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Enteral nutrition before bowel preparation improves the safety of colonoscopy in the elderly

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Background/aims: *Adverse events during colonoscopy are more likely to occur in elderly. To avoid the adverse events without decreasing the bowel cleanliness is still an unsolved problem. The aim of this study was to determine the effect of enteral nutrition before colonoscopy in a randomized controlled trail.* ***Materials and Method:*** *A total of 108 patients over sixty-five years of age and indicated for colonoscopy were randomized into four groups. Group 1 received a solution of two packages of polyethylene glycol electrolyte powder dissolved in 2000 mL water. Group 2 received 500 mL of enteral nutrition plus polyethylene glycol of the same dosage as in group 1. Group 3 received 200 mL of 25% magnesium sulfate solution. Group 4 received 500 mL of enteral nutrition plus 25% magnesium sulfate solution of the same dosage as in group 3. The intestinal cleaning and various physiological indications were measured before, after bowel preparation, and during colonoscopy.* ***Results:*** *No significant difference in the quality of colon cleansing was found among the four groups. The incidence of adverse effects in groups 2 and 4 was less than in groups 1 and 3.* ***Conclusion:*** *Additional enteral nutrition in elderly patients before bowel preparation did not affect the quality of colon cleansing. However, the process can significantly reduce the incidence of adverse effects.*

Key words: Elderly colonoscopy, bowel preparation

Yaşlı hastalarda barsak hazırlığından önce uygulanan enteral beslenme kolonoskopi güvenliğini artırır

Giriş ve Amaç: *Kolonoskopi sırasında olumsuz olaylara yaşlılarda daha sık karşılaşılmaktadır. Barsak temizliğinde azalma olmadan bu olumsuz olayların önüne geçmek halen çözülememiş bir sorundur. Bu randomize kontrollü çalışmanın amacı kolonoskopiden önce uygulanan enteral beslenmenin etkisinin araştırılmasıdır.* ***Gereç ve Yöntem:*** *Çalışmada 65 yaş üzeri 108 hasta 4 gruba randomize edildi. Birinci grup 2 litre suda çözülmüş 2 paket polietilenglikol kullandı. Grup 2, 500 ml enteral beslenme ile beraber birinci grup ile aynı dozda polietilenglikol kullandı. Grup 3 200 ml %25 magnezyum sülfat solüsyonu kullandı. Dördüncü grup 500 ml enteral beslenme solusyonu ile beraber üçüncü grupla aynı dozda magnezyum sülfat solüsyonu kullandı. Çeşitli fizyolojik belirteçler kolon hazırlığından önce, sonra ve işlem sırasında incelendi ve kolon temizlikleri karşılaştırıldı.* ***Bulgular:*** *Barsak temizliğinin kalitesinde farklılık tespit edilmedi. Grup 2 ve grup 4'de diğer gruplara göre olumsuz olaylar ile daha az karşılaşıldı.* ***Sonuç:*** *Yaşlı hastalarda barsak temizliğinden önce enteral beslenme uygulanmasının barsak temizliğini etkilemediği tespit edilmiştir. Bu uygulama yan etki sıklığını belirgin azaltmaktadır.*

Anahtar kelimeler: Yaşlı hastalarda kolonoskopi, barsak hazırlığı

INTRODUCTION

Effective bowel preparation can improve the accuracy of diagnostic colonoscopy, reducing the rate of misdiagnosed intestinal damage (1,2). Elderly colonoscopy is becoming increasingly popular with the rapid growth of the elderly population in China. The success of elderly colonoscopy depends on reductions in the incidence of adverse effects and safety improvements (3). In our investigation, we

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included enteral nutrition (Sino-Swed Pharmaceutical Corp, Shenzhen, China) to the conventional diet for bowel preparation for colonoscopy to determine the ability of the former to reduce complications while ensuring high-quality bowel cleansing. This study aims to create a more suitable bowel preparation method for elderly patients.

