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Evaluation of Effect of Split Administration of Compound Polyethylene Glycol Electrolyte Powder Combined With Simethicone Oil in Bowel Preparation Before Colonoscopy in the Elderly

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Objective: This study is to explore the application value of fractional administration of compound polyethylene glycol electrolyte powder combined with simethicone for bowel preparation before colonoscopy in elderly patients.

Methods: The objects are 60 elderly patients who underwent colonoscopy in our hospital in 2021. The patients were randomly divided into the control group and the observation group, with 30 cases in each group. The control group took two doses of polyethylene glycol electrolyte powder eight hours apart for intestinal preparation. On this basis, the observation group was given simethicone for bowel preparation. Adverse reactions, intestinal cleanliness, air bubbles in the intestines, lens clarity, time of entering the lens, amount of saline flushing, and lesion detection were compared between the two groups.

Results: There was no significant difference in adverse reactions, bowel cleanliness score, detection rate of $\geq$0.5 cm polyps, and adenomas between the two groups ($P > 0.05$), but the air bubbles and lens clarity, the time of entering the lens, amount of saline flushing, detection rate of <0.5 cm polyps of the observation group was significantly better than that of the control group ($P < 0.05$).

Conclusion: It is safe and effective for elderly patients to take compound polyethylene glycol electrolyte powder combined with simethicone for intestinal preparation.

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In 2020, there were more than 1.9 million new colorectal cancers (CRC) and more than 900,000 deaths among the world's common cancers. Among all cancers, the incidence of CRC in China ranks second, which has increased significantly compared with before, and it is even more common among the elderly. Moreover, China has become one of the countries with the highest number of new cases of CRC.[1] CRC mostly follows the pattern of progression from adenoma to cancer, and the development is relatively slow, which can be detected in advance during screening and obtain the opportunity for treatment.[2] Therefore, early detection and early diagnosis of intestinal lesions have become the top priority in the prevention and treatment of CRC.

Colonoscopy has gradually replaced barium enema because of its advantages of visual observation of lesions and direct tissue biopsy, and has become the most common, reliable, and simple method for diagnosing colorectal lesions, and has been widely used in clinical practice. At the same time, with the development of endoscopic diagnosis and treatment technology and the promotion of minimally invasive medicine, endoscopic treatment has become the preferred treatment for colon polyps, lateral developmental tumors, early colon cancer, and other diseases. However, the accuracy of colonoscopy diagnosis and the safety of treatment largely depend on the cleanliness of the bowel, and clean bowel preparation can reduce the rate of missed and misdiagnosed colonoscopy and facilitate endoscopic treatment.[3] Therefore, dietary guidance before colonoscopy, oral colon cleansing drugs, and bowel preparation is the basis for the smooth and safe conduct of colonoscopy, timely detection of lesions, and treatment. The ideal bowel preparation method is characterized by the ability to empty the stool in the colon in a short period of time, without causing changes in the colonic mucosa, without discomfort to the patient, and without causing water and electrolyte disturbances. In addition, when choosing an oral intestinal cleanser, what need to be considered are the patient's underlying disease, acceptance, and whether the drug causes discomfort to the patient.

There are many methods of bowel preparation, and the most commonly used in China is a variety of protocols based on polyethylene glycol electrolyte dispersion, which has the characteristics of maintaining normal intestinal flora and good intestinal cleanliness.[4] Polyethylene glycol electrolyte powder is a kind of osmotic laxative, which is a polymer made of polyethylene glycol 4000 as the main ingredient, and adding sodium chloride, potassium chloride, sodium bicarbonate, and other substances. After taking compound polyethylene glycol electrolyte dispersion, it can enter the intestine quickly with the help of hydrogen bonds in the molecule, can fix the water molecules, can increase the water in the intestinal lumen, can expand the volume of the intestinal lumen, can soften the stool, can accelerate peristalsis, is easy to excrete, and does not participate in the human metabolic process. The compound polyethylene glycol electrolyte dispersion will not destroy the balance of water and electrolytes in the body and will not lead to intestinal flora imbalance. The cleaning process is simple and the pain is minimal. It is highly effective for intestinal cleansing, with high tolerance and compliance.[5,6]

