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A Comparison of Bowel Preparations for Flexible Sigmoidoscopy: Oral Magnesium Citrate Combined With Oral Bisacodyl, One Hypertonic Phosphate Enema, or Two Hypertonic Phosphate Enemas

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OBJECTIVE: Magnesium citrate with hypertonic enemas or oral bisacodyl provides superior preparation quality for sigmoidoscopy over enemas alone. We compared three magnesium citrate sigmoidoscopy preparations in a randomized, single-blind, controlled trial.

METHODS: Two hundred and ninety-one adults scheduled for routine sigmoidoscopy were randomly assigned to receive one of three preparations containing oral magnesium citrate (296 cc) taken the night before the procedure in combination with the following: 1) oral bisacodyl (10 mg), given with the magnesium citrate the night before the procedure; 2) one hypertonic phosphate enema 1 h before the procedure; or 3) two hypertonic phosphate enemas, given singly at 2 and 1 h before the procedure. Endoscopists rated preparation quality, procedure duration, and depth of endoscopic insertion. Patients assessed preparation comfort and overall satisfaction.

RESULTS: Preparation quality was rated as excellent or good for 80.6% in the bisacodyl group, 88.7% in the one-enema group, and 85.1% in the two-enema group ($p = 0.30$). Patients reported the oral bisacodyl regimen was better tolerated ($p = 0.032$). Although the three regimens were comparable in most side effects, the bisacodyl preparation was associated with more diarrhea ($p = 0.0003$). Mean procedure duration, mean insertion depth, and prevalence of diverticula and polyps were similar in all groups. Fewer than 4% of patients required repeat procedures due to poor preparation quality.

CONCLUSIONS: There was no statistical difference between the quality of the three bowel preparations. Patients considered an oral bisacodyl and magnesium citrate regimen more easily tolerated, though it was associated with more diarrhea. (Am J Gastroenterol 1999;94:2122–2127. © 1999 by Am. Coll. of Gastroenterology)

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INTRODUCTION

Flexible sigmoidoscopy is among the most common outpatient procedures performed by primary care physicians (1). Good visualization of the colonic mucosa is essential to an adequate procedure. Numerous bowel preparations have been used over the years. Previous studies had not identified a clearly superior method and several found no significant difference between one- or two-enema preparations (2–7). However, two studies published over the past 2 years have shown better preparation methods.

One study showed a significant improvement in preparation quality and patient comfort using a combination of oral magnesium citrate and oral bisacodyl over a hypertonic phosphate two-enema preparation (8). Another study recently published from several of our authors compared magnesium citrate plus two hypertonic phosphate enemas, *versus* one- and two-enema preparations (9). It also showed a significant quality improvement with the two-enema/magnesium citrate preparation over the enemas alone, with no difference seen between one- or two-enema preparations. There was no significant difference in patient comfort ratings between the groups.

Based on these studies, we surmised that the addition of oral magnesium citrate to either an oral cathartic agent or enemas improved bowel preparation quality. The remaining question we attempted to answer is whether enemas, either one or two, combined with magnesium citrate, are superior to a completely oral preparation of magnesium citrate and oral bisacodyl.

MATERIALS AND METHODS

All patients undergoing flexible sigmoidoscopy in the Madigan Army Medical Center (MAMC) Adult Primary Care Clinic between July 1, 1997 and July 10, 1998 and in the Walter Reed Army Medical Center (WRAMC) Gastroenterology Clinic between May 1, 1998 and August 7, 1998 were invited to participate. Exclusion criteria included un-

dergoing the procedure without preparation, dementia, a history of serum creatinine >2.0 mg/dl, congestive heart failure, a history of hyperphosphatemia or hypermagnesemia, or age <18 yr old. Our institution's Human Use Investigation Committees approved this trial and all patients provided informed consent.

Patients were randomly assigned to receive preparations containing oral magnesium citrate (1.745 g/fl. oz., 296 ml, Citroma, Cumberland-Swan Inc., Myrna, TN) taken at 6:00 PM the night before the procedure in combination with one of the following:

1) oral bisacodyl (10 mg, Dulcolax, Novartis, Summit, NJ), administered with the magnesium citrate at 6:00 PM the night before the procedure;
2) one hypertonic phosphate enema (Fleet's Enema, C.B. Fleet Company, Lynchburg, VA), administered 1 h before the procedure;
3) two hypertonic phosphate enemas (Fleet's Enema) administered singly at 2 and 1 h before the procedure.

