Evaluation of bowel preparation before colonoscopy by ultrasonographic monitoring of colonic fecal retention: a case series

Masaru Matsumoto¹, Masayuki Fujioka², Toshihiko Okada^{2,3}, Yutaka Naka^{2,3}, Ayumi Amemiya⁴, Erina Matsushima⁴, Nao Tamai^{1,6}, Yuka Miura¹, Gojiro Nakagami^{5,6}, Hiromi Sanada^{5,6}

¹Department of Imaging Nursing Science, Graduate School of Medicine, The University of Tokyo, Tokyo, ²Katsuragi Hospital, Osaka, ³2nd department of Internal medicine, Osaka Medical College, Osaka, ⁴Department of Nursing Physiology, Graduate School of Nursing, Chiba University, Chiba, ⁵Department of Gerontological Nursing / Wound Care Management, Graduate School of Medicine, The University of Tokyo, Tokyo, ⁶Global Nursing Research Center, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan.

Abstract

Aims: While bowel preparation for colonoscopy is the key to successful examination, taking laxatives and showing stools to others causes both physical and mental distress to the patient. Thus, an alternative method to evaluation bowel preparation is necessary. In the current study, we studied the colonic fecal retention by ultrasonography (US) and examined the US finding which reflected completion of BP. **Material and methods:** The subjects were outpatients who underwent colonoscopy. This report summarizes the ultrasonographic images of patients who underwent multiple US examinations for all five sites of the colon just before, during, and immediately after bowel preparation. According to the standard protocol, the patients took 2 L of polyethylene glycol-ascorbic acid as a laxative, which was discontinued when the nurse visually judged the stool to be clear. **Results:** Seven patients in their 50s–80s, none of whom were unable to complete a colonoscopy due to residual feces were included in study. Following bowel preparation, the US images showed anechoic areas with haustration in four or all five areas of the colon. Three of the seven patients received low-dose laxatives (1.1–1.2 L); all three had watery stools in three or more colon areas and none of them were constipated at the time of taking 1 L of laxatives. **Conclusions:** Completion of bowel preparation can be assessed by the observation of anechoic areas with haustration in multiple colonic sites by ultrasonography.

Keywords: ultrasonography; colonoscopy; fecal retention; laxative; bowel preparation

Introduction

Colonoscopy is the gold standard procedure for the diagnosis and treatment of colon diseases [1]. Bowel preparation (BP) is critical for high quality colonoscopy, as it is closely related to the quality of the procedure [2].

Previous studies have indicated that up to one-quarter of colonoscopies may be conducted with inadequate BP [3,4], and suboptimal BP is thought to occur in up to 20% of all colonoscopy procedures [5,6]. Insufficient BP increases the requirement for repeat examinations, which ultimately increases healthcare costs and patient burden [7,8]. Therefore, it is necessary to be able to evaluate BP appropriately, perform bowel cleansing correctly and properly complete BP.

BP is also associated with patient distress. First, a nurse usually determines the degree of bowel cleansing from the color and properties of the stool discharged by a patient [9]. In other words, the patient's excretion is seen by others, which may cause mental distress to patients. Therefore, it is important to determine another method to directly visualize the condition of the colon and

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Corresponding author: Hiromi Sanada, PhD, RN, WOCN, FAAN
Global Nursing Research Center, Graduate
School of Medicine, The University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo,
113-0033, Japan
Phone: (+81) 3-5841-3419
Fax: (+81) 3-5841-3442
E-mail: hsanada-tky@umin.ac.jp

manage bowel cleansing. Second, patients who undergo colonoscopy usually have to take a considerable amount of laxatives, often around 2L [10], and taking more laxatives than is necessary may cause physical distress. The laxative requirement and BP before colonoscopy should depend on the individual's colonic condition, so as to minimize physical distress. Indeed, it has been reported that the quality of BP is different between patients with and without constipation [11]. Therefore, it is important to develop a visualization tool that can directly and non-invasively monitor the state of the patient's colon and manage BP.

Previous studies have reported that US can visualize fecal retention in the colon and some studies have shown that stool retention can be assessed by the presence of a crescent-shaped hyperechoic area [12–16]. The aim of our study was to evaluate by US the colonic fecal retention in patients prepared for colonoscopy and to establish which US findings reflect the completion of BP.

Material and methods

This study, conducted in May 2019, was approved by the Ethical Committee of the University of Tokyo (No. 2020017NI). The institutional review board approved this case series and waived the need for informed consent from patients; all participants were given the opportunity to opt-out by the poster and on the web site regarding the use of data.

Participants and setting

The study subjects were outpatients who underwent colonoscopy in a Japanese acute care hospital. In this hospital, patients with constipation or those who did not want to take large doses of laxatives were often checked for fecal retention using US during BP. A maximum of three US examinations were conducted (fig 1) and the BP was considered to be finished when the stool was judged to be transparent by a nurse using photographic examples of rectal effluent [9].

