], and rapid emptying from the stomach was also observed in our study. However, Sood et al. [7] showed that there was no significant difference in the effect on mean transit time of PEG 400 as compared to plain water on the stomach, duodenum and small bowel. Sodium phosphate shortens the transit time of the small bowel [6], but in our study SP had no effect on gastric and small bowel transit time. Osmotic laxative (MgSo4) also accelerates intestinal transit time in both the fasting and fed state [11].

The clinical significance of our small study is that by shortening the gastric and small bowel transit time by using PEG, it takes less

time to read the video and we can be confident that we have fully utilized the short life of the battery to obtain maximum images of the small bowel.

Recently, Graff et al. [12] investigated the effects of age and gender on gastric and small intestinal mean transit times using 111 Indium-labeled water and 99m Technetium-labeled omelet. Aging was shown to accelerate the gastric and small intestinal transit time significantly and the mean transit times were significantly longer in women. However, in our study, as in Bennink's observation [13], age and gender had no effect on transit time; although in our group the patients prepared with PEG were younger than the other groups, there was no statistical significance. The pathologic findings had no significant effect on the transit time.

Conclusion

We report, for the first time, the use of the capsule to measure gastric emptying time and small bowel transit time. The use of PEG in the colon preparation significantly shortened the transit time of the capsule through the stomach and small bowel as compared to both SP and no colonic preparation.

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