Immediately before undergoing sigmoidoscopy, patients completed surveys assessing procedure indication, history of constipation, diverticulosis or colonic polyps, and functional status (10), as well as rating preparation discomfort and side effects. Immediately after sigmoidoscopy, surveys measured patient perceptions of procedure comfort, satisfaction, and willingness to undergo the procedure again. A single question addressing overall ease of preparation was rated on a 5-point Likert scale, ranging between "easy," "tolerable," "slightly difficult," "extremely difficult but able to finish," and "unable to finish." Questions about specific preparation side effects (nausea, vomiting, bloating, cramping, pain, and diarrhea) were rated on a 4-point Likert scale, ranging between "none," "mild," "moderate," and "severe."

One of three internists at one center (MAMC) and one of two gastroenterology fellows at the other center (WRAMC) performed all sigmoidoscopies. All procedures were performed using 60-cm videoendoscopes (CIF-130S, CIF-100S; Olympus America, Inc., Melville, NY). Endoscopists were blinded to preparation type and asked to rate quality, record insertion depth, and note which exams required repeat preparation or were limited by preparation quality. Technicians noted procedure duration. Participating endoscopists rated quality according to the following standard, derived by a consensus among endoscopists in the Departments of Internal Medicine and Gastroenterology and found to be reliable in our previous study (9):

Excellent: No formed stool encountered; minimal fluid, which was easily aspirated; occasional liquid stool, no more than small bits of adherent feces;

Good: Occasional stool, >90% of mucosa readily visualized, with 100% easily visualized with suction or flush, such that no abnormality could have been overlooked;

Adequate: Formed stool present, or <90% of mucosa readily visualized, but the exam could still be completed with extensive flush and suction so that no abnormality could be overlooked;

Poor: Formed stool present to the degree that significant pathology could be missed or that there is added difficulty to the negotiation of the colon; possibly inadequate depending on procedure indication.

Statistical Analysis

Analysis was done with χ^2 for categorical variables and Student's *t* test, analysis of variance (with Scheffé's multiple comparison test), or Kruskall-Wallis for continuous variables, as appropriate, using STATA (11). Multivariate regression methods were used to adjust for potential confounding variables such as presence of polyps, specific endoscopist, or resident participation on procedure duration. Sample sizes were selected to show a 20% difference in preparation quality (two-tailed, $\alpha = 0.05$, $\beta = 0.20$) when the quality rating criteria were dichotomized into excellent and good *versus* adequate and poor. Interobserver reliability of quality rating criteria, using 10 representative photographs of study and nonstudy sigmoidoscopies shown to all participating endoscopists, was assessed using the κ statistic (12).

RESULTS

More than 95% of eligible patients enrolled and 89.3% of enrolled patients completed the study. Most of those patients not completing the study decided not to have the procedure, moved from the area, or had other medical testing supercede the procedure. Five patients violated blinding by identifying their preparation to the endoscopist (oral bisacodyl/citrate = 3, one-enema/citrate = 1, two-enema/citrate = 1). These patients were excluded from the preparation quality analysis. Study patients in the three groups were similar with regard to age, gender, race, procedure indication, and history of diabetes, diverticulosis, and polyps (Table 1). However, patients receiving the two-enema/magnesium citrate combination were more likely to have a history of constipation. Ninety-three patients (n = 93) received the oral bisacodyl/citrate combination; 97 (n = 97) received the one-enema/citrate combination; and 101 (n = 101) received the two-enema/citrate combination. Eighty-nine percent underwent sigmoidoscopy for cancer screening, similar in all groups. All endoscopists had an equivalent distribution of preparations, though not all endoscopists performed equal numbers of procedures (Table 1).

