Evaluation of bowel preparation quality in patients with a history of colorectal resection

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ABSTRACT

Background/Aims: *Suboptimal bowel function can negatively affect colon cleansing for colonoscopy after surgery. Very few studies have compared the relationship between the colorectal resection and the bowel preparation quality. We postulated that the colon cleansing quality in patients with a history of colorectal surgery might not be inferior to that of patients with no resection history.*

Materials and Methods: *Overall, 200 patients were enrolled in the study and distributed into two groups: the resection group (RG) and the control group. The surgical maneuvers were classified as right colectomy, left colectomy, and rectosigmoidectomy. The bowel preparation was performed using 2-L low-volume or 4-L high-volume regimens, and the preparation quality was evaluated using the modified Boston Bowel Preparation Scale (BBPS).*

Results: *There were no significant differences in achieving adequate cleansing observed between the RG and the control group (modified BBPS of 6-9; 88% vs. 88%). According to the logistic regression analysis of the RG, patients with a left colon resection had an odds ratio (OR) of 0.27 (p=0.003) for achieving a successful cleansing, and the low-volume preparation (OR=3.092, p=0.023) was the main predictor of a successful cleansing procedure. However, a longer time between colonoscopy and surgery was not related to unsuccessful bowel cleansing.*

Conclusion: *Our study demonstrates that a history of colorectal surgery is not a risk factor for inadequate colon cleansing.*

Keywords: *Colonoscopy, bowel preparation, colorectal resection, polyethylene glycol, ascorbic acid*

INTRODUCTION

Colonoscopy is a suitable tool for finding the lesions of the colon (1), and the diagnostic yield of colonoscopy is determined by the quality of colon cleansing. In other words, inadequate preparation of the colon before colonoscopy presents a significant concern in the practice of endoscopy. Inadequate bowel cleansing is observed in approximately 25% of all colonoscopies (2).

A history of colorectal surgery is regarded as a predictor of inadequate colon cleansing. Therefore, patients with colorectal resection are typically excluded from the majority of studies on bowel preparation. Few studies have specifically addressed whether a history of colorectal resection is in fact related to inadequate colon cleansing. Several studies have focused on the association between bowel preparation quality and preparation solutions or patient-related factors, such as age, sex, obesity, and combined diseases (3).

Currently, the number of colonoscopies is increasing following colorectal surgery for colorectal cancer (CRC). The patients are recommended for either surveillance endoscopy 1 year after the surgery or a clearing colonoscopic procedure. If the results are negative, colonoscopy should be repeated every 3 years thereafter. Based on our clinical experience, most clinicians believe that the bowel preparation quality is not significantly affected by a colorectal resection. Mussetto et al. (4) have reported that a low-volume regimen is not inferior to a high-volume regimen for adequate bowel preparation following colorectal surgery. In other words, low-volume preparations seemed to demonstrate a similar efficacy in patients with colorectal resection, as well as in those from the general population. Moreover, few studies have been designed to demonstrate whether a history of colorectal surgery represents a risk factor for inadequate colon cleansing (5,6).

Therefore, this study aimed to evaluate the relevance of colorectal surgery to the colon cleansing quality in patients with and without a history of colorectal surgery.

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MATERIALS AND METHODS

Study design

We retrospectively evaluated a total of 200 outpatients who underwent endoscopic evaluation at a single center from March to August 2015. Patients who underwent surveillance colonoscopy following colorectal resection and patients with other indications were enrolled into the study. We selected patients who received either 4 L of polyethylene glycol (PEG) or 2 L of PEG with ascorbic acid (PEG-Asc) as colon cleansing regimens. Written informed consent was received from patients who participated in this study. This trial was registered and approved by the institutional review board (ED16352).

