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Authors

Waraporn Sansaard
RN
Faculty of Nursing, Mahidol University, Bangkok, Thailand

Associate Professor Usavadee Asdornwised
PhD
Surgical Nursing Department, Faculty of Nursing, Mahidol University, Bangkok, Thailand

Rattima Sirihorachai
PhD
Surgical Nursing Department, Faculty of Nursing, Mahidol University, Bangkok, Thailand

Professor Varut Lohsiriwat
MD, PhD
Surgery Colorectal surgery unit, Department of Surgery, Faculty of Medicine Siriraj Hospital Mahidol University, Bangkok, Thailand

Corresponding author

Associate Professor Usavadee Asdornwised
PhD
Surgical Nursing Department, Faculty of Nursing, Mahidol University, Bangkok, Thailand

The effects of an abdominal vibration stimulation program on the quality of bowel preparation in patients undergoing screening and surveillance colonoscopy: A general surgeons blinded, randomised controlled trial

Abstract

Background: Effective colonoscopy is considered accurate and safe when there is good quality bowel preparation. In this study, we aimed to evaluate the effectiveness of an abdominal vibration stimulation program on the quality of bowel preparation in patients undergoing screening and surveillance colonoscopy.

Design: This study was a single-centre, randomised, controlled trial.

Methods: The participants consisted of 72 patients who received elective in-patient screening and surveillance colonoscopy at a tertiary hospital in central Thailand. Patients were randomly assigned to two groups: an experimental group (n=38) and a control group (n=34). Both groups received the same bowel cleansing regimen of 90 ml split-dose sodium phosphate solution. The experimental group received the abdominal vibration stimulation. General surgeons, who were blinded to which group participants were assigned, evaluated the bowel preparation of all participants using the Boston Bowel Preparation Scale (BBPS).

Results: The experimental group showed a statistically significant higher mean score on the BBPS than the control group (p=0.049). The BBPS score for the colon and rectum as a whole of the experimental group was 7.21 ± 1.80 and for the control group was 6.29 ± 2.08.

Conclusion: The addition of abdominal vibration stimulation can improve the quality of bowel preparation in patients undergoing screening and surveillance colonoscopy.

Keywords: colonoscopy, bowel preparation, abdominal vibration stimulation

Introduction

Colorectal cancers are the third most commonly diagnosed forms of cancer in men and the second most common in women. Sixty percent of cases occur in developing countries, and the incidence of the disease exhibits regional variations[1]. The American Cancer Society reports that, in the United States of America, one in 23 men and one in 26 women may develop colorectal cancer at some time in their life[2]. Colonoscopy is the most widely accepted procedure worldwide for assessing the colon and detecting polyps and establishes the international standard for diagnosis of colon diseases. Therefore, it offers an alternative for colorectal cancer screening in the general population and is the only examination that facilitates colorectal cancer surveillance in risk groups. This method relies on viewing images inside the colon so it requires thorough preparation of the bowel for optimal examination[3].

Poor bowel preparation prolongs procedure time and increases the need for sedative medication[4]. Consequently, patients require repeat examinations, which leads to delays in screening for disease, particularly colon cancer, and results in post-endoscopy complications such as abdominal pain and intestinal perforation[5].

Walking exercise, at least 3000 steps, during bowel preparation can improve bowel clearance. Noh et al.[4] used the Boston Bowel Preparation Scale (BBPS) to compare bowel clearance in patients who undertook conventional walking exercise with bowel clearance in patients who received abdominal vibration stimulation and found that vibration achieved similar results to walking – BBPS score for the entire colon for vibration was 7.38±1.55 and for walking was 7.39±1.55 (p=0.297)[4]. Therefore, a method should be developed that provides a similar effect as that of walking exercise for patients unable or unwilling to perform walking exercise.

Research findings have indicated that using abdominal massage and whole-body vibration therapy can help relieve severe constipation. Physical massage of the abdomen and whole-body vibration therapy increases bowel movement resulting in reduced constipation symptoms and alleviated abdominal distension[6,7]. Studies have also found that abdominal vibration stimulation with a slimming belt can enhance gastrointestinal function, reduce transit time inside the colon and relieve constipation in elderly patients[4]. Therefore, we hypothesised that abdominal vibration stimulation may improve bowel cleansing in preparation for colonoscopy.

Aim

The aim of the research was to compare the quality of bowel preparation in colonoscopy patients who received abdominal vibration stimulation in combination with usual bowel preparation and colonoscopy patients who received only the usual bowel preparation.

