

Comparison of Safety and Effectiveness Between Sodium Phosphate and Polyethylene Glycol 4000-base Solution for Bowel Preparation for Colonoscopy in Elderly Patients

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ABSTRACT

Aim: To compare the safety and effectiveness of two colonic lavage solution in elderly patients.

Methods: Thirty-eight consecutive patients received either standard 2 L of polyethylene glycol 4000-base solution (PEG) or 90 mL of sodium phosphate (NaP) in a split regimen of 45 mL of NaP at 12 hours apart, prior to colonoscopic evaluation. The primary endpoint was serum electrolyte, creatinine, calcium, magnesium and phosphate levels before and after complete preparation. Secondary endpoints included colonic cleanliness evaluated by an overall assessment and segmental evaluation assessed by a scoring system for cleanliness and visibility of bowel.

Results: Thirty-two patients received PEG and six patients received NaP. Both groups showed no significant differences in preparation scores. There were minimal electrolyte changes with PEG, whereas hypocalcemia and hyperphosphatemia developed in 16.7% and 84.4% of patients in the NaP group.

Conclusion: Both bowel cleaning agents were proved to be similar in effectiveness for elderly patients. NaP preparation caused more significant changes in the levels of potassium and calcium, which were hypocalcemia and hyperphosphatemia. We recommend that NaP should only be given to medically fit subjects and PEG should be given to high risk groups, i.e cardiovascular or renal impairment.

Key words : Colonoscopy, Bowel preparation, Sodium phosphate, Polyethylene glycol

[Thai J Gastroenterol 2009; 10(2): 91-97.]

INTRODUCTION

Nowadays, colonoscopy is performed more and more often as a routine examination in elderly patients but tolerability and safety of examinations and preparation are often considered questionable in the elderly although colonoscopy has been proved to have a high yield and low risk.^(1,2) In the past two decades, various bowel preparation methods have been proposed that included castor oil, anthroquinones, diphenylmethanes, phenolphthalein and magnesium citrate, in combination with low residue diet. Along with these bowel-cleansing agents, enemas formed the traditional bowel preparation.⁽³⁻¹²⁾ In 1980, Davis *et al*⁽¹¹⁾ developed a polyethylene glycol (PEG) base solution. PEG has been the most often used cleansing agent in recent years. Many studies have demonstrated its good tolerability and effectiveness in cleansing the colon.⁽¹³⁻¹⁸⁾ The main disadvantage of PEG is the large amount of volume that is needed to take, and this is not well tolerated by some patients. As reported, 5-15% of patients were unable to finish the prescribed dosage.^(10,19)

Sodium phosphate has been used for bowel preparation since 1969.^(20,21) In 1990, oral sodium phosphate (NaP), a high osmotic cathartic containing monobasic and dibasic sodium phosphate, was first evaluated by Vanner *et al*.⁽¹³⁾ by comparing with PEG solutions. Several studies have been conducted to compare both NaP and PEG solutions, the majority of which have suggested a superiority or equivalence of NaP for adequate mechanical bowel preparation and safety.^(14,19,22,23)

The bowel cleansing efficacy of PEG and NaP has been studied widely. The comparison of these two regimen have yielded conflicting results, although a recent meta-analysis report favoured NaP.^(24,25) However, various studies also warned of potential problem with NaP preparations, such as hyperphosphatemia, hypocalcemia, hypokalemia, congestive heart failure and renal failure.^(13,26,27) Moreover, NaP was proven to be more cost-effective and it has since been used worldwide.^(14,22,24) Previous studies comparing colonoscopy preparation methods have been conducted on patients with younger age.

The aim of the study was to determine which preparations would be optimal for older patients. The primary aim was to investigate the feasibility of safety blind allocation of patients to PEG or NaP and to assess the changes in electrolytes and other relevant parameters. The secondary aim was to evaluate the quality of bowel preparation.

PATIENTS AND METHODS

A prospective observational study was conducted at GI unit of Internal Medicine Department of Pramongkutkiao hospital. The study population consisted of in-patients who were referred for diagnostic and therapeutic colonoscopy between March 2007 and January 2008. A total of 38 consecutive patients with age over 60 years old received either sodium phosphate (Swift[®], Berlin Pharmaceutical Industry Co., Ltd., Bangkok, Thailand) or polyethylene glycol 4000-base Solution (NIFLEC[®], Thai Meiji Pharmaceutical Co., Ltd., Bangkok, Thailand) by assignment of nursing personnel. A trained registered nurse (RN) assigned patients to their group and gave instruction to them according to their assigned bowel preparation method. Inclusion criteria were out-patients scheduled for routine colonoscopy, age over 60 years old and willing to sign the informed consent. Patients with impair renal function (creatinine level over 1.6 mg/dL), severe congestive heart failure, previous colectomy or bowel resection, unstable angina and acute coronary syndrome, massive ascites, megacolon suspected bowel obstruction were excluded.