Patients

All patients aged between 18 and 80 years presenting for scheduled colonoscopy were included in the study. Patients who had previously undergone colorectal resection for CRC were included in the resection group (RG), whereas patients with other indications (such as general screening, anemia, polypectomy follow-up, change in bowel habits, etc.) were included in the control group. The exclusion criteria were as follows: (i) severe renal disease, (ii) severe cardiac disease, (iii) referral for emergency colonoscopy, (iv) a history of colorectal resection for any indication other than CRC, (v) prior double colorectal resection, and (vi) lack of data about the bowel preparation quality at the report. Patients in the RG were further divided into three subgroups according to the surgical procedure: right colectomy, left colectomy, and rectosigmoidectomy.

Patient data collection

The following patient data were collected: demographics (age, sex, weight, and height); medical history (e.g., diabetes mellitus, hypertension); the time interval between the surgery and colonoscopy (days); and type of preparation solution used (PEG-Asc, PEG).

Preparation methods

The patients received either PEG or PEG-Asc as the bowel preparation solution, and the application of the two solutions was equally distributed in each group.

Patients who received the PEG-Asc (Coolprep; TaeJoon Pharmaceuticals) were given two sachets of powder (100 g of macrogol 3350 per sachet plus ascorbic acid/ascorbate and electrolytes) to be dissolved in water to create the PEG-Asc solution. The first 1 L of the PEG-Asc was consumed at 8:00 PM the day before the colonoscopy, and the second 1 L was received 5 h before the colonoscopy. Patients who received the 4 L PEG (Colyte; TaeJoon Pharmaceuticals) were given first 2 L of PEG solution at 8:00 PM on the day before the colonoscopy, and the second 2 L of PEG solution 5 h before the colonoscopy. Patients were permitted to have liquid diet as a dinner at least 1 h before taking the preparation solution. The physician performed colonoscopy between 9:00 AM and 12:00 PM.

Evaluation of bowel preparation

Assessment of the bowel cleansing efficacy

To evaluate the colon cleansing quality, the Boston Bowel Preparation Scale (BBPS) was used. BBPS (7) is a 4-point scoring system, from 0 (inadequate) to 3 (excellent), applied to the three parts of the colon broad regions: the right colon, transverse colon, and rectosigmoid colon.

However, for the RG, we used a modified BBPS that was designed in 2015 for patients who have undergone prior colorectal surgery. The endoscopist documented the cleansing scores of the remnant colon in the colonoscopy report. Similar to the original BBPS, the modified BBPS is also a 4-point scoring system that is applied to the three broad regions of the remnant colon: the proximal colon, mid colon, and distal colon. For example, if a patient had right colectomy, the bowel cleansing quality was assessed in the remnant colon segment divided into three parts (transverse colon, descending colon, and rectosigmoid colon).

The endoscopist in the present study was previously trained in using both BBPS and modified BBPS through visual examples.

Subgroup analysis

The primary outcome was the proportion of adequate colon cleansing for the control group and the RG. BBPS score of ≥6 was considered indicative of an adequate quality of colon cleansing. Patients in the RG were classified according to the surgical procedure: right hemicolectomy, left hemicolectomy, or rectosigmoidectomy. Secondary outcomes included factors associated with adequate preparation in RG, which were expressed as odds ratios (ORs). We evaluated factors including patient age, sex, body mass index (BMI), intervention type, time between the surgery and colonoscopy, diabetes mellitus, hypertension, and preparation method.

Statistical analysis

Continuous data are shown as the mean±standard deviation, and discontinuous data are shown as the number of patients (%). Chi-squared and t-tests were applied for discontinuous and continuous variables, respectively; $p<0.05$ was considered statistically significant.

In addition, in the RG, the Cox proportional hazard model was used to analyze the factors associated with successful bowel cleansing. Significant factors ($p<0.1$) in the univariate analysis were subjected to a multivariate analysis to determine the independent predictive factors. Data were analyzed using the Statistical Package for Social Sciences version 20 (IBM Corp.; Armonk, NY, USA).

RESULTS

Baseline characteristics

During the study period, a total of 260 patients underwent bowel preparation for colonoscopy using either the PEG or PEG-Asc solutions. Of these patients, 60 were excluded from the study because of a history of surgery for causes other than CRC (n=22), prior double colorectal resection (n=8), lack of data on the colonoscopy report (n=18), and severe comorbidity (n=12).