Hypothesis

Patients undergoing colonoscopy who receive the abdominal vibration stimulation program in combination with usual bowel preparation will have better quality of bowel preparation than patients who receive only the usual bowel preparation.

Methods

Study design

This study was performed as a single-centre, randomised, controlled trial. General surgeons evaluated the bowel preparation of all participants using the Boston Bowel Preparation Scale (BBPS) and were blinded to whether participants were assigned to the experimental or control group.

Participant selection

The participants were recruited on a voluntary basis. The population included male and female patients aged between 18 and 80 years who had been pre-scheduled by a doctor for a colonoscopy.

Inclusion criteria

The inclusion criteria for the participants were enrolled patients who had indications and a doctor's referral for a diagnostic colonoscopy to detect colorectal cancer, lower gastrointestinal bleeding or inflammatory bowel disease; evaluate acute and chronic diarrhea, chronic constipation or unexplained abdominal pain, and intervene after abnormal radiological examination results for ablation or removal of foreign bodies from the colon.

Exclusion criteria

The exclusion criteria were allergy to laxatives, allergy to sodium phosphate (Swiff, Xubil), body mass index (BMI) more than or equal to 35 kg/m^2, bedridden status, pregnancy, obstruction of the colon or suspected obstruction determined by a doctor's diagnosis, history of pelvic cancer, history of colon surgery (except appendectomy) and physical examination showing palpation of a lump in the abdomen

or suspected presence of abdominal aneurysm by the doctor performing the examination.

Withdrawal criteria

The withdrawal criteria were cancellation of the colonoscopy by the doctor performing the examination, and not receiving a complete evaluation of bowel cleansing from the general surgeon. Complete evaluation included evaluation of all three parts of the colon – the left colon, transverse colon and right colon.

Study procedure

Control group

One day before the colonoscopy

The day before their colonoscopy, the nurse on duty assessed participants through collection of health information and gave them standard practical advice in preparation for the colonoscopy. The researcher then recorded personal information from medical records and interviews, and the nurse at the surgical unit recommended the standard practice of preparing for the examination with pamphlets and educational videos.

Participants were advised to drink water and take a sodium phosphate laxative. A total of 90 ml of laxative was divided into two doses of 45 ml each, given at 6:00 pm and 10:00 pm. Participants drank 1000 ml of water with each laxative dose.

Day of the colonoscopy

On the day of the colonoscopy, participants waited for their appointments and received usual care from the nurse on duty. At 6.30 am, the nurse in the surgical unit took participant's blood to monitor electrolytes after taking the laxative.

Experimental group

One day before the colonoscopy

Participants in the experimental group received the same care as participants in the control group and the researcher recorded personal information from medical records and interviews. In addition to the usual bowel preparation of water and sodium phosphate laxative, participants in the experimental group received abdominal vibration stimulation with a slimming belt set at 50–100 Hz (slimming belt level 2–4) in three rounds of ten minutes each with 20-minute breaks between rounds – total of 70 minutes, from 7.00 pm to 8.10 pm. To prevent nausea, vomiting or choking on the laxatives remaining in the stomach[4], abdominal vibration started one hour after taking the first laxative dose, to allow participants time to excrete and clear the intestines first.

Day of the colonoscopy

Participants in the experimental group received the same care as participants in the control group. In addition to electrolyte monitoring, participants in the experimental group received abdominal vibration stimulation once again, as on the previous evening, in the surgical unit from 7.00 am until 8.10 am.

All participants

A pedometer watch was used to check the number of steps walked by all participants. The data indicated that the number of steps were not different between the experimental group and control group.

After the colonoscopy, the general surgeon who performed the procedure assessed the cleanliness of the colon of all participants by using the BBPS.

Study outcomes and data collection instruments

The primary outcome was adequacy of bowel cleansing which was assessed using the BBPS. The BBPS scores of the experimental and control groups were compared. Information was collected by the researchers via interviews with the patients. The screening instrument was the Thai version of Mini-Cog, which screens for elderly people with cognitive impairments. Mini-Cog consists of two parts – Part 1 is a short-term memory test and Part 2 is an executive function test. In this study, the instrument was only used with patients over 60 years of age. If the total score was greater than or equal to three, it meant that there was no cognitive impairment[8].

Personal data for each participant was collected by the researchers from interviews and medical records using a personal data record form. The form had two parts – Part 1: General records and Part 2: Records of injury/illness, treatment regime and practice during the colonoscopy.

