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Elemental Diet as Preparation for Colonoscopy in Inflammatory Bowel Disease

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ABSTRACT

Objective : To investigate the usefulness of an elemental diet (ED) as a bowel preparation regimen for colonoscopy in inflammatory bowel disease (IBD).

Material and Methods : One day before colonoscopy, patients with IBD received 1,200 ml of an ED in place of the regular, conventional low-fiber diet in the preparatory regimen. Polyethylene glycol (PEG) lavage solution was used for colonic cleansing, symptoms were assessed, and a physical examination was performed. The total amount of PEG solution used, degree of colonic cleansing achieved, and patient acceptance were evaluated.

Results : The subjects were 21 patients with ulcerative colitis and 7 patients with Crohn's disease. The regimen using an ED required significantly less PEG (mean PEG volume, 1,373±393 mL ; $p<0.001$) than did previous colonoscopy using the conventional preparatory regimen. Acceptable amounts of residual stool level were found in 96% of cases. Approximately 80% of patients found the modified regimen easier than the conventional one, and 72% preferred the modified regimen for their next colonoscopy ($p<0.001$).

Conclusion : Bowel preparation with an ED significantly reduces PEG volume for gut lavage prior to colonoscopy and is effective, safe, and acceptable for patients with IBD.

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Key words : cathartics, colonoscopy, food formulated, inflammatory bowel diseases, patient satisfaction

INTRODUCTION

Inflammatory bowel disease (IBD) is a general term for chronic inflammatory conditions occurring mainly in the gastrointestinal tract, and common forms of IBD include ulcerative colitis (UC) and Crohn's disease (CD)[1-3]. The number of patients with IBD is increasing[4]. According to data published by the Japanese Ministry of Health, Labour and Welfare, the numbers of patients in Japan with UC and CD were 113,306 and 30,891, respectively, in 2009 and are increasing annually by approximately 8,000 and 1,500, respectively. As the number of patients with IBD increases, colonoscopy must be performed with increasing frequency for the diagnosis, treatment, and surveillance of IBD. For example, colonoscopy is essential for evaluating mucosal healing in patients with IBD and, in patients with UC in particular, colonoscopy is frequently used to assess disease activity and to monitor patients for cancer and dysplasia[5-7].

For successful coloscopic observation, achieving the highest possible level of colonic cleansing is important.

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However, bowel preparation is often insufficient because high-volume gut lavage is often not achieved. An orally administered polyethylene glycol (PEG) lavage solution is an effective and commonly used pretreatment for colonoscopy, but many patients find it difficult to tolerate because of its taste and the large quantity required (minimum volume of 2,000 mL). In addition, even the conventional PEG bowel preparation regimen often adversely affects IBD lesions and can exacerbate inflammation[8]. Therefore, bowel preparation regimens have been created specifically for patients with IBD. However, selecting a regimen is difficult, and regimens are often modified depending on the condition of individual patients. Whichever regimen is selected for bowel preparation, it must achieve good colonic cleansing, must be acceptable to patients, and must be at least as safe as the conventional regimen. A bowel preparation regimen that can satisfy the above requirements is, therefore, greatly desired.

Elemental diets (EDs) are diets containing almost all amino acids and oligopeptides as a nitrogen source and also provide calories. They are low in fat and can be easily digested and directly absorbed in the small intestine. An appropriate oral dose is reportedly effective for inducing and maintaining remission in patients with CD[9-11]. Furthermore, EDs do not leave a residue during digestion and absorption. Because residue in the colon often interferes with colonoscopic observation, an ED regimen would be useful in bowel preparation for colonoscopy in patients with IBD.

In this study, we examined whether the required PEG dose on the day of colonoscopy could be reduced by using an ED instead of a conventional low-fiber regimen 1 day before colonoscopy in patients with UC and CD. The effectiveness, safety, and patient acceptance of this modified bowel preparation regimen were examined, and its efficacy in the colonoscopy of patients with IBD was evaluated.

MATERIAL AND METHODS

This study was approved by The Jikei University School of Medicine Ethics Committee on September 6, 2010 (Registration number : 21-110 5688). After sufficient information for the study was provided, informed consent was obtained from all patients. The study was performed from October 2010 through September 2011 in accordance with the Declaration of Helsinki of 1975, as revised in 1983. Inclusion criteria were having clinical IBD in remission for more than 1 year, undergoing surveillance colonoscopy within 1 year of receiving conventional pretreatment for colonoscopy, and having no active lesions or change in the severity of IBD on previous colonoscopic observation. Exclusion criteria are shown in Table 1.