MATERIALS and METHODS

Inclusion criteria

- ✧ Patients > 65 years of age with colonoscopy indication
- ✧ Patients with previous abdominal surgeries, including those with severe cardiopulmonary, liver, or kidney dysfunction, were not enrolled.

Grouping

All the patients were randomized into four groups.

Group 1 (the polyethylene glycol electrolyte [PEG] solution group): One day prior to colonoscopy, two packages of PEG powder (68.56 g per package) were dissolved in 2000 mL warm water. The patients ingested 1000 mL of the PEG solution at 19:00 PM and the rest at 20:00 PM.

Group 2 (the PEG plus enteral nutrition group): One day prior to colonoscopy, the patients ingested 500 mL of enteral nutrition before 16:00 PM. The procedures employed in Group 1 were also performed in Group 2.

Group 3 (the magnesium sulfate group): One day prior to colonoscopy, the patients ingested 100 mL of 25% magnesium sulfate solution at 19:00 PM, followed by 800 mL to 1000 mL warm water. These steps were repeated after 30 min.

Group 4 (the magnesium sulfate plus enteral nutrition group): One day prior to colonoscopy, the patients ingested 500 mL of enteral nutrition before 16:00 H. The procedures employed in Group 3 were also performed in Group 4.

The solution formulation of the enteral nutrition we used is: 100 mL enteral nutrition contains protein 3.4 g, adipose 3.2 g, saturated fatty acids 0.5 g, essential fatty acids 1.9 g, sustained release starch 12g/ 100 mL, fructose 70 g, dietary fiber 1.5 g, sodium ion 63 mg, potassium 107 mg.

The costs of each group for one patients are as follows: Group 1: 100 RMB (price for PEG); Group 2: 180.8 RMB (100 RMB for PEG, 80.8 RMB for enteral nutrition); Group 3: 2 RMB (the price for $MgSO_4$); and Group 4: 82.8 RMB (2 RMB for $MgSO_4$ and 80.8 RMB for the enteral nutrition). The price of enteral nutrition in the market we usually use are listed in Table 1.

Table 1. Enteral nutrition products in the market

Name	Energy density (kcal/mL)	Price
Fresubin	1	42.3
Ensure	1	78
Nutrison	1	101
Ruigao (TP-HE)	1.5	81.2
Polymeric Feeding	1.5	96
Polymeric Feeding	1	79.2
Ruixian (TPF)	1.5	57.6
Ruineng (TPF-T)	1.3	98
Ruidai (TDF-D)	0.9	80.8
Enteral Nutritional Suspension (SP)	1	110

All of the patients followed the conventional dietary requirements of bowel preparation before colonoscopy. Three days prior to colonoscopy, the patients were allowed a semi-liquid diet; a liquid diet was allowed one day prior to colonoscopy.

Outcome measures

The following outcomes were measured to assess the suitability of the bowel preparation method.

Before bowel preparation: Age, gender, constipation/diarrhea, weight, blood pressure, heart rate, blood glucose, liver and kidney functions, electrolytes, oxygen saturation, and electrocardiogram.

After bowel preparation: Weight, blood pressure, heart rate, frequency of defecation, blood glucose, liver and kidney functions, electrolytes, oxygen saturation, electrocardiogram, and symptoms of the digestive or cardiovascular systems.

During colonoscopy: Intestinal cleanliness, heat rate, blood pressure, and oxygen saturation.

The following criteria were used in evaluating the quality of intestinal cleansing (4)

Grade I: No solid excreta, clear vision, and a small amount of clear liquid is noticeable;

Grade II: No solid excrement, a small amount of residue, vision is clear and does not affect the observation;

Grade III: Presence of defecation, as well as dirty liquid, and observation can be performed after flushing with water; and

Grade IV: Defecation residue can be detected, inspection is obstructed or suspended.