BBPS scores were recorded for each participant by the surgeon performing the colonoscopy using the version of the BBPS that has images showing the cleanliness of bowel preparations. Scores were given for cleanliness at three sites – the left colon and rectum, the transverse colon and the right colon. Cleanliness was rated using a scale ranging from 0 to 3 where a higher score was given for greater cleanliness. The scores for all three sites were combined giving a total score for the colon and rectum as a whole with a maximum of nine points. Total BBPS scores of greater than or equal to six were considered to correspond to adequate bowel cleansing[9]. This BBPS was used for assessment during each examination for every patient participating in the

study. The general surgeons who performed the colonoscopy were blinded concerning assignment to the experimental or control group.

Sample size

The sample size was calculated based on the effect size values of a previous study by Noh et al.[4] finding that, when comparing colorectal cleanliness scores between the groups receiving and not receiving the abdominal vibration stimulation program, the mean standard deviation of the bowel cleanliness scores were 7.38±1.55 and 6.17±1.15, respectively. The effect size was calculated with the G*Power 3.1 program by using the mean and standard deviation values to obtain an effect size of 0.887, whereby Power=0.95 and α=0.05, to obtain a total sample size of 70 people. Furthermore, to prevent data loss during data collection, 20 per cent was added to the sample size for an increase to a total of 84 cases divided into intervention and control groups of 42 each (see Figure 1).

Random allocation

The participants were randomly divided into two groups using simple random sampling. A table