Relevant data show that due to the weakening of gastrointestinal motor function, about 30% of elderly patients have obvious symptoms of gastrointestinal motility abnormalities, and often have cardiovascular and cerebrovascular diseases. Additionally, a large amount of water is required to drink for bowel preparation when taking compound polyethylene glycol electrolyte powder, which leads to intolerance in elderly patients, and results in unsatisfactory bowel preparation, and has a certain risk for patients with cardiovascular and cerebrovascular diseases, which affects compliance and tolerance of bowel preparation in elderly patients. China's latest guidelines point out that the regimen of 2∼3 L compound polyethylene glycol electrolyte powder taken in divided doses for bowel preparation can provide high-quality intestinal cleansing, which is suitable for Chinese people with relatively small body mass index.[7] However, polyethylene glycol electrolyte dispersion cannot effectively remove remaining air bubbles in the intestine, and a large number of air bubbles will reduce clarity of the examination field, which is not conducive to microscopic observation, resulting in an increase in the missed diagnosis rate. At the same time, to better observe the intestinal mucosa, it is necessary to repeatedly flush and aspirate the intestines, which will prolong unnecessary examination time and easily cause discomfort such as bloating and abdominal pain. It has been found that the combined

application of simethicone can reduce the content of air bubbles in the intestine, improve clarity of the lens field of vision, shorten the time of colonoscopy, and facilitate detection of lesions, which is of great significance for improving the quality of colonoscopy.[8,9]

In this study, we analyzed the effect of a bowel preparation regimen of polyethylene glycol electrolyte powder combined with simethicone in divided doses before colonoscopy, aiming to find a more appropriate method for elderly patients.

Information and methods

Clinical data

A total of 60 elderly patients who underwent colonoscopy in our hospital in 2021 were selected as the research subjects, including 46 males and 14 females, aged 60–75 years old. They were randomly divided into control group and observation group, with 30 cases in each group. There were 23 males and 7 females in the observation group. The mean age was (67.8 ± 6.2) years. There were 23 males and 7 females in the control group. The mean age was (68.3 ± 7.1) years. There was no significant difference in gender and age between the two groups ($P > 0.05$), which was comparable. This study was approved by the Medical Ethics Committee of the hospital.

Enteral preparation drugs and methods

Bowel preparation drugs

[1] Polyethylene glycol (PEG) composite electrolyte powder [polyethylene glycol (IV) electrolyte composite powder, Xiutaishen (Beijing) Biopharmaceutical Co., Ltd., national drug approval number H20040034], each package of PEG electrolyte powder contains Formula A and Formulation B, wherein Formulation A contained 13.125 g of polyethylene glycol 4000. Formulation B contains 0.1785 g sodium bicarbonate, 0.3507 g sodium chloride and 0.0466 g potassium chloride.

[2] Simethicone emulsion (Boxi) [import drug registration number: H20160184 company name: Brelin-Chemie AG] specification is 30 mL/bottle.

Methods of bowel preparation

Eat easily digestible foods 2 days before the test (you can eat colorless foods such as noodles and rice, and you can eat until full; do not eat vegetables, fruits, fungus and other colored foods, especially fruits with seeds, such as watermelon, grapes, etc.). If you have constipation, start taking laxative drugs (compound polyethylene glycol electrolyte powder, fruit guide, linaclotide, etc.) 2–3 days in advance, and ensure smooth stool before colonoscopy. The day before the examination, dinner will be finished before 6 p.m.; after fasting, the intestines will be prepared at 8 p.m.: pour a large box of Shutaiqing (6A + 6B packets) into a special paper cup, add warm boiled water (the temperature does not exceed 50°) to the 750 mL scale and stir well, and drink a cup every 30 minutes. Take a total of 2 boxes at night, drink water at night without restrictions, and allow for no eating or drinking.