The worst results obtained from the rectosigmoid, descending colon, transverse colon, ascending colon, and cecum were recorded to evaluate the quality of the entire intestinal preparation.

The effectiveness of bowel cleansing was evaluated as follows (4)

Markedly: Level I;

Effective: Level II;

Invalid: Levels III and IV;

Efficiency (%) = [(Level I +level II) / total cases]x 100.

Statistical Analyses

Statistical analyses were performed using the Statistical Program for Social Science 13.0. χ2- ,t-tests, and analysis of variance (ANOVA) were used to analyze count, as well as measurement, data. Significant difference tests were performed. Values of $p < 0.05$ were considered statistically significant.

RESULTS

General Information of Patients in Each Group

This trial enrolled 107 patients who were randomly divided into four groups. All patients in this trial had good compliance. No significant difference was found in the patients' age, gender, and underlying diseases, among others ($p > 0.05$), and the data were comparable (Table 2).

Intestinal Cleanliness

The intestinal cleanliness of each patient was evaluated after colonoscopy according to a set of standards. Group 4 (magnesium sulfate plus enteral nutrition group) had the highest proportion of class I cleanliness among the four groups, accounting for 43.5% of the four groups, whereas Group 3 (magnesium sulfate group) had the highest proportion of class II cleanliness, accounting for 53.3% of the four groups (Figure 1).

Defecation Frequency and Intestinal Cleaning Rate

The average defecation frequency after taking laxatives was seven times. No significant difference between the different groups was found ($p = 0.364$) (Table 3).

After bowel preparation by the four methods, the cleaning efficiency of the four groups was over 80%, with the efficiency reaching 87.0% in Group 4. There were no significant differences in the intestinal cleansing efficiency among the four groups ($p > 0.05$) (Table 3). Furthermore, by ANOVA multiple analysis, neither the weight nor the gender contributed to any significant difference ($p > 0.05$).

Changes in the Patients' Weight, Heart Rate, Blood Pressure, Blood Glucose, and Occurrence of Adverse Effects

The amount of enteral nutrition ingested had no effect on the changes observed in the patients' weight, heart rate, systolic blood pressure, diastolic blood pressure, and fasting blood glucose in all four groups. However, the change rates in each group were different: Groups 2 and 4 showed smaller

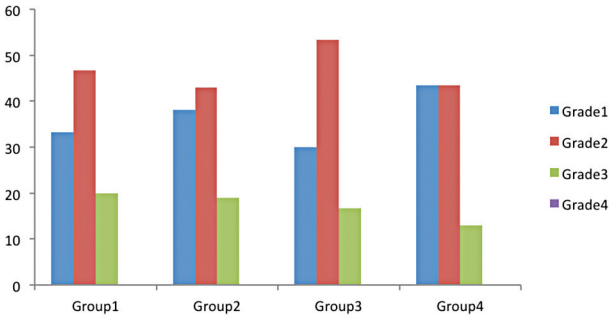

Figure 1. Evaluation of intestinal cleanliness in each group

Table 2. General information of patients in each group

Group	Number (n)	Age (years)	Gender		Underlying diseases						
			Male	Female	Diarrhea	Constipation	Abdominal distension	Intestinal polyps	Anatomy	Emaciation	Ca199/CEA overexpression
1	30	84.6±12.6	18	12	2	5	2	10	2	2	7
2	24	82.5±15.8	13	11	1	2	1	9	3	1	7
3	30	83.3±13.4	17	13	3	3	2	12	1	1	8
4	23	82.8±14.2	12	11	1	3	2	8	2	1	5

ranges in variation compared with Groups 1 and 3, which were not administered enteral nutrition. Significant differences were found (Table 4).

