Tokai J Exp Clin Med., Vol. 25, No. 1 , pp.27-32, 2000

Reducing the volume of polyethylene glycol electrolyte lavage solution to less than 2 liters for bowel preparation

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(Received November 22, 1999; Accepted December 13, 1999)

Smaller volumes of polyethylene glycol electrolyte lavage solution (PEG), an oral whole-bowel irrigation solution employed in colorectal preparation, were given to patients to decrease the discomfort associated with pretreatment. Comparison was made between groups receiving standard and modified preparations. A total of 68 patients (gastrointestinal surgery: 55; total colonoscopy: 13) were enrolled in the study. The mean volume of PEG used was significantly smaller in the modified than in the standard preparation (1,694 ml vs. 2,735 ml, $p<0.01$). In addition, the mean PEG administration period was significantly shorter for the modified preparation (183 min vs. 237 min, $p<0.05$). However, the mean PEG excretion time and the number of bowel movements were not significantly different between the two groups. There was also no significant difference between the two groups in terms of the efficacy, safety, usefulness, or tolerability of the preparations. These results suggest that it is possible to reduce the PEG volume by more than 1 L to alleviate patient discomfort without a significant loss of efficacy. The modified method is useful for preparing the large bowel for either gastrointestinal surgery or total colonoscopy.

Key words : Bowel preparation, colonic lavage, polyethylene glycol electrolyte lavage solution, colonoscopy, colorectal surgery

INTRODUCTION

Total colonoscopy (TC) is used extensively in many fields and the development of a non-absorbable isotonic electrolyte lavage solution with polyethylene glycol (PEG) as its main constituent has contributed greatly to this development [1-4]. However, severe discomfort is caused by bowel distension using 4 L of PEG in accordance with the original regimen and this has led to arguments about its usefulness, despite the lack of any need to alter the diet before ingestion. Because of this, various modifications of the PEG regimen have been studied and it has been reported that the volume administered can be reduced [5-7]. As a consequence, administering 2 L rather than 4 L has become standard practice in Japan. However, patients still frequently complain of pain and discomfort after taking 2 L of PEG prior to surgery or TC.

The present study was conducted in patients undergoing gastrointestinal surgery or TC to clarify the efficacy of PEG used in combination with magnesium citrate and without dietary restrictions. The possibility of reducing the total volume of PEG to less than 2 L with some dietary modification was also assessed, as was the relationship between the total volume of PEG administered and the severity of patient discomfort.

MATERIALS AND METHODS

A total of 68 patients hospitalized during the six-month period from April to September 1999 were enrolled, including 55 who were scheduled to undergo gastrointestinal surgery requiring colorectal preparation and 13 who were scheduled to undergo TC. Thirty-five of the 68 patients underwent bowel preparation using the standard PEG and magnesium citrate regimen that is currently employed at our department during the first half of the 3-month period (the standard preparation group). This group com-

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prised 30 patients who were to undergo surgery [esophageal (n = 4), gastric (n = 1), colorectal (n = 15), and hepatobiliary (n = 10)] and 5 patients who were to undergo TC (Table 1). During the second half of the 3-month period, the remaining 33 patients were given a new regimen consisting of PEG and magnesium citrate with some dietary restrictions (the modified preparation group). This latter group comprised 25 patients who were scheduled to undergo surgery [esophageal (n = 2), gastric (n = 3), colorectal (n = 14), and hepatobiliary (n = 6)] and 8 patients who were to undergo TC (Table 1). Informed consent was obtained from all the patients.

BOWEL PREPARATION

Surgical patients:

The standard preparation group was first given 50 g of magnesium citrate (Magcorol-P, Horii Co. Ltd., Japan) starting at 14:00 after a normal diet up to lunch on the day before surgery (no dietary restrictions). PEG of the same composition as that used by Davis et al. (Niflec containing 118 g of PEG/137.155 g, Hoechst Marion Roussel Co. Ltd., Japan) was then administered at volumes ranging from 1 to 4 L, until the watery yellow stool became a clear, colorless solution with no residual particles. Administration of this preparation was completed by approximately 20:00 (Table 2).