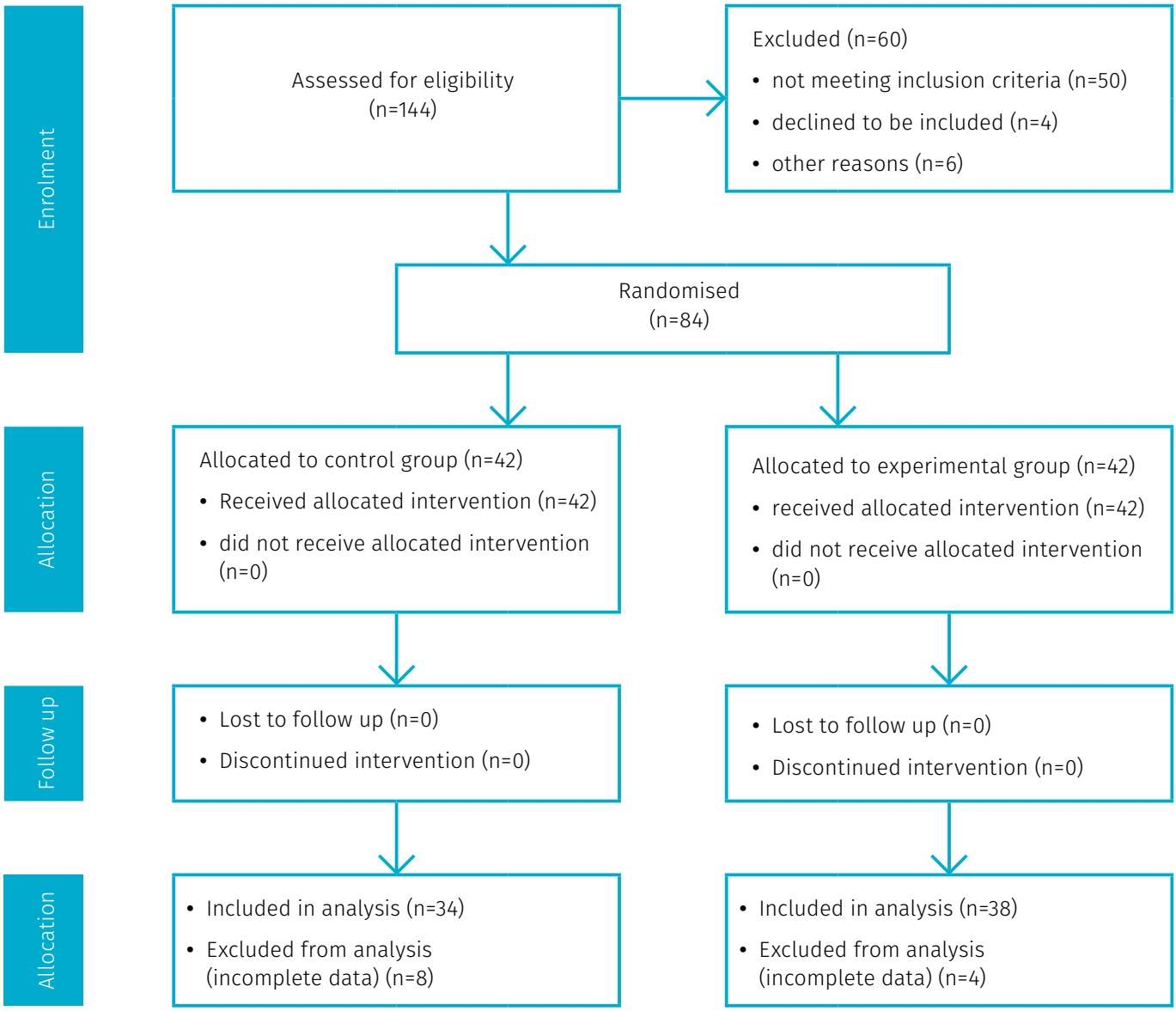

Figure 1: Consort diagram

of random numbers from 1 to 84 was generated by computer to identify participants to be in the experimental and control groups, and the numbers were placed in envelopes. The 42 participants in the experimental group received the abdominal vibration stimulation and usual bowel preparation, and the 42 participants in the control group received usual bowel preparation only.

Statistical analysis

This research was analysed using a statistical computer program package, the SPSS (Version 18), with a significant level for hypothesis testing at 0.05. The following personal information was analysed: general information and information on illness/injury, treatment regime and practice during the colonoscopy. Descriptive statistics were used to describe the variable characteristics of the samples, including frequency, percentage and median distributions to analyse and compare variances in personal data between the experimental and control groups. Nominal data was tested by chi-square testing or Fisher's Exact Test, and statistical differences in median cleanliness of bowel preparations between the experimental and control groups was compared using Mann-Whitney U test.

Ethical considerations

This study was approved by the Institution Review Broad, Faculty of Nursing and Faculty of Medicine Siriraj Hospital, Mahidol University (MU-MOU CoA: No. IRB-NS2022/677.2803) on 28 March 2022. The Thai Clinical Trials Registry identification number is TCTR20230202005.

Results

1. Baseline characteristics

The participant group consisted of patients who had been scheduled for elective colonoscopy that was planned by a doctor in advance. The participant group included 84 participants aged from 18 to 80 years who were divided into two equal groups with 42 patients in the experimental group and 42 patients in the control group. The researcher removed 12 participants because they had not been assessed for cleanliness of all three parts of the colon, either due to risk from the examination or because they were not fully assessed. Consequently, 72 patients participated in the research study – 38 in the experimental group and 34 patients in the control group (see Figure 1).

Table 1 shows data for the following characteristics: age (years), gender, BMI, presence of diabetes mellitus and hypertension, history of constipation according to Rome IV criteria, history of laparotomy/laparoscopy, regular medications, indication for colonoscopy, numbers of steps per day, time to first bowel movement (minutes), timing of colonoscopy after last laxative, cecal intubation success, time to cecal intubation (minutes), total procedure time (minutes) and findings of colonoscopy. Apart from presence of hypertension, there were no statistically significant differences between the two groups.

2. Adequacy of bowel cleansing

Table 2 shows the median total BBPS scores for the colon and rectum as a whole, the median BBPS scores for the three sections of the colon and the number of participants who were rated as having excellent bowel preparation (total BBPS score of 8 or 9). The median BBPS scores of the experimental and control groups were compared using the Mann-Whitney U test.

Statistically significant differences were found in the total BBPS scores for the colon and rectum as a whole, (p=0.049*) and in the left colon (p=0.008). However, no statistically significant differences between the groups were found in quality of bowel preparation of the right colon (p=0.364) and transverse colon (p=0.102).

The total BBPS scores in the control group ranged from 1 to 9 with a median of 6. The total BBPS scores in the experimental group ranged from 2 to 9 with a median of 7. A score of 6 or 7 means good bowel preparation, a score of 8 or 9 is considered to mean excellent bowel preparation. More participants in the experimental group had scores indicating excellent bowel preparation than in the control group (22 (58%) and 13 (38%), respectively) but this difference was not statistically significant (p=0.096).

Discussion

In Thailand, colorectal cancer is the fourth most common cancer – after liver, lung and breast cancers – with 11496 new cases per year and a mortality rate of 6845 cases per year. Screening and prevention by removing colon polyps during the early stages of the disease significantly decreases the mortality rate for colorectal cancer. Therefore, it is useful to know the risk factors for developing the disease so screening can be targeted to various groups[10]. Furthermore, certain factors – including age, obesity, hypotensive medications, some bowel conditions and mobility limitations – may affect the efficacy of bowel preparation programs.