[1] Control group: take 2 more boxes starting at 4:00 a.m. on the day of the examination, drink water until 6:00 a.m., and then do not eat and drink again, and observe the bowel movement until the bowel is clear.

[2] Observation group: take 2 more boxes starting at 4:00 a.m. on the day of the examination, take 30 mL of oral simethicone emulsion 30 minutes after the last dose, drink water until 6:00 a.m., and then do not eat and drink, and observe the bowel movement until the bowel is watery.

Observe indicators

Tolerability and compliance

By way of inquiry, record whether the patient has taken all bowel preparation drugs and the specific amount taken, and calculate compliance.

Adverse reactions

Through inquiry, record whether the patient has nausea, vomiting, bloating, abdominal pain, and other adverse reactions after taking the drug.

Intestinal cleanliness

1–5 grade scoring method is adopted.

Level 1 (1 point): The intestines are very clean, completely free of stool and fecal residue, colonoscopy went well; Grade 2 (2 points): There is a small amount of fecal water in the intestine, no fecal residue, the intestine is basically visible, and the colonoscopy is basically smooth; Grade 3 (3 points): There is a small amount of fecal water and fecal residue in the intestine, the intestine is basically visible, and the colonoscopy is slightly affected; Grade 4 (4 points): There is more feces and feces in the intestines, and some intestines are not even visible; Grade 5 (5 points): The intestine is covered with

Table 1 Comparison of patient compliance between the two groups [n(%)]

Constituencies	Total number of cases	Number of cases of complete medication
Observation group	30	30 (100)
Control group	30	29 (96.67)
χ^2 value	–	1.017
P value	–	0.313

Table 2 Comparison of adverse reactions between the two groups [n(%)]

Constituencies	Total number of cases	Number of adverse reactions
Observation group	30	3 (10.00)
Control group	30	2 (6.67)
χ^2 value	–	0.218
P value	–	0.640

stool and fecal residue, and the colonoscopy cannot be completed at all.

Intestinal bubbles

0–3 grade scoring method is adopted.

Grade 0 (0 points): There are no air bubbles in the intestine at all, and the vision is very clear; Grade 1 (1 point): There are a small number of air bubbles in the intestine, which basically does not affect the visual field; Grade 2 (2 points): There is a certain amount of air bubbles in the intestine, and some of the examination vision is limited, so irrigation is required; Grade 3 (3 points): There are a large number of air bubbles in the intestine, the field of vision is limited, and irrigation must be performed.

Lens clarity

0–3 grade scoring method is adopted.

Level 0 (0 points): The lens is completely clear and does not need to be developed; Level 1 (1 point): The lens is slightly blurry, and the lens needs to be rinsed with 1–2 tubes of water; Level 2 (2 points): The lens is blurry, and the lens needs to be rinsed with 3 tubes of water; Level 3 (3 points): The lens is very blurry and requires at least 4 tubes of water to be used to rinse the lens.

Entry time

Record the operation time from the anus to the end of the ileocecal part during colonoscopy, which is counted in minutes.

Normal saline flushing volume

Count the amount of normal saline used to flush the lens, and count it in mL.

Lesion detection

Statistics on the detection of <0.5 cm polyps, ≥0.5 cm polyps and adenomas.

Statistical Methods

SPSS 23.0 statistical software was used for statistical analysis. Numerical data were expressed as [n(%)] and chi-square test was used for comparison. Measurement data are expressed as "mean ± standard deviation," and the t-test is used for comparison. $P < 0.05$ was statistically significant.

Outcome

Patient tolerance and compliance (Table 1)

The tolerability of the patients in the two groups was high; one patient in the control group vomited after taking the polyethylene glycol electrolyte solution and did not take all fluids, but patients in both groups took a sufficient amount of simethicone. Compliance with this regimen was compared in the following table, and the difference between the two groups was not statistically significant after chi-square test, $P > 0.05$.