There were no differences in the quality ratings given the three bowel preparations, with 81%, 89%, and 85% of those receiving the exclusively oral, single-enema, or double-enema regimens rated as excellent or good, respectively (Fig. 1). There were no differences in the amount of colon visualized or procedure duration, even after adjustment for the presence of polyps, specific endoscopist, and resident participation (Table 2). There were also no differences in the

Table 1. Patient Characteristics and Endoscopists by Preparation Type

Characteristic	Oral Bisacodyl + Magnesium Citrate	One Enema + Magnesium Citrate	Two Enemas + Magnesium Citrate	*p* Value
Age (yr)	60.0	59.6	60.1	0.88
Gender (% male)	46.3	49.5	50.5	0.83
Race (%)				
White	78.5	81.1	78.8	0.89
Black	7.5	6.3	9.1	0.77
Asian-American	11.8	10.5	9.1	0.83
Other	2.2	2.1	3.0	0.91
History of (%)				
Constipation	9.5	12.3	22.7	0.02
Diabetes	17.9	7.2	16.8	0.06
Diverticuli	3.2	6.2	6.9	0.47
Polyps	6.3	6.2	3.0	0.48
Procedure indication (%)				
Cancer screening	93.6	84.5	89.1	0.13
Hematochezia	3.2	7.2	6.9	0.41
Other	3.2	8.2	4.0	0.22
Endoscopist (%)				
A (n = 90)	30.0	27.8	42.2	0.70
B (n = 30)	30.0	36.7	33.3	
C (n = 85)	30.6	34.1	35.3	
D (n = 66)	34.8	36.7	28.8	
E (n = 20)	40.0	40.0	20.0	

likelihood of visualizing polyps or diverticula in the three study groups. Patients reported no differences in procedure discomfort and were equally likely to be willing to undergo repeat sigmoidoscopy in the future. Interobserver agreement (κ) of study quality criteria within the four preparation quality categories was moderate (0.58). When quality ratings were dichotomized into excellent and good *versus* adequate and poor, interobserver reliability increased (κ = 0.76).

Patients rated the oral regimen more easily tolerated, followed by the single-enema/citrate combination. The two-enema/citrate combination was considered significantly more difficult than either of the other two regimens (p = 0.032) (Fig. 2). There was a stepwise increase in patient

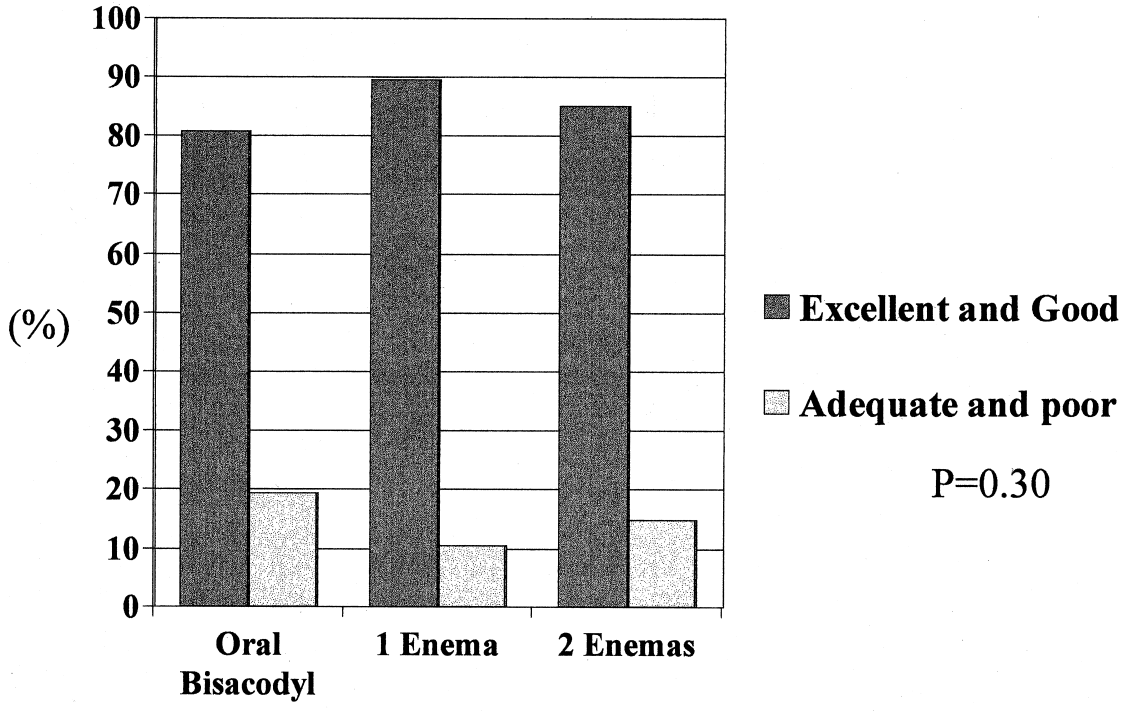

Figure 1. Excellent and good *versus* adequate and poor quality ratings, by preparation type.