Table 1: Participant characteristics and endoscopic findings

		Experimental group (n=38)	Control group (n=34)	p-value
Age in years (mean ± standard deviation)		61.8 ± 8.6	63.2 ± 11.7	0.559
Gender	Female	22 (58%)	17 (50%)	0.502
	Male	16 (42%)	17 (50%)	
Body mass index (mean ± standard deviation)		22.5 ± 4.0	22.7 ± 3.6	0.859
Diabetes mellitus		3 (8%)	8 (24%)	0.101
Hypertension		13 (34%)	22 (65%)	0.010*
Constipation**		20 (53%)	13 (38%)	0.221
Previous laparotomy/laparoscopy		9 (24%)	11 (32%)	0.412
Current opioid user		0	1 (3%)	0.472
Indication for colonoscopy	bleeding per rectum	21 (55%)	11 (32%)	
	bowel habit change	6 (16%)	8 (24%)	
	abdominal pain	4 (11%)	3 (9%)	
	constipation	6 (16%)	3 (9%)	
	colorectal cancer screening	1 (3%)	9 (27%)	
Number of steps walked during mechanical bowel preparation (median and interquartile range)		798 (625–1270)	853 (472–1788)	0.437
Time to first defecation after completion of sodium phosphate in hours (mean ± standard deviation)		1.2 ± 0.7	1.2 ± 1.0	0.823
Time to colonoscopy after completion of sodium phosphate in hours (mean ± standard deviation)		14.7 ± 2.1	15.0 ± 2.0	0.495
Successful cecal intubation		38 (100%)	33 (97%)	0.472
Time to cecum intubation in minutes (mean ± standard deviation)		25.0 ± 10.3	25.6 ± 11.1	0.817
Total endoscopic examination in minutes (mean ± standard deviation)		38.7 ± 12.8	40.2 ± 13.6	0.640
Endoscopic findings	normal appearance	18 (47%)	14 (41%)	
	colorectal neoplasms	6 (16%)	16 (47%)	
	haemorrhoids or rectal prolapse	8 (21%)	2 (6%)	
	diverticular disease	4 (11%)	2 (6%)	
	colitis	2 (5%)	0	

** p-value < 0.05*
*** According to Rome IV criteria*

The incidence of colorectal cancer has been found to increase with age after the age of 40 years whereby those aged 60 to 79 are fifty times more likely to be at risk than those aged under 40[10]. In addition, complications related to bowel preparation regimens may also be increased in the elderly[11]. Participants in this study were aged between 60 and 80 years of age, with a median age of 62.5 years, so may have had a higher risk of complications related to bowel preparation. However, there was no statistical difference between the ages of participants in the control and experimental groups.

The participants in this study had BMIs in the normal range of 18.5 to 22.9 kg/m^2. According to a study by Soltani et al.[12], high BMI is associated with colorectal cancer. Obesity has also been associated with multiple gastrointestinal disorders including colon polyps and colon cancer. In addition, a high BMI (>30 kg/m^2) is associated with inadequate bowel preparation[13]. Only participants with a BMI less than 35 kg/m^2 were included in our study; therefore, inadequate bowel preparation due to obesity was unlikely.

Medications for hypertension may affect gastrointestinal mobility and therefore have an impact on bowel preparation[13]. There were more participants with hypertension in the control group of our study than in the experimental group (22 (65%) and 13 (34%), respectively) and this may have affected bowel preparation.

Certain bowel conditions may lead to difficult and risky bowel preparation. The indications for colonoscopy in the participants in our study included rectal bleeding (in 21 participants (55%) in the experimental group and 11 participants (32%) in the control group), change in bowel habit (in six participants (16%) in the experimental group and eight participants (24%) in the control group) and colorectal cancer screening (in one participant (3%) in the experimental group and nine participants (27%) in the control group).