Table 1. Exclusion criteria

1. Informed consent not provided
2. Age <13 or >75 years
3. Suspected IBD with extremely severe stenosis or obstruction for which pretreatment with bowel cleansing agents, such as PEG solution, is contraindicated
4. Use of PEG solution is contraindicated : in particular, extremely active IBD, such as toxic megacolon
5. Severe kidney, heart, or liver disease and diabetes
6. Pregnant or lactating
7. Judged to be unsuitable for inclusion by the principal investigator physician or research associate physician
8. Having an active lesion or change in degree of IBD from previous colonoscopic observation

On the day before colonoscopy, patients were allowed to ingest only 1,200 mL (1,200 kcal) of an ED (Elental®, Ajinomoto Pharmaceuticals Co., Ltd., Tokyo, Japan ; 4 packs per day, each pack containing 300 mL (300 kcal) of ED). No instructions were given regarding the timing of ingestion of each pack. Patients chose a flavor that was easy for them to drink when they were provided with the study information, and the chosen flavor was added to the ED before ingestion. Patients were allowed to drink water and take oral medications. When patients could not drink the entire 1,200 mL of ED, they were asked to drink as much as possible and to record the amount. Sodium picosulfate (75 mg ; 0.75% Laxoberon solution 10 mL®, Teijin Pharma Ltd. Tokyo, Japan) was administered the night before colonoscopy, as in the conventional bowel preparation regimen.

On the day of colonoscopy, at least 1,000 mL of PEG solution (Niflec®, Ajinomoto Pharmaceuticals Co., Ltd.) was orally administered. The consistency, color, and residue of stool specimens were then checked. Colonoscopy was performed only when the stool specimen was clear, colorless, and watery, and additional volumes of PEG were given until this state was achieved (Table 2). Patients with such symptoms as abdominal pain were examined to prevent a procedural accident, and bowel preparation was continued or terminated according to the findings. All endoscopists,

Table 2. The modified bowel preparation regimen for colonoscopy

Day before colonoscopy	Day of colonoscopy
1. Oral administration of 1,200 mL of an elemental diet (300 ml/pack × 4 packs). Water and oral medication, but no solids, were allowed. 2. Oral administration of 75 mg sodium picosulfate at 9 pm.	1. Oral administration of 1,000 mL of PEG lavage solution at a steady rate over 2 hours. 2. Additional oral administration of PEG lavage solution until stool specimens become clear, colorless, and watery.

Table 3. Three-point rating system of colonic cleansing

1. Residual stool
Negligible, enabling satisfactory inspection
Low, enabling acceptable inspection after removal by aspiration and washing
Considerable, obstructing inspection
2. Residues
Negligible, enabling satisfactory inspection
Low, enabling acceptable inspection after removal by aspiration and washing
Considerable, obstructing inspection
3. Residual colonic fluid
Almost clear or transparent but slightly yellowish
Generally slightly opaque
Considerable, obstructing inspection

who had performed coloscopy at least 1,000 times and for more than 5 years, were blinded to patient participation.

Assessment of the effectiveness of bowel preparation by gut lavage

The physician who performed the colonoscopy assessed the effectiveness of bowel preparation by gut lavage with a 3-point rating system of colonic cleansing on the basis of residual stool, residues, and residual colonic fluid (Table 3).

Assessment of patient acceptance

Each patient completed a questionnaire after colonoscopy to assess the total dose of ED, impression after ED intake, impression of the new bowel preparation regimen using the ED (in comparison with the conventional bowel preparation regimen), and preferred bowel preparation regimen for the next colonoscopy. The PEG dose and duration of administration were also assessed.

Statistical analysis

Wilcoxon signed-rank tests were performed to compare the amount of PEG solution administered in the conventional regimen with that administered in the present regimen, and Spearman's rank correlation coefficients were used to analyze the amount of PEG and the time needed for bowel preparation to evaluate the preferred bowel preparation regimen for the next colonoscopy. Wilcoxon signed-rank test was performed to evaluate the difference in the amount of PEG solution between the new regimen and the conventional regimen. Statistical significance was set at $p<0.05$.