Table 2. Outcomes by Bowel Preparation Received

Outcome	Oral Bisacodyl + Magnesium Citrate (n = 93)	One Enema + Magnesium Citrate (n = 97)	Two Enemas + Magnesium Citrate (n = 101)	*p* Value
Preparation quality (%)				
Excellent	58.1	69.1	69.3	0.30*
Good	22.6	19.6	15.8	
Adequate	12.9	9.3	11.9	
Poor	6.5	2.1	3.0	
Repeat preparation required (%)	4.3	2.1	3.0	0.66†
Polyps present (%)	24.4	22.7	23.0	0.96
Diverticuli present (%)	35.6	32.0	30.0	0.71
Means				
Procedure duration (min)	13.0	12.5	12.0	0.63
Length of insertion (cm)	54.8	56.5	56.6	0.51
Preparation tolerance (%)				
Easy	60.0	53.7	41.6	0.032‡
Less than easy	40.0	46.3	58.4	
Diarrhea from preparation (any, %)	80.0	67.7	52.5	0.0003‡
Fully satisfied (%)	91.4	92.8	95.0	0.60

* Dichotomized data: good/excellent *vs* adequate/poor, χ^2; † χ^2; ‡ χ^2 dichotomized data from Likert scale.

reports of preparation difficulty from the magnesium citrate/bisacodyl regimen to a single-enema and double-enema method ($p = 0.01$ for trend). Although there were no differences in the incidence of most side effects including nausea, vomiting, pain, cramping, and bloating, patients receiving the completely oral preparation (bisacodyl/citrate) were more likely to experience diarrhea (odds ratio [OR], 2.7; 95% confidence interval [CI], 1.5–4.7) (Fig. 2), though this higher incidence of diarrhea did not affect patient satisfaction (Table 2).

There was no difference in preparation quality ratings between patients reporting a history of constipation, diverticula, or polyps, or by patient demographics including age. However, diabetic patients were less likely to have preparations rated as excellent or good (OR, 0.25; 95% CI, 0.12–0.53).

DISCUSSION

Our study found no differences in preparation quality between an exclusively oral regimen (bisacodyl/citrate) and a combination of magnesium citrate with either one or two