Adverse reactions (Table 2)

Adverse reactions in both groups were mild, mainly nausea, vomiting, and mild abdominal discomfort. The results of chi-square test showed that there was no significant difference between the two groups, $P > 0.05$.

Bowel preparation

In terms of bowel preparation, there was no significant difference in bowel cleanliness scores between the two groups, $P > 0.05$. However, the observation group was significantly better than the control group in terms of intestinal bubbles and lens definition, entry time was significantly shorter than that of the control group, and the amount of normal saline irrigation was significantly less than that of the control group, $P < 0.05$ (Table 3).

Lesion detection

There was no significant difference in the detection rate of 0.5 cm polyps and adenoma ≥ between the two groups, $P > 0.05$. However, the detection rate of polyps <0.5 cm in the observation group was significantly higher than that in the control group, $P < 0.05$ (Table 4).

Table 3 Comparison of bowel preparation between the two groups ($\bar{x} \pm s$)

Constituencies	Number of examples	Gut cleanliness score	Intestinal bubble status score	Lens sharpness score	Lens entry time (min)	Normal saline irrigation volume (mL)
Observation group	30	1.50 ± 0.63	0.53 ± 0.68	0.77 ± 0.63	9.23 ± 2.54	12.97 ± 9.50
Control group	30	1.63 ± 0.61	2.20 ± 0.61	2.27 ± 0.69	13.87 ± 3.05	47.27 ± 14.25
P value	–	0.29	<0.001	<0.001	<0.001	<0.001

Discussion

Colonoscopy is currently considered the gold standard for colorectal cancer (CRC) screening. However, studies have found that 0.3% to 0.9% of patients develop CRC, *i.e.*, interphase cancer, within 3 years of resection of the adenoma. Reasons for developing interphase cancer include missing or incomplete removal of lesions during initial colonoscopy. Poor bowel preparation can interfere with observation and lead to missed diagnosis. Therefore, high-quality bowel preparation is important.[10]

The detection rate of adenoma is a recognized quality indicator of colonoscopy, and the quality of bowel preparation directly affects the quality of colonoscopy.[11] Good bowel preparation can enable endoscopists to perform colonoscopy smoothly and observe the colorectal mucosa in more detail, so as to perform accurate biopsy and delicate treatment of lesions, especially for early colorectal lesions. Good bowel preparation can significantly reduce the missed diagnosis rate.[12] Colonoscopy has a high risk for elderly patients with many underlying diseases and poor tolerance, and poor bowel preparation can lead to missed diagnosis and complications, which will affect the examination effect and subsequent treatment. Therefore, bowel preparation should be safe and effective. For this reason, when we choose colon cleansing drugs, we should choose drugs and regimens with few side effects that are easy to accept and have high cleanliness.

Compound polyethylene glycol electrolyte powder is a commonly used intestinal cleanser recommended at home and abroad.[13] It is highly effective and safe, and is also suitable for special populations such as electrolyte disorders, renal failure, congestive heart failure, and advanced liver disease. Studies have found that about 20% of unqualified bowel preparation is related to the inability of patients to tolerate high-dose bowel preparation drugs.[14] Common oral use of bowel preparation is to take 2000–3000 mL of compound polyethylene glycol electrolyte solution within 6 hours before endoscopy. Due to the oral administration of a large amount of fluids in a short period of time, it is easy to cause nausea, vomiting, abdominal distension, abdominal pain, and other discomforts in elderly patients with physiological degeneration, resulting in patients not being able to take laxatives as required. At the same time, drinking a large amount of fluids in a short period of time can cause stress to increase blood pressure and increase heart rate, and because the heart function of elderly patients is generally poor, and various body functions gradually decline, this will have a greater burden on the elderly body.[15] It has been reported in the literature that single and divided doses of PEG electrolyte powder have comparable intestinal cleansing effects, while divided doses have milder intestinal discomfort symptoms, and patients have higher rates of complete dosing and re-dosing.[16] It has also been shown that taking bowel preparation drugs in divided doses is more effective than taking them alone to achieve better bowel cleansing.[17] In this study, the method of oral administration was divided into two groups, and adverse reactions such as nausea and abdominal distension were mild; patients had good tolerance and high compliance.