A total of 200 patients were ultimately analyzed, and 100 patients were assigned to each group. The baseline characteristics of patients are presented in Table 1. The two groups did not significantly differ in terms of age, sex, BMI, and the number of medical conditions.

Table 1. Baseline characteristics

	Resection Group (n=100)	Control Group (n=100)	p[a]
Age (mean±SD, years)	56.78±14.6	55.75±13.58	0.188
Male, n (%)	66 (50.8%)	61 (46.9%)	0.535
Height (mean±SD, cm)	163.6±77.0	164.1±82.8	0.761
Weight (mean±SD, kg)	60.8±10.3	63.3±11.3	0.414
BMI (mean±SD, kg)	22.6±2.74	23.4±2.98	0.594
No. of medical conditions			0.307
Hypertension, n (%)	30 (30%)	31 (31%)	
Diabetes mellitus, n (%)	9 (9%)	15 (15%)	
Thyroid disease, n (%)	4 (4%)	3 (3%)	
Coronary heart disease, n (%)	1 (1%)	2 (2%)	
Others, n (%)	7 (7%)	7 (7%)	

[a]Statistical significance between the groups was tested by Student's t-test or $\chi 2$ analysis
BMI: body mass index

Efficacy of bowel cleansing

Colonoscopy cleansing data were obtained from all 200 patients. Table 2 shows the bowel preparation quality scores based on BBPS. In the RG, we applied the modified BBPS for scoring. Both the groups showed a successful cleansing efficacy, with scores of 7.64 and 7.07 in the RG and the control group, respectively, with no significant difference ($p=0.183$). Mean BBPS scores at the mid and distal segments were 2.57 and 2.70, respectively, for the RG, and 2.36 and 2.48, respectively, for the control group, with no significant difference. However, mean (modified) BBPS scores for the proximal segments were significantly higher in the RG than in the control group. The rate of adequate bowel preparation quality was the same between the RG (total BBPS score ≥6) and the control group (88% [95% confidence interval (CI) 82-94] vs. 88% [95% CI 82-94], respectively; $p<0.05$) (Figure 1).

Resection group

Patients in the RG were classified according to the intervention type-right hemicolectomy, left hemicolectomy, and rectosigmoidectomy-with the following distribution: left hemicolectomy (10%), right hemicolectomy (34%), and rectosigmoidectomy (56%).

Adequate bowel preparation was analyzed using logistic regression analysis for age, sex, BMI, intervention type, presence of comorbidity, elapsed time between surgery and colonoscopy, and type of preparation. Univariate analysis revealed that female patients ($p=0.074$) and those who received 2 L of PEG-Asc ($p=0.018$) showed successful bowel cleansing, whereas a history of left colectomy was significantly related to a poor colon cleansing quality ($p=0.036$; Table 3). Other variables including sex, BMI, the presence of comorbidity, and the amount of elapsed time between the surgery and colonoscopy were not associated with the bowel preparation quality. A multivariate analysis indicated that patients who had

Table 2. Comparison of efficacy of bowel cleansing based on (modified) boston scale

	Resection Group (n=100)	Control Group (n=100)	p[a]
Proximal colon	2.37±0.87	2.23±0.65	0.003
Mid colon	2.57±0.67	2.36±0.60	0.488
Distal colon	2.70±0.75	2.48±0.66	0.108
Total score	7.64±1.64	7.07±1.40	0.183

[a]Statistical significance between groups was tested by Student's t-test or $\chi 2$ analysis

Table 3. Logistic regression analysis of factors affecting successful bowel cleansing in patients who had undergone prior colorectal resection

Variable	Univariate		Multivariate	
	HR (95% CI)	p	HR (95% CI)	p
Female (vs. male)	1.75 (0.789-4.525)	0.074		
Intervention type, time from intervention		<0.001		0.108*
Left colectomy vs. right colectomy	0.310 (0.104-0.928)	0.036	0.298 (0.097-0.918)	0.035
Rectosigmoidectomy vs. right colectomy	0.259 (0.053-1.258)	0.094	0.395 (0.078-2.015)	0.264
Preparation (2 L PEG-CS vs. 4 L PEG)	3.037 (0.208-1.341)	0.018	3.092 (0.078-2.015)	0.023

*p value for the test of a difference in cleansing success across any of the three types of prior surgery.