Pre-colonoscopy preparation

All patients were advised to have low-fiber diet and avoid iron supplement on the fourth day through the second pre-procedural day. On the day before the procedure, they were advised to have only clear liquid. The patients were then told to take either PEG or NaP colonic bowel preparation. Patients in the NaP group took 45 ml of NaP solution at 2:00 PM and 5:00 PM in the evening of the study. The PEG instructions told the patient to take 2 liters of PEG solution between 5:00 PM and 8:00 PM the day before study

Data collection

As part of their routine, pre-procedural evaluation, all patients referred for colonoscopy were interviewed by nursing personnel. The collected data were as follow: age, sex, preparation type (PEG vs NaP), indications for colonoscopy.

Blood tests for electrolytes, creatinine, calcium, phosphate and magnesium were collected before bowel preparation procedure and after the completion of the bowel preparation.

Colonoscopy and quality of bowel preparation

All colonoscopies were performed by senior fel-

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lows under the direct supervision of a staff gastroenterologist. A calibration exercise was conducted to ensure that the participating endoscopists understood and agreed on the rating of bowel-preparation quality by using the Ottawa bowel preparation scale.⁽²⁸⁾ This validated scale rates each of the right, the mid, and the rectosigmoid colon on a 5-point scale (0-4), as well as a global 3-point rating for overall colonic fluid. The total score ranges from 0 to 14. An excellent preparation were scored 2 to 4 while scores higher than 4 indicated progressively worsening bowel preparations. A completely unprepared colon would be scored 11 to 14, depending on the amount of colonic fluid. The endoscopists rated the bowel-preparation quality during the procedure and recorded the results on a separate standardized form.

Statistical Analysis

For safety reasons, as the feasibility of safety allocation to either solution was assigned by nursing personnel, a consecutive serial of 38 patients was observed in our study. Power statistics was not performed. Data are presented as mean values and standard deviations. Chi-Square statistics or Fisher exact test was used to compare nominal and categorical measures. Absolute score values and absolute serum levels and proportional changes of blood parameters were compared between both groups with student's t-test or Mann Whitney U-test if it was non-Gaussian distribution. A *p*-value of <0.05 (two-tails) was considered as statistically significant.

RESULTS

Thirty-eight consecutive entered the study. Thirty-two patients were allocated to receive PEG and six patients were allocated to receive NaP. The baseline characteristics and the indications for colonoscopy are presented (Table 1). The most common reason for colonoscopy was anemia.

Laboratory changes

Changes in laboratory values from baseline were commonly seen. However, none of the enrolled patients developed clinically overt manifestations of these derangements. No significant changes in sodium (Na) and creatinine levels occurred in any patients. As a whole, statistically significant changes in serum potassium (K), sodium chloride (Cl), serum bicarbonate

Table1. Characteristics of patients allocated to NaP or PEG

	Preparation methods	
	NaP (n = 32)	PEG (n = 6)
Male/female	18/14	4/2
Age	76.88 ± 5.22	80.00 ± 3.85
Indications for Colonoscopy		
Bowel habit change	3	1
Anemia	12	1
Constipation	8	0
Chronic diarrhea	2	1
LGIB	2	0
Abdominal pain	1	0
Weight loss	2	1
Screening	2	2

(CO₂), phosphate (PO₄), magnesium (Mg), calcium (Ca) levels from base line were found in the NaP group. PEG was associated with statistically significant changes in chloride (Cl) and calcium (Ca) levels (Table 2). When the proportional changes of test results were compared between both groups, the proportional increasing in phosphate was significantly different (Table 3).

As outlined in Table 4, no patients in the PEG group developed "significant" electrolyte changes in Na, K, Ca and PO₄ levels. However, some patients in the NaP group developed significant electrolyte level changes. In particular, 84.4% of patients took NaP developed Hyperphosphatemia (PO₄>4.5), comparing with 16.7% in the PEG group (with statistical significance) Furthermore, 16.7% of NaP subjects developed hypocalcemia, comparing with none in the PEG group. Finally, 16.7% of patients taking PEG developed hypokalemia (K <3.0), comparing with 3.3% of the NaP group.