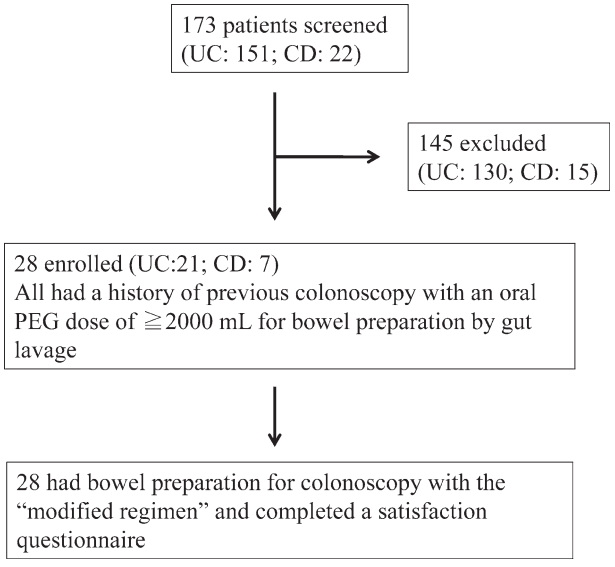

Fig. 1. Patient screening, enrollment, and follow-up

Results

A total of 173 patients with IBD (151with UC, 22 with CD) were enrolled. Once the inclusion and exclusion criteria were applied, 28 patients with IBD remained (Fig. 1). The mean age of participating patients (13 men, 15 women) was 44±16 years (range, 20-74 years). All had a history of previous colonoscopy with an oral PEG dose of 2,000 mL or more for bowel preparation by gut lavage. Twenty-one patients had UC (10 with pancolitis, 5 with left-sided colitis, 5 with proctitis, and 1 with right-sided colitis), and 7 pa-

Table 4. Characteristics of participating patients (n=28)

Characteristic	Category	All	Ulcerative colitis	Crohn's disease
Number of patients, *n* (%)		28 (100.0)	21 (100.0)	7 (100.0)
Sex, *n* (%)	Male	13 (46.4)	8 (38.1)	5 (71.4)
	Female	15 (53.6)	13 (61.9)	2 (28.6)
Age, years	Mean	44	46	36
	SD	16	16	15
	Range	20–74	20–74	30–48
Disease type, *n* (%)	UC subtype			
	pancolitis	10 (35.7)	10 (47.6)	–
	left-sided colitis	5 (17.9)	5 (23.8)	–
	proctitis	5 (17.9)	5 (23.8)	–
	right-sided colitis	1 (3.6)	1 (4.8)	–
	CD subtype			
	colitis	4 (14.3)	–	4 (57.1)
	ileocolitis	2 (7.1)	–	2 (28.6)
	ileitis	1 (3.6)	–	1 (14.3)
	other	0 (0)	–	0 (0%)
Disease activity, *n* (%)	Remission	8 (28.6)	5 (23.8)	3 (42.9)
	Mild	15 (53.6)	13 (61.9)	2 (28.6)
	Moderate	5 (17.9)	3 (14.3)	2 (28.6)
	Severe	0 (0)	0 (0)	0 (0)

tients had CD (4 with Crohn's colitis, 2 with Crohn's ileocolitis, and 1 with Crohn's ileitis). Crohn's ileocolitis in both patients was complicated by severe bowel stenosis. Disease activity was judged with the endoscopic classification of Matts[12]. Colonoscopy revealed that all patients were in remission or had mild or moderate disease activity (Table 4). No adverse events associated with bowel preparation were observed in any patients, and no aggravation of IBD was seen after colonoscopy.

Assessment of the effectiveness of bowel preparation by gut lavage

The amount of residual stool in the large intestine was judged as "negligible" (enabling satisfactory inspection) in 20 patients (71%), "low" (enabling acceptable inspection after removal by aspiration and washing) in 7 patients (25%), and "considerable" (obstructing inspection) in 1 patient (4%). The amount of other residue in the large intestine was judged as "negligible" in 14 patients (50%), "low" in 13 patients (46%), and "considerable" in 1 patient (4%). Residual colonic fluid conditions were judged as "almost clear, or transparent but slightly yellowish" in 15 patients (53%) and "generally slightly opaque" in 11 patients (39%).