Bowel preparation

BP was standardized as follows: The day before the examination, intakes were restricted to a light, low-fiber breakfast and after midday, only clear liquids were allowed. In addition, the evening before the examination, patients were required to take three Sennoside tablets. On the day of the examination, patients were hospitalized in the outpatient unit for the second phase of colon preparation with 2L polyethylene glycol-ascorbic acid (MoviPrep®, EA Pharma Co., Ltd., Tokyo, Japan). Nurses confirmed the stool color and properties in the toilet when the patient determined that the stool became a clear liquid.

Fig 1. Ultrasonography during bowel preparation. A maximum of three ultrasonographies (US) were conducted. Bowel preparation was considered to be finished when the nurse confirmed a clear stool in the toilet; the total oral dose at that time was recorded.

Ultrasound

US of the rectum, ascending, transverse, descending and sigmoid colon was performed using ultrasound systems (Aplio 500 and Aplio a450 systems, Canon Medical System Corporation, Otawara, Tochigi, Japan) with a curved-array probe (1.5–6.0 MHz). The resulting images were supplemented by transverse and longitudinal sonographic scans. All sonographic procedures were performed by a certified sonographer specializing in the abdominal region, with 20 years of experience. The sonographer was blinded to the results of the assessment for stool color and properties.

With reference to previous studies [12,17], we defined the US levels of fecal retention as follows: a weak/strong fecal retention finding was indicated by a marginally highly echoic colonic lumen and posterior echo behind the colon on transverse images and a flattened outer boundary wall and highly echoic colon wall on longitudinal images; a watery stool retention was indicated by an anechoic area on transverse images and an anechoic area with haustration on longitudinal images [18]. The US finding of multiple reflections was determined to be gas retention. The typical ultrasonographic findings related to fecal retention are shown in figure 2 and 3.

Colonoscopy

Several trained gastroenterologists performed the colonoscopies. A colonoscopy was defined as incomplete when there was no visualization of anatomic features, such as the ileocecal valve, appendiceal orifice, ileocolonic anastomosis, or terminal ileum, as previously described [19].

Results

A total of seven patients (five men, 71.4%) were included in study and their characteristics are summarized in Table I. The patients' age at presentation ranged from 50 to 83 years, with a median age of 69 years. Six patients (85.7%) took Sennoside (12 mg; 3 tablets after dinner

Fig 2. Ultrasonographic findings related to fecal retention: a) colonic fecal retention in a 69-year-old male patient. A longitudinal ultrasonographic image showing hyperechoic areas and acoustic shadow with haustrations on the wall of the descending colon (arrows); b) colonic gas in a 59-year-old male patient. A longitudinal ultrasonographic image showing multiple reflections on the wall of the descending colon (arrow); c) watery stool in a 83-year-old male patient. A longitudinal ultrasonographic image showing anechoic areas, indicating water retention in the descending colon (arrows).

and 3 tablets before sleep) prescribed by their doctors. Three patients (42.9%) had daily bowel movements, with normal stool properties and amounts. On the morning of the colonoscopy, six of the seven patients (85.7%) had a bowel movement. Time from the start of 2 L polyethylene glycol-ascorbic acid to taking 1 L ranged 67 to 80 minutes, with a median time of 73 minutes. Time from the start of 2 L polyethylene glycol-ascorbic acid to the completion of bowel preparation ranged 91 to 155 minutes, with a median time of 121 minutes.

The change in ultrasonographic findings, total dose of laxative and degree of bowel cleanliness are shown in Table II. None of the patients were determined to have

an incomplete colonoscopy. The ultrasound images at the completion of BP showed anechoic areas with haustration in four, or all five areas of the colon. Three patients (Cases 1–3) received low-dose laxatives (1.1 to 1.2 L); the US images of these three patients showed anechoic findings indicating watery stool retention in three or more colon areas. None of the three patients were constipated at the time of consuming 1 L of laxatives.

Discussions

This study firstly showed colonic US imaging at BP before colonoscopy. The US results demonstrated that four or all five areas of the colon showed anechoic areas with haustration and the lack of hyperechoic area in the stool indicated that BP had been completed. Patients who received 1 L of laxative, had watery stools in three or more of the colon sites and no fecal retention in any of these sites, received a smaller dose of laxatives. Therefore, it is possible to determine by US that BP has been completed.

The US images at the completion of BP showed anechoic areas with haustration in four or all five areas of the colon, which indicated that BP was complete. As a practical point for the future, endoscopy nurses should be able to observe the colon with a hand-held US device to assess BP completion without causing the patient the mental distress of having to have their stool observed. In the same way, that the effectiveness of hand-held US observation and treatment of constipation has been shown [20,21], the effectiveness of US observation by endoscopy nurses needs to be studied in the near future. There will also be a need to develop a US education program for nurses to observe colonic fecal retention [22]. In addition, non-invasive assessment of BP with US may help to determine the timing of BP completion for each patient and minimize the physical distress caused by laxatives. Indeed, constipated patients have been reported

Fig 3. Time course of ultrasonographic images at colon in a 69-year-old male patient (ID1). Longitudinal ultrasonographic images showing anechoic areas, indicating water retention in the descending colon (arrows). The stool was judged to be transparent by the nurse, and the patient finished bowel preparation after taking 1.1 L of laxative.