HR: hazard ratio; CI: confidence interval

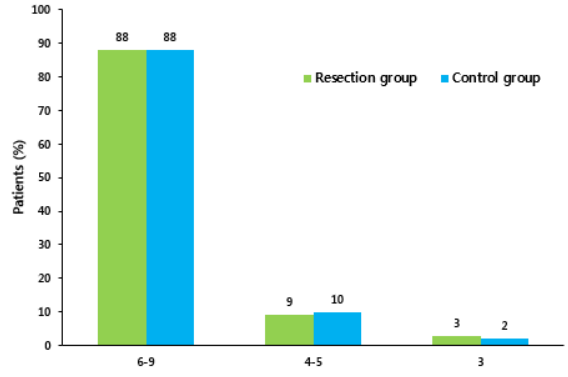

Figure 1. Comparison of bowel cleansing efficacy between patients who previously underwent surgery and control patients using the modified boston bowel preparation scale

undergone left colectomy had an OR of 0.27 (p=0.003) for achieving a successful bowel cleansing, in comparison with those who had undergone right colectomy. Patients who had undergone right colectomy had the highest bowel preparation success rate (91.2%; 95% CI 81.1%-100%), whereas patients who had undergone left colectomy had the lowest success rate (83.9%; 95% CI 74%-87.7%). Moreover, low-volume preparation (OR 3.092, p=0.023) was the primary predictor of a successful bowel cleansing, and a longer time interval since surgery was not associated with an unsatisfactory preparation quality.

DISCUSSION

This study demonstrates that a history of colorectal surgery is not an independent predictor of inadequate colon cleansing. In contrast to our findings, a few previous studies hypothesized that prior colon resection would be a predictor of inadequate bowel preparation (5,8,9). However, these studies rarely focused on the association between a history of colorectal resection and bowel preparation quality. Furthermore, they included gastrectomy as a bowel resection factor, or bowel preparation analysis was performed using broad scales such as the Aronchick scoring system. We evaluated the relationship between the bowel preparation quality and a history of colorectal resection using our own scales, BBPS, and modified BBPS scores. In addition, we stratified the RG according to the surgical method and evaluated the factors implicated in successful cleansing.

This study aimed to evaluate whether a history of colorectal surgery was a definitive risk factor for inadequate colon cleansing. According to our results, the total (modified) BBPS score did not significantly differ between the two groups at 7.07 in the control group and 7.64 in the RG. Moreover, patients in the RG demonstrated an "adequate" bowel preparation quality, as did the patients in the control group (BBPS of 6-9: 88% vs. 88%).

Our study has several strengths and important differences from previous studies. First, this is, to the best of our knowledge, the first study to apply the modified BBPS to a surgery group. Few studies have demonstrated a relationship between colon cleansing and surgery, and they all used either the Aronchick Scale (4,6) or the modified Ottawa Bowel Preparation Scale. However, the Aronchick Scale is a broad scoring system that does not permit the use of segmental scores, and the modified Ottawa Bowel Preparation Scale differs from the original Ottawa Bowel Preparation Scale in terms of the total score, which makes comparisons between different groups difficult. Furthermore, these two previous scoring systems take retained fluid into account, although bowel preparation is rated after completion of cleansing maneuvers (7). In contrast, the modified BBPS is simple, easily comprehensible with brief instruction, and similar to the original BBPS, leading to less confusion for the endoscopist. By utilizing the same total score frame-

work in both BBPS and modified BBPS, from 0 to 9, we were able to compare the RG with the control group. In addition, the modified BBPS does not involve a fluid quantity rating, and it is specifically designed for comparisons between two groups.