Table 2: Quality of bowel preparation using Boston Bowel Preparation Scale (0 = worst, 9 = best)

	Experimental group (n=38) mean ± standard deviation	Control group (n=34) mean ± standard deviation	p-value
Total BBPS score	7.21 ± 1.80	6.29 ± 2.08	0.049*
BBPS score for right colon	2.03 ± 0.79	1.85 ± 0.82	0.364
BBPS score for transverse colon	2.47 ± 0.69	2.18 ± 0.83	0.102
BBPS score for left colon and rectum	2.71 ± 0.61	2.26 ± 0.75	0.008*
Number of participants with excellent bowel preparation**	22 (58%)	13 (38%)	0.096

* p-value < 0.05
** Total BBPS score of 8 or 9

The endoscopic findings of participants' colonoscopies included colorectal neoplasms (in six participants (16%) in the experimental group and 16 participants (47%) in the control group), haemorrhoids or rectal prolapse (in eight participants (21%) in the experimental group and two participants (6%) in the control group) and diverticular disease (in four participants (11%) in the experimental group and two participants (6%) in the control group). The higher number of colorectal neoplasms in the control group, may have resulted in more difficult bowel preparation in the control group[14]. However, the endoscopic finding for nearly half the participants in both groups was normal appearance (18 participants (47%) in the experimental group and 14 participants (41%) in the control group). We found that the results of bowel preparation in the experimental group, who received abdominal vibration stimulation, were significantly better than the control group.

The number of steps taken by participants in our study ranged from 472 to 1788, with a median of 816 steps. This is fewer steps that the recommended 3000 and is due to limited space available for participant physical activity in the hospital. The median number of steps taken by participants in the experimental group was 798 (IQR 625–1270) while the median number of steps taken by participants in the control group was 853 (IQR 472–1788). This difference is not statistically significant (p=0.437) so walking is unlikely to have affected bowel preparation in our study. This is consistent with a study by Noh et al.[4] who compared the effect on bowel

preparation of walking a minimum of 3000 steps and abdominal vibration stimulation – the median number of steps taken by participants in the control group was 634 steps.

The results of this study indicate that abdominal vibration stimulation might improve the quality of bowel preparation in patients undergoing inpatient colonoscopy; this could be because the abdominal vibration stimulation affects autonomic neurological mechanisms. Vibrations from the slimming belt are effective for colon function at 50–100 Hz through the abdominal wall. Parasympathetic induction of the gastrointestinal tract stimulates colon motility and relaxation of the sphincter; thus, faecal matter stuck in the lining of the colon is excreted. According to pathophysiological concepts, this resulted in the differences between the experimental group and the control group, as bowel cleansing using laxatives only relies solely on physical mechanisms and may be insufficient for good bowel preparation[4].

The use of abdominal vibration stimulation, whether delivered by an instrument or by human massage, in combination with laxatives can improve the quality of colon function[4]. Although both methods have limitations, using a slimming belt is the most suitable option for modern nursing contexts as it is easily available, not expensive, easy to use, safe for patients and meets international standards. It facilitates the provision of quality nursing care with less labor. However, there may be side effects from using a slimming belt – one patient in our study reported mild itching of the abdominal skin after using the belt.

In our study, the colonoscopy could not be performed on one participant in the control group due to a large amount of residual faecal matter. If the colonoscopy had been performed, there would have been a risk of intestinal perforation from obstruction of faeces inside the colon; therefore, re-preparation of the colon was required. This did not occur in the experimental group.

In conclusion, the results of this study indicate that the use of the abdominal vibration stimulation in patients undergoing inpatient colonoscopy produces better quality of bowel preparation than the use of laxatives alone.

Limitations

The limitations of this study include that it was conducted in a single centre and random allocation of participants into experimental and control groups may have resulted in uneven distribution of certain bowel conditions and other characteristics in the two groups. In addition, there are no guidelines for duration of abdominal vibration stimulation with a slimming belt. Noh et al.[4] used abdominal vibration stimulation for between 30 and 80 minutes and reported no significant difference in BBPS scores between different durations. In our present study, therefore, participants received abdominal vibration stimulation for a total of 60 minutes in six rounds or of ten minutes each.

Conclusion

Abdominal vibration stimulation appears to provide positive outcomes for the quality of bowel preparation in patients who undergo colonoscopy screening and surveillance.

Knowledge translation

This study found that participants in the experimental group had better quality of bowel preparation than the control group. Both groups were allowed to walk normally and neither group walked the 3000 steps that is recommended for improving bowel preparation. It can be concluded, therefore, that abdominal vibration stimulation can be used in patients who are unable or unwilling to walk and patients with limited mobility. Furthermore, since the participants were aged between 60 and 80 years, the results of this study could be used as a guideline for developing and planning bowel preparation in adult and elderly patients undergoing colonoscopy. A program may also be developed for outpatient colonoscopy.

Conflict of interest and funding statement

The authors declare no conflicts of interest.

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