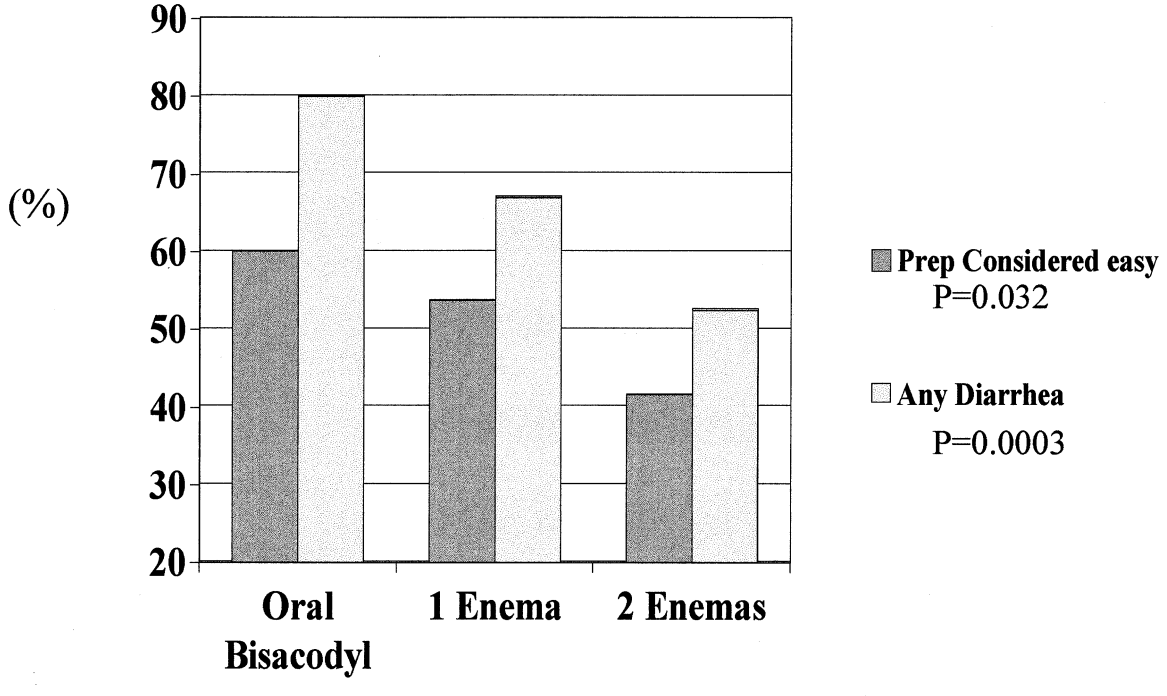

Figure 2. Patients considering the preparation easy and the presence of any diarrhea, by preparation type.

enemas. Patient satisfaction and tolerance of all three preparations was high, though patients clearly preferred the oral regimen to the enema regimens. There was a stepwise decrease in patient-reported preparation difficulty from the double-enema preparation, to the single-enema, and the exclusively oral regimen. This suggests that patients would prefer to avoid enemas. A higher incidence of diarrhea was seen in the exclusively oral regimen, but this did not diminish patient satisfaction and most of this diarrhea was rated as mild. When combined with oral magnesium citrate, one hypertonic phosphate enema worked just as well as two enemas, confirming prior studies looking at enemas alone (3, 5, 9).

The importance of a good colon preparation cannot be overstated. With the current belief that polyp removal may lower subsequent colon cancer rates, a meticulous evaluation of the colonic mucosa is essential. The combination regimens in this study provided either excellent or good preparations in more than 84% of patients, significantly higher than the 57% rate seen with enema alone in our previous study and similar rates in other studies (8, 9). Further, fewer than 4% of the procedures were repeated due to inadequate preparations, compared with 13% with enemas alone in our previous study (9). The agents used in this study are safe and inexpensive (7–9). A reduction in the number of repeat procedures could prove quite cost-effective when repeat procedure time and expense is considered. Because many endoscopy suites prefer to give enemas in the clinic to assure compliance, the completely oral regimen could potentially lessen nursing time and could better streamline clinic scheduling by avoiding the task of assisting patients with enema use.

Other completely oral regimens, such as oral hypertonic sodium phosphate (OHP) and electrolyte-balanced polyethylene glycol (PEG), have also been evaluated for both barium enema and colonoscopy preparation. In 1993, a study compared OHP, PEG, and castor oil regimens in colonoscopy and found overall better preparation quality and better patient tolerance with the OHP regimen (6). This study also separately evaluated the left colon preparation quality and found no statistical differences, with each regimen producing >80% excellent or good preparations—similar to our results. Castor oil is not used frequently due to its poor palatability and side effects, but both the PEG and OHP regimens are often used for colonoscopy preparation. Several other studies and a meta-analysis have shown oral hypertonic sodium phosphate preparation quality to either be equivalent to or superior to PEG preparation quality, but patients seem to tolerate it better (13–16). Oral hypertonic sodium phosphate is also inexpensive and may be a viable option in selected individuals for sigmoidoscopy. Whether it is superior in preparation quality and patient comfort to the combination regimens evaluated in our study is unknown.

The strengths of this study include a large study population (n = 291) from two study sites, blinding of endoscopists, intention-to-treat analysis, and objective quality ratings with substantial interrater agreement and study randomization. However, study limitations do exist. First of all, given the preparation quality excellent ratings of 69.3%, our study was sufficiently powered to demonstrate a statistically significant difference of excellent ratings of 30%. However, when quality ratings were combined into excellent and good ratings, the study was powered to show a 20% difference between groups. Finally, patients receiving two enemas and magnesium citrate had higher baseline constipation, but analysis of this difference found no impact on any of our reported outcomes in either univariate or multivariate models.

CONCLUSIONS

In summary, clinicians performing flexible sigmoidoscopy should strongly consider the use of bowel preparations including magnesium citrate, in combination with either one hypertonic phosphate enema or oral bisocodyl. The use of these regimens would improve mucosal visualization, which would allow better polyp screening and reduce the number of repeat procedures due to poor preparations. The use of magnesium citrate and oral bisacodyl could also reduce nursing time. Such benefits could save overall clinic time and money.

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