Assessment of patient acceptance

Approximately 90% of participants were able to drink 900 to 1,200 mL of ED on the day before colonoscopy : 50% (14 of 28) of patients drank 1,200 mL, and 39% (11 of 28) drank 900 mL (Table 5). The impression after ED intake was "not painful" in 12 patients (43%), "slightly painful" in 5 patients (18%), "moderately painful" in 8 patients (28%), and "very painful" in 3 patients (11%).

Although at least 2,000 mL of PEG solution was required in the conventional bowel preparation regimen for previous colonoscopic examination, the mean PEG volume was 1,375±393 mL for the modified regimen, which marks a significant reduction ($p<0.001$; Fig. 2). The mean duration of PEG administration was 140±57 minutes, and the duration was significantly correlated with the volume of PEG administered ($r=0.5239$, $p=0.0042$; Fig. 3). None of the patients required additional enema or irrigation. Approximately 80% of patients found the modified regimen with ED easier than the conventional regimen : "much easier" in 11 patients (39%) and "slightly easier" in 11 pa-

Table 5. Assessment of patient acceptance of then modified bowel preparation regimen (n=28)

Day	Assessment item	Category	Value	(%)
One day before colonoscopy	ED oral intake (mL)	Mean	996	
		SD	259	
		Range	300–1,200	
		1,200	14	(50.0)
		900	11	(39.3)
		600	1	(3.6)
		300	2	(7.1)
	Impression after ED intake	Not painful	12	(42.9)
		Slightly painful	5	(17.9)
		Moderately painful	8	(28.6)
		Very painful	3	(10.7)
On day of colonoscopy	PEG dosage (mL)	Mean	1,375	
		SD	393	
		Range	1,000–2,000	
		1,000	12	(42.9)
		1,200	1	(3.6)
		1,400	2	(7.1)
		1,500	7	(25)
		2,000	6	(21.4)
	Impression of regimen using ED compared with conventional regimen	Much easier	11	(39.3)
		Slightly easier	11	(39.3)
		Comparable	3	(10.7)
		Slightly more difficult	2	(7.1)
		Much more difficult	1	(3.6)
		Wilcoxon signed-rank test	P<0.001	

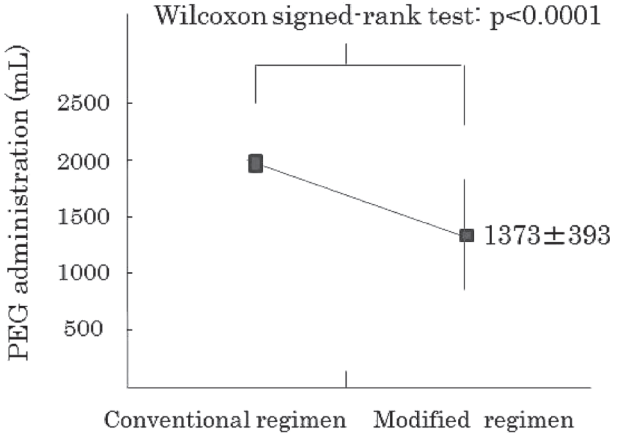

Fig. 2. Volume of PEG solution required for colonoscopic examination. Values are shown as mean±S.D. (n=28)

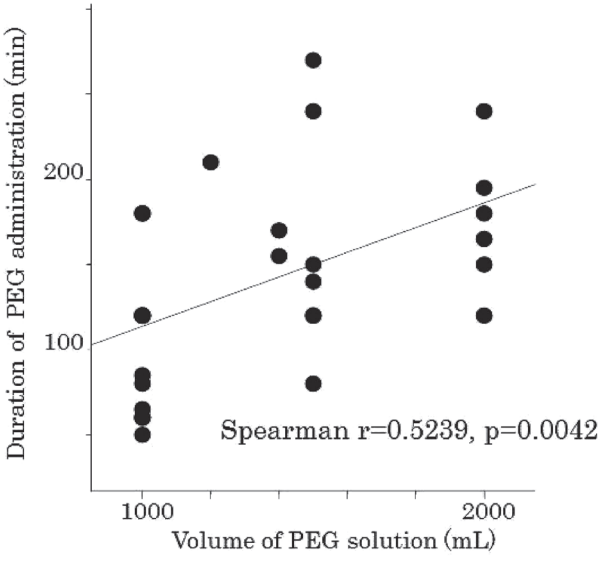

Fig. 3. Correlation between PEG volume and duration of PEG administration

tients (39%). Twenty patients (72%) preferred the new regimen to the conventional regimen for the next bowel preparation for colonoscopy ($p<0.001$). The mean PEG dose in these 20 patients was significantly lower than that in the remaining 8 patients (Mann-Whitney U test : $p=0.0362$). Thus, compared with the conventional bowel preparation regimen, the new regimen using an ED significantly reduced the required PEG dose and, consequently, improved patient acceptance.