No liver and kidney dysfunction or electrolyte imbalance occurred during bowel preparation in all groups. In addition, blood oxygen saturation was in the normal range, and no changes in EKG were observed. Hypoglycemia, shock, dizziness, angina, and vomiting were not observed in Groups 2 and 4, and no patient in these groups required intravenous fluids. However, nausea and abdominal pain were noted in Groups 2 and 4. The proportions of whole adverse reactions were higher in Groups 3 and 4, where 16.7% and 20.0% of the patients, respectively, required intravenous rehydration therapy (Table 5).

Table 3. Intestinal cleaning efficiency and average defecation frequency of each group after taking drugs

Group	Total efficiency (%)	Average defecation frequency
1	24/30 (80)	6.80±1.540
2	17/21 (81.0)	6.73±1.574
3	25/30 (83.3)	7.43±1.794
4	20/23 (87.0)	7.03±1.771
X2	0.940	
P	0.073	0.364

Table 4. Observation of changes in outcomes during bowel preparation

Group	ΔBW (kg)	ΔHR (times/min)	ΔBP (mmHg)		ΔFBG (mmol/l)
			Systolic blood pressure	Diastolic blood pressure	
1	0.550±0.402	5.17±4.684	7.50±5.374	6.00±4.235	1.11±0.56
2	0.317±0.278	3.57±2.176	4.67±0.342	3.33±4.221	0.347±0.219
P	0.013	0.035	0.027	0.017	0.000
3	0.633±0.392	7.67±3.437	7.83±5.522	6.17±4.292	0.99±0.577
4	0.500±0.347	4.10±2.412	7.17±5.032	4.33±4.372	0.56±0.290
p	0.045	0.000	0.070	0.029	0.000

ΔBW: Difference in the weight of patients before and after bowel preparation; ΔHR: Difference in the heart rate of patients before and after bowel preparation; ΔBP: Difference in the blood pressure of patients before and after bowel preparation; ΔFBG: Difference in the fasting plasma glucose of patients before and after bowel preparation

Table 5. Occurrence rates of adverse events in each group

Group	Hypoglycemia	Shock	Abdominal pain	Angina	Vomiting	Dizziness	Chest pain/ tightness	Intravenous rehydration therapy
1	6/30 20.0%	1/30 3.3%	4/30 13.3%	3/30 10.0%	0	5/30 16.7%	7/30 23.3%	5/30 16.7%
2	0	0	3/24 12.5%	2/24 8.3%	0	0	1/24 4.2%	0
X^2	0.030	1.000	0.627	1.000		0.061	0.063	0.059
P	0.026	0.556	0.313	0.354		0.050	0.047	0.045
3	7/30 23.3%	1/30 3.3%	6/30 20.0%	7/30 23.3%	1/30 3.3%	6/30 20.0%	8/30 26.7%	6/30 20.0%
4	0	0	3/23 16.0%	4/23 17.4%	0	0	1/23 4.3%	0
X^2	0.015	1.000	0.715	0.451	1.00	0.030	0.061	0.028
p	0.013	0.566	0.237	0.233	0.566	0.026	0.030	0.023

DISCUSSION

Bowel preparation is an essential step for colonoscopy and a key point in ensuring clear vision for the procedure (7,8). Effective bowel preparation can improve the diagnostic accuracy of colon diseases and reduce the rate of misdiagnosed intestinal damage (9). Elderly colonoscopy is becoming increasingly popular with the rapid growth of the elderly population in China. The lower organ reserve capacity of elderly patients, together with fluctuations in their diet, rest, body temperature, osmotic pressure, electrolytes, and other physiological factors, affect the homeostasis of the body, as well as increase the heart rate, respiratory rate, blood pressure, and cardiovascular blood flow. Adverse reactions, including weight loss, dizziness, low blood pressure, hypoglycemic events, and cardiovascular events, are likely to occur during bowel preparation (10). Thus, methods by which reduction in adverse events and improvements in the safety of bowel preparation for elderly colonoscopy may be obtained are worthy of clinical attention.