The modified preparation group ate a typical pre-barium enema examination, semi-solid diet containing thin oatmeal (Enimacrin, Glico Co. Ltd., Japan), for breakfast and lunch on the day before surgery. Fifty g of magnesium citrate was administered after lunch at 14:00, then PEG at volumes ranging from 1 to 4 L, starting at 15:00, until the watery yellow stool became a clear, colorless solution with no residual particles. Administration of this preparation was also completed by approximately 20:00 (Table 2).

Table 1 Sixty eight patients divided into standard (n=35) and modified (n=33) preparation groups.

	Standard	Modified
Surgical patients :	**30**	**25**
Esophagus	4	2
Stomach	1	3
Colon & rectum	15	14
Hepatobiliary	10	6
Colonoscopy patients :	**5**	**8**
	(n=35)	(n=33)

Table 2 Comparison between standard and modified PEG* preparations.

	Standard	Modified
Surgical patients :		
Day before	Diet unrestricted until lunch	Barium enema diet until lunch
14:00 p. m.	Magnesium citrate (50 g)	Magnesium citrate (50 g)
15:00 p. m.	PEG 1–4 L**	PEG 1–4 L**
Colonoscopy patients :		
Day before	Diet unrestricted until dinner	Barium enema diet until dinner
21:00 p. m.	Magnesium citrate (50 g)	Magnesium citrate (50 g)
Day of exam 7:00 a. m.	PEG 1–4 L**	PEG 1–4 L**

* Polyethylene glycol electrolyte lavage solution.
** Administered until no residual particles were found in the bowel fluid.

Colonoscopy patients:

Patients in the standard preparation group who were scheduled to undergo total colonoscopy were administered 50 g of magnesium citrate at 21:00 after a normal diet up to the evening of the day before colonoscopy (no dietary restrictions). On the day of colonoscopy, starting at 7:00, PEG was administered in volumes ranging from 1 to 4 L until the watery yellow stool became a clear, colorless solution with no residual particles. Administration of this preparation was completed by approximately 13:00 (Table 2).

The patients in the modified preparation group who were scheduled to undergo total colonoscopy received the same semi-solid diet on the day before colonoscopy. They received 50 g of magnesium citrate after supper at 21:00. PEG was administered from 7:00 on the day of colonoscopy in volumes ranging from 1 to 4 L until stool became clear. Administration of this preparation was also completed by approximately 13:00 (Table 2).

ASSESSMENT AND STATISTICAL ANALYSIS

Assessment was done in a manner similar to that reported by Tsuchiya et al. in phase II and III clinical studies on MGV-5 (Niflec, Hoechst Marion Roussel Co. Ltd. Japan) [8−10]. The patients were asked to fill out a questionnaire, entering the time they started taking PEG and the time of the final defecation. The records were collected and the volume of PEG (ml), the time required to take the PEG (min), the PEG excretion time (min), and the number of bowel movements calculated.

The efficacy of PEG was classified in terms of the amount of residue in the intestine: "markedly effective" (no residual particles), "effective" (slight residual particles), "slightly effective" (a moderate amount of residual particles), and "not effective" (a large amount of residual particles). The efficacy rate (%) was calculated from the "effective" plus "markedly effective" results. The safety of PEG, based on a consideration of symptoms, side effects, and complications was classified as "very safe," "safe," "slightly safe," or "unsafe". The safety rate (%) was calculated from the "safe" plus "very safe" results. The usefulness of the preparation was also classified based on the efficacy and safety. The tolerability of PEG was rated in terms of taste and ease of consumption. The taste was classified as "good;" "fairly good;" "bearable;" and "unpleasant". The ease of consumption was classified as "could have taken more;" "could have taken more, although the dose was already a little too much;" "forced it down," and "could not take all, because the dose was excessive". The tolerability rate was calculated as "fairly good" plus "good for taste" and "could have taken more, although the dose was a little too much" plus "could have taken more" for consumption, and rating was done in the same manner as for usefulness. These ratings were obtained by assessing the forms collected from doctors and nurses of the Department of Gastrointestinal Surgery.