DISCUSSION

As the number of cases of IBD has increased rapidly in recent years, colonoscopy has become a frequently used and essential modality for the diagnosis and treatment of IBD and for surveillance to detect both dysplasia and early colitic cancer in patients with long-standing UC[5-7]. However, bowel preparation, despite being essential for colonoscopy, can exacerbate inflammation[13]. In addition, in patients with IBD complicated by bowel stenosis, insufficient gut lavage often hinders colonoscopic inspection. Because colonic cleansing is often unsatisfactory with conventional bowel preparation regimens, an appropriate regimen should be selected according to the type and activity of IBD and the clinical condition and symptoms, such as the presence of a stenosis.

In the severe active stage of UC in particular, a high volume of gut lavage solution exacerbates lesions of the gastrointestinal tract and inflammation[8]. Thus, to assess mucosal inflammation in many patients with active UC, abdominal ultrasonography, computed tomography, and magnetic resonance imaging are performed, together with limited colonoscopy of the rectum and sigmoid colon with no bowel preparation or with preparation by enema only. In addition, dysplasia and colitic cancer in such patients can easily be missed because of progressive mucosal inflammation, including erosions and ulcers, and, therefore, full surveillance colonoscopy should be performed in the remission stage when patients can tolerate effective conventional bowel preparation with an oral lavage solution.

Takenouchi and Ohshima[14] have reported that the use of EDs can reduce the dose of PEG. Furthermore, EDs are low-irritation diets that place a low burden on the gastrointestinal tract, especially one with active mucosal lesions. Thus, a bowel preparation regimen using an ED is likely safer than conventional regimen for patients with IBD[9,10]. For UC, this modified regimen is expected to be useful for colonoscopic surveillance in the remission stage, for full colonoscopy to identify the sites of lesions, and for the assessment of therapy outcomes in patients with mild-to-moderate symptoms. The subjects of the present study were in the remission stage or had mild symptoms.

For CD, disease type and activity and the presence of bowel stenosis are important factors in choosing a bowel preparation regimen. A regimen with a standard oral dose of lavage solution can be used in patients without stenosis but not, because of the risk of bowel obstruction, in patients with severe stenosis. In addition, because a standard dose can induce bowel obstruction even in patients with mild-to-moderate bowel stenosis, the smallest possible dose of lavage solution should be used. Because the new regimen described in the present study uses an ED, which contains a predigested form of nutrients and thus provides an extremely low residue diet that enables a lower volume of PEG to be used, it will be useful for preventing bowel obstruction in patients with bowel stenosis. We examined 2 patients with CD who had severe bowel stenosis that would not allow a colonoscope to be passed : one had a stenosis 35 cm from the anus, and the other had stenosis in the ileocecal region. In both patients the conventional bowel preparation regimen was not effective and caused abdominal pain and nausea, whereas our new regimen with an ED achieved effective colonic cleansing with 1,000 mL of PEG and did not cause adverse events. Abdominal symptoms, such as abdominal pain and nausea, are commonly caused by bowel preparation in patients with CD. Because these symptoms can be attributed to stenosis, the new bowel preparation regimen with an ED may be more effective than the conventional regimen and, so, should be considered in patients with bowel stenosis.

Effective colonic cleansing is the most important requirement in bowel preparation for colonoscopy, but also important are safety, convenience, and patient acceptance. Our new regimen using an ED satisfied the above requirements in all patients but one and, therefore, can be considered an option for bowel treatment for colonoscopy in patients with IBD. The one patient for whom bowel preparation with the new regimen failed had UC in remission but intractable constipation. Effective colonic cleansing was not achieved even after administration of 2,000 mL of

PEG solution. Some patients did not like the taste of the ED, had difficulties drinking it, or complained of hunger, as solid food was prohibited the day before colonoscopy. Such issues can be addressed by creating an acceptable flavor and increasing the ED dose. Our questionnaire study revealed the need to modify the regimen on the basis of each patient's condition at colonoscopy. More precisely, some patients had no preferred regimen for the next colonoscopy, perhaps because the new milder regimen with ED was preferred when their appetite was suppressed due to active IBD but would not be acceptable when their appetite was good due to low IBD activity.