Table I. Patients characteristics, bowel preparation and defecation status.

ID	Age	Sex	BMI (kg/m ²)	Primary disease	Laxative until the day before	Defecation status		Bowel preparation	
						Usual	Morning of colonoscopy day	TTT 1L (min)	TTC (min)
1	69	M	19.3	HT, hyperlipidemia	Sennoside 12 mg*	Bowel movement: 3 times/week Stool: properties: normal Stool amount: normal	1 soft stool	67	121
2	83	M	31.0	HT, diabetes, constipation	Sennoside 12 mg*	Bowel movement: 2-3 times/week Stool: properties: normal or hard Stool amount: normal	4 soft or watery stools	75	155
3	51	M	26.6	Anal polyp, hernia	Sennoside 12 mg*	Bowel movement: 7 times/week Stool: properties: normal Stool amount: normal	3 soft stools	73	91
4	50	F	41.7	HT, diabetes, reflux esophagitis	Sennoside 12 mg*	Bowel movement: 7 times/week Stool: properties: normal Stool amount: normal	1 soft stool	80	121
5	71	F	21.7	Bronchial asthma, bowel obstruction	None	Bowel movement: 7 times/week Stool: properties: soft Stool amount: normal	3 soft stools	72	155
6	59	M	27.2	Colon polyps, esophagitis	Sennoside 12 mg*	Bowel movement: 7 times/week Stool: properties: normal Stool amount: normal	3 soft stools	68	124
7	69	M	26.6	Chronic gastritis, constipation	Sennoside 12 mg*	Bowel movement: 2 times/week Stool: properties: normal Stool amount: normal	None	no data	105

BMI: body mass index, TTT: time to take, TTC: time to completion, tb: tablets, HT: hypertension; *: 3 tb after dinner and 3 tb before sleep

Table II. Change of colonic contents based on ultrasonographic findings, total dose of laxative and degree of bowel cleanliness.

ID	Site	Ultrasonographic findings			Total dose of laxative
		Baseline	When taking 1 L of laxative	At the end of bowel preparation	
1	AC	+	watery stool	watery stool	1.1L
	TC	+	watery stool	watery stool	
	DC	-	watery stool	watery stool	
	SC	watery stool	watery stool	watery stool	
	R	watery stool	watery stool	watery stool	
2	AC	+	watery stool	watery stool	1.2 L
	TC	+	watery stool	watery stool	
	DC	-	watery stool	watery stool	
	SC	-	watery stool	watery stool	
	R	-	-	watery stool	
3	AC	-	watery stool	watery stool	1.2 L
	TC	-	watery stool	watery stool	
	DC	-	watery stool	watery stool	
	SC	gas	-	watery stool	
	R	+	-	-	
4	AC	+	+	watery stool	1.4L
	TC	-	watery stool	watery stool	
	DC	-	watery stool	watery stool	
	SC	-	watery stool	watery stool	
	R	-	-	watery stool	
5	AC	watery stool	watery stool	watery stool	1.5 L
	TC	watery stool	watery stool	watery stool	
	DC	+	watery stool	watery stool	
	SC	gas	watery stool	watery stool	
	R	-	+	watery stool	
6	AC	watery stool	watery stool	watery stool	1.6L
	TC	-	watery stool	watery stool	
	DC	gas	-	watery stool	
	SC	+	gas	watery stool	
	R	-	-	watery stool	
7	AC	+	no data	watery stool	2.0 L
	TC	+	no data	watery stool	
	DC	+	no data	watery stool	
	SC	+	no data	watery stool	
	R	-	no data	-	

AC: Ascending colon, TC: Transverse colon, DC: Descending colon, SC: Sigmoid colon, R: Rectum, +: Hyperechoic finding indicating fecal retention, -: No specific finding

to have less effective BP than non-constipated patients [11,18] and in these cases, observation-based, individualized support for BP is required before colonoscopy. In the cases IDs 1, 2 and 3, all received low doses of laxatives (1.1–1.2 L); these three patients had watery stools in three or more colonic areas and no fecal retention was observed in any of these cases after 1 L of laxative. ID7 usually defecated twice a week, which was the least frequent of the participants in this study. Although data are not available for 1 L of laxatives, patients with constipation may need to take more laxatives than those without

symptoms. It will be necessary to investigate whether evaluation of BP using US can reduce the amount of laxatives taken by patients.

The present study has some limitations. Because this study was based on the assumption that polyethylene glycol was taken internally, we did not consider the use of sodium phosphate or sodium picosulfate with magnesium citrate. Furthermore, the quality of BP was not assessed from endoscopic images [23]. Future studies will need to investigate the relationship between US images and endoscopic images.

Conclusions. Our results demonstrate that completion of BP can be assessed by observing the anechoic area with haustration observed in multiple colonic sites by US.

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