Statistical analysis was carried out using Wilcoxon's t-test for the volume of PEG, the time required to take PEG, the PEG excretion time, and the number of bowel movements. Separate χ^2 tests were conducted for efficacy, safety, usefulness, and tolerability. Differences were regarded as significant at $p<0.05$ (Table 3).

RESULTS

The response rate in terms of completely answered questionnaires was 95.6 % (65/68 patients). The results obtained are listed and compared in Table 3. The mean volume of PEG taken by the standard preparation group was 2,735 ml (2,890 ml for the surgical patients and 2,580 ml for the colonoscopy patients). The mean volume of PEG taken by the modified preparation group was 1,694 ml (1,783 ml for the surgical patients and 1,605 ml for the colonoscopy patients), which was significantly smaller than in the standard preparation group ($p<0.01$, Table 3). The mean time for ingesting the PEG was 237 min in the standard preparation group (237 min for the surgical patients and 237 min for the colonoscopy patients) and 183 min in the modified preparation group (188 min for the surgical patients and 178 min for the colonoscopy patients). The mean time required to ingest PEG was significantly shorter in the modified preparation group ($p<0.05$, Table 3). The mean PEG excretion time was 222 min in the standard preparation group (215 min for the surgical patients

Table 3 Comparison between the standard (n=35) and the modified (n=33) preparation groups in terms of volume of polyethylene glycol electrolyte lavage solution (PEG), administration time, excretion time, and number of bowel movements.

		Standard	Modified	
		*		
PEG volume (ml)	**:**	**2735**	**1694**	**p<0.01**
Surgical patients		2890	1783	
Colonoscopy patients		2580	1605	
		*		
PEG administration time (min)	**:**	**237**	**183**	**p<0.05**
Surgical patients		237	188	
Colonoscopy patients		237	178	
PEG excretion time (min)	**:**	**222**	**186**	**N. S.****
Surgical patients		215	216	
Colonoscopy patients		229	155	
Number of defecations	**:**	**9.2**	**6.8**	**N. S.****
Surgical patients		9.9	6.6	
Colonoscopy patients		8.4	6.9	

* All numerial data recorded as mean values; statistical comparison is by Wilcoxon's t test.
** N. S.; Not significant

Table 4 Statistical comparison between the standard (n=33) and the modified (n=32) preparation groups with respect to efficacy, safety, usefulness, and tolerability.

	Standard	Modified	
Efficacy	81.8 % (27/33)	68.8 % (22/32)	N. S.*
Safety	97.0 % (32/33)	96.9 % (31/32)	N. S.
Usefulness	90.9 % (30/33)	84.4 % (27/32)	N. S.
Tolerability	75.8 % (26/33)	87.5 % (28/32)	N. S.

* χ^2 test, N. S.; Not significant

and 229 min for the colonoscopy patients) and 186 min in the modified preparation group (216 min for the surgical patients and 155 min for the colonoscopy patients). No significant difference in mean PEG excretion time was observed between the two groups (Table 3). The mean number of bowel movements was 9.2 in the standard preparation group (9.9 for the surgical patients and 8.4 for the colonoscopy patients) and 6.8 in the modified preparation group (6.6 for the surgical patients and 6.9 for the colonoscopy patients). No significant difference in the mean number of bowel movements was observed between the two groups (Table 3).