Second, contrary to our expectations, surgical resection was not found to be a definitive risk factor for poor colon cleansing. As mentioned before, a history of colorectal resection has been widely considered to be a predictor of inadequate bowel cleansing, and patients with such a history are usually excluded from studies. Since inadequate bowel preparation is expected due to suboptimal bowel function (10) and adhesions (11), the use of high-volume regimens is usually recommended in patients who have previously undergone surgery (12). According to a study by Mussetto et al. (4), a low-volume regimen is not inferior to a high-volume regimen for satisfactory bowel preparation in patients who underwent colorectal surgery. In addition, based on our clinical experience, bowel preparation in patients who underwent colorectal resection may not be as poor as expected. According to the results of the present study, there was no difference in the bowel preparation quality between the RG and the control group. Nevertheless, evidence of bowel dysfunction has been demonstrated after surgery (13), although the mechanism of poor bowel preparation in patients with colon resection has not been established (6).

Third, we evaluated the factors related to the efficacy of bowel preparation. In the RG, the bowel preparation quality was the most challenging in patients who underwent left colectomy. In left colectomy, the absence of the descending colon may impair the force that pushes the luminal contents downwards (4). As opposed to left colectomy, right colectomy has superior cleansing outcomes. Diarrhea, which accelerates transit and favors bowel cleansing, occurs more frequently after right hemicolectomy, because the right colon demonstrates the greatest absorptive ability (14). Surprisingly, the low-volume 2-L PEG-Asc solution showed a better probability of adequate bowel preparation, although the reason for this finding remains unclear. However, our results may be supported by the results of a previous study showing that the low-volume preparation was not inferior to the standard, high-volume regimen (4). These results are clinically significant because a low-volume preparation, which is easily consumed and has greater acceptability, is recommended in patients who underwent colorectal surgery. A longer time lapse between the surgical resection and colonoscopy was not found to affect the quality of the colon cleansing. This could be attributed to long-term adaptive mechanisms that may play a role in balancing the alterations in colorectal physiology after colorectal resection (4). Indeed, during the colonoscopic surveillance program for the RG, it was suggested that the colorectal resection would not subsequently affect the bowel preparation quality over time.

The major limitation to this study is that several factors influencing the study outcomes were not considered due to retrospective nature of the study. First, the tolerability of the patients and the completeness of the bowel preparation regimen, which are critical factors in the bowel preparation efficacy, were not evaluated. However, PEG and PEG-Asc are both fairly well-tolerated bowel preparation solutions, and the compliance rate of these solutions is usually good. Second, the colonoscopies were performed by multiple colonoscopists; thus, an interobserver variation may exist in the evaluations of the bowel preparation quality. However, experienced endoscopists participated in this study and performed calibration exercises for the modified BBPS to reach a satisfactory level of agreement prior to study initiation, which may have reduced the possible operator bias. Third, the allocation of patients to each group could not be randomly controlled due to retrospective study design. Therefore, some unexpected confounding factors resulting from selection bias may affect the process and results of this study. Further, larger and prospective randomized studies are needed to confirm our results. Finally, our study used a modified BBPS, which has not been previously validated. However, no validated scoring systems exist, since very few studies have focused on patients with colorectal resection. In conclusion, we investigated the relationship between the bowel preparation quality and a history of colorectal resection. Our findings suggest that prior colorectal surgery is not a risk factor for an inadequate colon cleansing quality. Moreover, in the analysis of the RG, the main predictor of a successful preparation was the low-volume preparation, whereas previous left hemicolectomy was a significant risk factor for unsuccessful cleansing. In addition, a longer elapsed time since surgery was not related to unsuccessful bowel cleansing. However, since our results do not clarify whether bowel resection is a predictor of an inadequate bowel preparation, larger randomized and prospective studies are warranted to ascertain our results.

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Informed Consent: Written informed consent was obtained from patients who participated in this study.

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