Bowel-preparation quality

Both preparation strategies were associated with reasonably worsening bowel cleansing, with both groups showing mean total Ottawa preparation scores of more than 4 (Table 5). The right colon was consistently difficult to be clean, with segment scores of 1.67 and 1.90 out of 4 (between good and fair), without significant differences. For the remaining colonic segments and for the total preparation score, NaP group

Table 2. Blood values in NaP and PEG group, pair wise compared before and after the intake of the solution

	Value before intake	Value after intake	Mean difference (95%CI)	p-value
Preparation 1 (NaP)				
Na	138.38 ± 2.85	139.13 ± 3.15	-0.76 (-2.19,0.68)	0.288
K	4.14 ± 0.87	3.78 ± 0.55	0.36 (0.08,0.65)	0.014
Cl	102.01 ± 2.81	103.60 ± 3.16	-1.59 (-2.89,-0.28)	0.019
CO ₂	26.63 ± 2.02	25.62 ± 2.14	1.01 (0.35,1.67)	0.004
P	3.37 ± 0.53	5.31 ± 1.28	-1.94 (-2.44,-1.44)	<0.001
Mg	2.22 ± 0.24	2.11 ± 0.25	0.1 (0.03,0.18)	0.008
Ca	9.27 ± 0.46	9.08 ± 0.45	0.19 (0.01,0.37)	0.039
Cr	0.99 ± 0.30	1.06 ± 0.42	-0.08 (-0.16,0.01)	0.090
Preparation 2 (PEG)				
Na	137.58 ± 2.62	140.27 ± 0.98	-2.68 (-5.95,0.58)	0.088
K	4.25 ± 0.46	3.93 ± 0.23	0.32 (-0.1,0.74)	0.111
Cl	101.82 ± 3.06	104.38 ± 3.50	-2.57 (-4.29,-0.85)	0.012
CO ₂	27.42 ± 2.34	25.78 ± 4.13	1.63 (-2.15,5.42)	0.318
P	3.33 ± 0.30	3.57 ± 0.63	-0.23 (-0.96,0.49)	0.445
Mg	2.17 ± 0.27	2.02 ± 0.15	0.15 (-0.01,0.31)	0.060
Ca	9.23 ± 0.47	8.97 ± 0.54	0.27 (0.07,0.46)	0.017
Cr	1.37 ± 0.48	1.37 ± 0.40	0 (-0.15,0.15)	1.000

Table 3. Comparison of proportion changes in pre-ingestion and post-ingestion values between NaP and PEG

	NaP	PEG	Mean difference (95%CI)	p-value
Dif_Na	-0.76 ± 3.77	-2.68 ± 3.11	1.92 (-1.43,5.28)	0.252
Dif_K	0.36 ± 0.75	0.32 ± 0.4	0.05 (-0.6,0.69)	0.887
Dif_Cl	-1.59 ± 3.43	-2.57 ± 1.64	0.98 (-1.96,3.93)	0.503
Dif_CO ₂	1.01 ± 1.74	1.63 ± 3.61	-0.63 (-4.4,3.15)	0.693
Dif_P	-1.94 ± 1.38	-0.23 ± 0.69	-1.71 (-2.89,-0.53)	0.006
Dif_Mg	0.10 ± 0.21	0.15 ± 0.15	-0.05 (-0.23,0.13)	0.600
Dif_Ca	0.19 ± 0.5	0.27 ± 0.19	-0.08 (-0.5,0.35)	0.718
Dif_Cr	-0.08 ± 0.25	0 ± 0.14	-0.08 (-0.29,0.13)	0.469

Table 4. Important electrolytes abnormalities

Post-preparation electrolytes	Preparation group	
	NaP (n = 32)	PEG (n = 6)
Na >145 mEq/L	1 (3.3%)	0 (0%)
Na <125 mEq/L	0 (0%)	0 (0%)
K <3.0 mg/dl	1 (3.3%)	1 (16.7%)
Ca <8.1 mg/dl	1 (16.7%)	0 (0%)
PO ₂ >4.5 mg/dl	27 (84.4%)	1 (16.7%)

Table 5. Bowel preparation quality by preparation group

	Preparation group, mean score		p-value
	NaP	PEG	
Right colon	1.90	1.67	0.675
Mid colon	1.16	1.50	0.445
Rectosigmoid colon	0.94	1.17	0.596
Colonic fluid	0.84	1.00	0.568
Total score	4.84	5.33	0.916