The efficacy rate was 81.8 % (27/33 patients) for the standard preparation group and 68.8 % (22/32 patients) for the modified preparation group, while the safety rate was 97.0 % (32/33 patients) and 96.9 % (31/32 patients). The usefulness rate was 90.9 % for the standard preparation group (30/33 patients) and 84.4 % for the modified preparation group (27/32 patients), and the tolerability rate was 75.8 % (25/33 patients) and 87.5 % (28/32 patients). No significant differences between groups were observed for any of these parameters (Table 4).

DISCUSSION

A modified Brown method used to be the main regimen for preparation of the large bowel for colorectal surgery and colonoscopy [11]. The use of PEG spread quickly after it was developed by Davis et al. in 1980 [2–4]. However, Japanese patients frequently complained about taking 4 L of PEG according to the original regimen, despite the lack of dietary restrictions, and this has led to studies on various modified regimens [12–15]. The standard combination of PEG and magnesium citrate, used by our department since 1988, has made it possible to reduce the total dose of PEG to 2–3 L for most patients (Table 2). The present review, 10 years after the adoption of PEG, showed that a mean PEG volume of approximately 2.8 L can be used ever without dietary restrictions. Our patients who underwent surgery on the esophagus included a relatively large number of elderly individuals who found it hard to tolerate 3 L of PEG. However, 2 L of PEG did not provide sufficient lavage. The modified method involving dietary restriction made it possible to reduce the PEG volume to less than 2 L, to a mean volume of 1,694 ml (Table 3). Since the diet was restricted, however, the average daily calorie intake was decreased to a total of 857 Kcal/day from the day before surgery. This indicates the need to review the preoperative delivery of calories, including an increase by preoperative hyperalimentation. The quality of the modified diet should also be improved with regard to both taste and quantity, since the semi-solid diet used in this study was unsatisfactory in these respects. Because the semi-solid diet is classified as an inpatient diet by the national health insurance system, the cost to the patient is not increased. In fact, because the PEG volume was reduced by half to < 2 L, this contributed to some cost benefit for the patients.

It was possible to reduce the total PEG volume to approximately 1 L in some patients in the modified preparation group, which increased tolerability of the regimen. Although assessment of the PEG volume showed no significant difference between the two groups, patient discomfort was thought to be somewhat relieved. Some 80% of the colonoscopy outpatients in the modified preparation group were able to undergo colonoscopy after taking only 1 L of PEG (data not shown). This suggested that the patient's age and activity level may have a significant relationship with the efficacy of colonic lavage. A favorable response to the modified regimen has been received from patients, especially those who experienced both the standard and modified methods, although the number is small (data not shown). These patients stated that if the total PEG volume could be reduced to 1 L, some dietary restriction was no longer a problem. An investigation of outpatients by questionnaire is now underway.

The dose of PEG was larger and the total time required to take it was longer for the standard preparation group, but the PEG was excreted more quickly by this group. The modified preparation group took a lower PEG volume in a shorter time, but the PEG excretion time was longer for this group. It has been reported that the efficacy of lavage by PEG is proportional to the dose and the speed at which it is taken [8–10].

The present study showed that, if the total PEG volume taken was less than 1.7 L, the PEG dose per unit time was approximately 1 −2 L/hr. It was suggested that taking the PEG a little faster might be more useful. In order to relieve patient discomfort as much as possible by reducing the dose of PEG to 1 L and to carry out lavage by shortening the PEG excretion time, it will be necessary to conduct additional studies involving the use of a laxative to increase gastrointestinal peristalsis.

These results suggest that it is possible to reduce the PEG volume by more than 1 L using the modified bowel preparation regimen, which will alleviate patient discomfort without any loss of efficacy. This method is considered useful in preparing the large bowel for gastrointestinal surgery or total colonoscopy.

ACKNOWLEDGMENTS

The authors thank Megumi Iwasawa, Takeshi Shirato, and Kenichi Aoki for their valuable advice concerning the manuscript, and Toshikazu Arioka for his assistance with the statistical analysis. This study was supported in part by a grant from the Tokai University Medical Research Organization.

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