Most patients with IBD have repeated relapses and remissions and require long-term follow-up with colonoscopy. Satisfactory bowel preparation is required for successful colonoscopy, and, thus, choosing an effective, well-tolerated regimen is crucial. Bowel preparation should be performed with a regimen chosen according to the symptoms and the disease condition of individual patients with IBD. Because no regimen is satisfactory for all patients at all times, the bowel preparation regimen, either the conventional regimen or a modified regimen, must be selected on an individual basis. We believe that our new regimen is safer and more effective and has good patient acceptance ; therefore, it reduces the burden of bowel preparation and is a useful option for use with the growing number of patients with IBD.

Conclusion

Our new bowel preparation regimen using ED is effective and safe and has good patient acceptance. We believe that this regimen can be tolerated by many patients with IBD and will therefore be beneficial for the growing number of patients with IBD.

Authors have no conflict of interest.

References

1. Peyrin-Biroulet L, Loftus EV Jr, Colombel JF, Sandborn WJ. The natural history of adult Crohn's disease in population-based cohorts. Am J Gastroenterol. 2010 ; 105 : 289-97.
2. Ramadas AV, Gunesh S, Thomas GA, Williams GT, Hawthorne AB. Natural history of Crohn's disease in a population-based cohort from Cardiff (1986-2003) : a study of changes in medical treatment and surgical resection rates. Gut. 2010 ; 59 : 1200-6.
3. Kornbluth A, Sachar DB. Ulcerative colitis practice guideline in adults (Update) : American College of Gastroenterology, Practice Parameters Committee. Am J Gastroenterol. 2004 ; 99 : 1371-85.
4. Loftus EV Jr. Clinical epidemiology of inflammatory bowel disease : incidence, prevalence and environmental influences. Gastroenterology. 2004 ; 126 : 1504-17.
5. Kobayashi K, Igarashi M, Sada M, Katsumata T, Saigenji K. Surveillance for dysplasia and colitic cancer by magnifying colonoscopy in patients with ulcerative colitis. Dig Endosc. 2005 ; 17 : S25-8.
6. Sada M, Igarashi M, Yoshizawa S. Surveillance by magnifying endoscopy in patients with ulcerative colitis. Dig Endosc. 2005 ; 17 : 297-303.
7. Eaden JA, Abrams KR, Mayberry JF. The risk of colorectal cancer in ulcerative colitis : a meta-analysis. Gut. 2001 ; 48 : 526-35.
8. Fukutomi Y, Tajika M, Yamazaki K. A case of ulcerative colitis associated with sepsis and intra vertebral canal abscess induced by oral administration of polyethylene glycol electrolyte lavage solution. Gastroenterol Endosc. 2004 ; 46 : 1181-5.
9. Takagi S, Utsunomiya K, Kuriyama S. Effectiveness of an 'half elemental diet' as maintenance therapy for Crohn's disease : a randomized-controlled trial. Aliment Pharmacol Ther. 2006 ; 24 : 1333-40.
10. Tanaka T, Takahama K, Kimura T. Effect of concurrent elemental diet on infliximab treatment for Crohn's disease. J Gastroenterol Hepatol. 2006 ; 21 : 1143-9.
11. Esaki M, Matsumoto T, Hizawa K. Preventive effect of nutrition therapy against postoperative recurrence of Crohn's disease, with reference to findings determined by intra-operative enteroscopy. Scand J Gastroenterol. 2005 ; 40 : 1431-7.
12. Matts SFG. The value of rectal biopsy in the diagnosis of ulcerative colitis. Q J Med. 1961 ; 30 : 393-407.
13. Okawa K, Ishiguro S, Aoki T. Ischemic colitis induced by pretreatment with a cathartic for colonoscopy : report of two cases. Gastroenterol Endosc. 1992 ; 34 : 2610-4.
14. Takenouchi M, Ohshima H. The efficacy and the tolerability of 1 liter of polyethylene glycol preparation regimen with the combined use of an elementary diet in screening colonoscopy. Gastroenterol Endosc. 2011 ; 53 : 3749-55.