Regular bowel preparation methods include a restricted diet, oral laxatives, or cleansing enema (11). Magnesium sulfate is a commonly used salt laxative. Although this compound is effective in intestinal cleansing, magnesium sulfate stimulates the intestinal tract and may cause dehydration or electrolyte imbalance if a patient lacks fluid supplement (12). The cost of oral PEG is relatively high, but the time costs during bowel preparation are lower, and its side effects are fewer. This supplement is widely used clinically (13,14). However, adverse reactions still occur because of the reduced organ reserve ability of elderly patients (15,16).

In this study, intestinal cleansing and adverse reactions of elderly patients were observed during the most commonly used clinical bowel cleansing methods (oral magnesium sulfate solution and PEG) before colonoscopy. Comparison of the results obtained with those after addition of oral enteral nutrition to bowel preparation was performed. In this study, we found that the bowel cleansing rate was over 80% in the four groups. The addition of 500 mL enteral nutrition to the conventional bowel preparation methods did not affect the intestinal cleanliness and clarity of vision during colonoscopy. No significant differences among the four groups were found ($p>0.05$).

Conventional dietary restrictions during bowel preparations are implemented to reduce stool formation in the intestine, ensuring clear vision during colonoscopy (17). Adverse reactions of insufficient capacity may occur during dietary restriction, but once food intake is increased, defecation will also increase. In the present study, the patients in Groups 2 and 4 were on a regular diet during bowel preparation but ingested an additional 500 mL of enteral nutrition solution. Intestinal cleanliness was not affected, and the defecation frequency did not significantly increase. No statistically significant difference was found in the average defecation frequency among the four groups, probably because of our appropriate choice of enteral nutrition. The enteral nutrition we used is rich in low-molecular weight peptides, has comprehensive nutrition, has no residue, is easy to digest, and can be absorbed completely. This type of nutrition has high bioavailability and can effectively deliver energy, proteins, vitamins, and trace elements to enhance the tolerance of elderly patients for colonoscopy.

As previously mentioned, prior to colonoscopy, patients were on a restricted diet and ingested oral laxatives simultaneously to clean the intestines to ensure clear vision during colonoscopy. However, a considerable loss in body fluids can easily lead to various adverse reactions that are prone to occur in elderly patients, whose compensatory functions of the body are poor, especially in the heart and brain blood vessels (18,19). Results show that the blood pressure, heart rate, fasting glucose, and body weight of all four groups changed after bowel preparation but to different degrees. A significant difference between Groups 1 and 2 ($p <0.05$), as well as between Groups 3 and 4 ($p <0.05$), was found. The incidence of hypoglycemia, shock, chest tightness, and chest pain in the group with enteral nutrition was significantly lower than in the group without enteral nutrition, consistent with the changes in blood pressure, heart rate, and blood glucose. This study suggests that ingestion of 500 mL enteral nutrition by elderly patients during bowel preparation before colonoscopy can reduce the incidence of side reactions such as hypoglycemia, shock, chest tightness, and chest pain, thereby increasing the safety of bowel preparation.

During intestinal preparation, oral laxatives can stimulate the stomach and intestines, easily resulting in gastrointestinal symptoms, such as nausea, vomiting, and abdominal pain (20,21). The results suggest that PEG is less likely to trigger side reac-

tions such as those previously mentioned than magnesium sulfate solution. Gastrointestinal side effects cannot be reduced when 500 mL enteral nutrition is ingested after catharsis in both PEG and magnesium sulfate groups ($p > 0.05$).

In conclusion, ingestion of additional enteral nutrition by elderly patients during bowel preparation for colonoscopy has no effect on the quality of colon cleansing but can significantly reduce the incidence of adverse events, such as hypoglycemia, shock, dizziness, and chest pain, among others. Although the proposed method cannot reduce the abdominal pain, nausea, and symptoms in the digestive tract, additional enteral nutrition can improve the safety of bowel preparation in elderly patients and is therefore a method suitable for elderly patients.

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