*Mann-Whitney U test

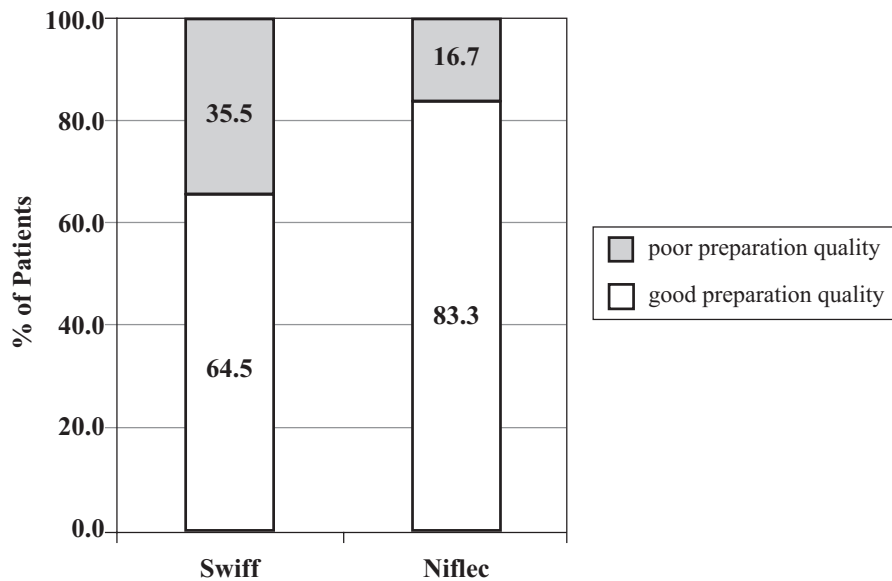


Figure 1. Percentage of patients with poor preparation quality. Poor quality is defined as total Ottawa Prep score more than 5 (includes fair, poor, and inadequate scores). A good preparation score includes colon-segment scores rated as excellent or good without any more than one colon segment rated as fair.

produced a little better cleanliness than PEG group (Table 5 and Fig 1). Only 16.7% of PEG group had poor preparation, compared with 35.5% of NaP group without statistical significance.

DISCUSSION

The key objective of this observation study was to determine which of the preparations would be suitable for older patients. The result of this study demonstrated that both bowel preparation strategies were generally effective in term of producing at least fair-to-good bowel cleansing. Both cleansing agents were proved to have equal effectiveness. The safety of preparation was better in the PEG group. PEG caused less change in laboratory tests. NaP also caused clinically and statistically significant changes in the levels of K, Cl, CO₂, Mg, Ca and PO₄. These changes have been observed in previous studies with younger patients too.^(3,6,11) Potentially significant changes in PO₄ were observed almost exclusively in the NaP group. Significant hyperphosphatemia were strictly observed with NaP preparations. We did not observe any clinical manifestations of these electrolyte abnormalities and no patient required specific treatment for these findings.

Hookey *et al.*⁽²⁹⁾ extensively reviewed the litera-

tures regarding the safety of oral PO₄ solutions. In their review, the investigators found that oral PO₄ solutions were generally safe and that most adverse events occurred when these agents were used in high doses or in the patients with contraindications to their use, such as renal impairment or significant comorbidities. NaP result in Hyperphosphatemia in patients when compared to PEG. Yoshioka *et al.*⁽³⁰⁾ reported a significant increase in phosphate levels in the NaP group but it was not clear if any of these patients was symptomatic. Other biochemical parameters, however, were not affected.

Misha *et al.*⁽³¹⁾ reported two patients with renal impairment who developed severe symptomatic hyperphosphatemia and hypocalcemia after bowel preparation with oral NaP. Serum Phosphate was elevated with some degree of renal impairment.

Elevated serum phosphate also was correlated independently with increasing age. Age above 60 years was more frequently associated with abnormal post-cleansing laboratory values. A significant greater rise in phosphate levels in older patients might be explained by subclinical loss of renal function or an increase in intestinal transit time that may accompany the process of ageing. A slower passage through the intestine would allow for more phosphate absorption. Hyperphosphatemia might also be due to a reduction in plasma

volume cause by the bowel preparation, predisposing elderly patients to volume depletion⁽³²⁾.

CONCLUSIONS

Both bowel cleaning agents were found to be equally effective for bowel preparation in elderly patients. We found electrolyte changes in NaP group and significant hyperphosphatemia in NaP group. We recommend that NaP should only be used in medically fit subjects with age older than 60 years, and advise PEG in patients at risks, i.e. elderly, frail patients and those with renal impairment and heart failure.

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