Table 4 Comparison of lesion detection between the two groups [n(%)]

Constituencies	Number of examples	Polypus		Adenoma
		≥0.5 cm	<0.5 cm	
Observation group	30	10 (33.33)	14 (46.67)	7 (23.33)
Control group	30	8 (26.67)	6 (20.00)	6 (20.00)
χ^2 value	–	0.317	4.800	0.098
P value	–	0.573	0.028	0.754

The presence of small bubbles and foams is an obstacle to successful colonoscopy that can impair the endoscopist's vision, limit luminal visibility, and reduce diagnostic accuracy.[18] The addition of adjuvants to bowel preparation may improve colonoscopy outcomes and overall patient experience.[19] Kutyla *et al* found that the addition of simethicone to an auxiliary pump during colonoscopy increased polyp detection by 10%, by defoaming and improving intestinal visibility.[20] Taking simethicone after oral PEGylated electrolyte dispersion can also improve colonic visibility by reducing colonic bubbles.[21] Simethicone is a defoamer containing the surfactant dimethicone, which decomposes by reducing surface tension of the foam. The released gas is absorbed by the mucosa or discharged through the gastrointestinal tract, so as to achieve the effect of defoaming. It can also treat the discomfort caused by excessive gas accumulation in the gastrointestinal tract, and is also suitable for taking it after gastrointestinal endoscopy to reduce discomfort caused by excessive inflation and insufficient inhalation during the examination. However, simethicone has been found to form deposits in the endoscopic channel, and as a result, an increasing number of studies have been conducted in combination with oral simethicone in addition to conventional bowel preparation medications.

Simethicone as an adjunct to bowel preparation has been shown to improve visibility by reducing air bubbles, and there are many studies on different timing and dosage of medications.[22–24] Taking dimethicone the night before colonoscopy has been found to improve visibility, preventing formation of bubbles, and improving the quality of bowel preparation.[22] It was found that the addition of simethicone to the colonoscopy in the morning of the colonoscopy compared with adding simethicone to the colonoscopy on the night before colonoscopy.[23] Low-dose dimethicone has been found to be as effective as high-dose dimethicone in detecting benign colorectal tumors.[24] Therefore, more clinical trials are needed to determine the ideal dose and duration of use of dimethicone.

In this study, a 30 mL of simethicone oil was ingested half an hour after taking the polyethylene glycol electrolyte powder solution on the morning of the test, and results showed that the combination of simethicone oil could significantly reduce the amount of air bubbles in the intestine, but had no significant effect on the intestinal cleansing effect.[25] There was no significant difference in intestinal cleanliness scores between the two groups. There was no significant difference between the patients taking polyethylene glycol electrolytes in divided doses, gastrointestinal tolerance and acceptability were better, and compliance was higher after combining with simethicone. There was no significant difference in comparison with the simple fractional administration of polyethylene glycol electrolytes.

According to this study, for elderly patients undergoing bowel preparation, taking polyethylene glycol electrolyte powder in divided doses, with fewer adverse reactions such as nausea and abdominal distention, and then combined with simethicone emulsion, can safely and effectively remove intestinal cavity bubbles, ensure the clarity of the lens, reduce the frequency of repeated flushing, shorten the time of colonoscopy, and is conducive to the detection of minor lesions. Therefore, the clinical application value of compound polyethylene glycol electrolyte powder combined with simethicone oil in the intestinal preparation of elderly patients before colonoscopy is high, and safety is good, which is worthy of promotion in clinical practice.

For patients undergoing colonoscopy, an individualized plan should be formulated based on factors such as dosing time, dosage, dietary restrictions, and special patient groups to ensure compliance and tolerability, improve the quality of bowel preparation, and reduce the rate of missed diagnosis.

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The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. Ethical approval was obtained from Shandong Rongjun General Hospital Ethics Committee; consent was obtained from all participants. There was no funding applicable to the study.

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