Effect of Gum Chewing on Bowel Motility in Patients with Colorectal Cancer after Open Colectomy: A Randomized Controlled Trial

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ABSTRACT

Background: Postoperative ileus (POI) usually delays the postoperative recovery after open colectomy. Gum chewing may facilitate bowel motility through cephalic-vagal stimulation. Bowel sounds, the time to first postoperative flatus and defecation, the common nursing outcomes of bowel motility, has not been investigated in Thai patients. This study examines the effect of gum chewing on bowel motility in colorectal cancer patients after open colectomy.

Methods: A single blind randomized controlled trial was conducted with 32 patients in experimental and 32 patients in control groups. The experimental group chewed a piece of sugar-free gum with a fruity flavor for 20 minutes each time, three times a day starting from the first postoperative day till the date of first oral liquid received, while the control group receive routine care.

Results: The bowel sounds of the experimental group after chewing gum significantly increased more than those of the control group ($p = 0.00$). The time to the first postoperative flatus in the experimental group was significantly shorter than that in the control group; likewise the first postoperative defecation was also shorter ($p = 0.04$, $p = 0.02$, respectively).

Conclusion: Gum chewing is helpful in stimulating bowel motility measured by an increase in bowel sounds and in reduced times to first postoperative flatus and defecation. This nursing intervention may be used for stimulating bowel motility in patients with colorectal cancer after an open colectomy.

Keywords: Gum chewing, bowel motility, recovery, colorectal cancer, colectomy

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INTRODUCTION

Postoperative ileus (POI), the transient inhibition of gastrointestinal motility, is the most common complication that is found most in a patient after a large bowel resection.[1] The incidence of POI is 14.9%, based on a total of 257,336 patients in the United States undergoing colectomy.[2] The etiology of POI is multifactorial, but it is believed that a major contribution is from sympathetic hyperactivity, an increased concentration of catecholamine and an inflammatory response from the surgical manipulation.[1,3] Electrolyte imbalances, peritoneal irritation and narcotic analgesia effect may be the causes of POI.[4] Vasoactive intestinal peptides, which increase after the operation, directly inhibit the smooth muscle contraction in the intestine. In addition, pain increases the release of substance P, which is also know to inhibit bowel motility.[5] It can cause the

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accumulation of secretions and gas, resulting in an absence of bowel sounds, a lack of passage of flatus defecation, nausea, vomiting and abdominal distension.[6] In addition, POI impedes the patient's recovery, presenting itself by delays in enteral feeding, slow wound healing and ambulation, increased postoperative pain, and pulmonary complications.[7] However, POI can recover by itself depending on the gastrointestinal organs. The small intestine recovers first, within 24 hours. The function of the stomach takes 24 to 48 hours to return, whereas large bowel motility occurs after 48 to 72 hours. If the POI cannot recover on time, it is prolonged POI.[1,3] Therefore, the length of stay would increase for up to 5 days more than average.[8] This makes hospitalization costs rise by up to 15%.[9] The medical treatments and alternative interventions to facilitate an early recovery of bowel functions comprise laxative drugs, early oral feeding, early ambulation, massage, electrical stimulation and acupuncture.[3,6,7,10] There are still controversies regarding the use of these.

However, gum chewing is one of alternative methods implemented to minimize POI through cephalic-vagal stimulation.[11,12] Many studies have been performed among different populations. However, the outcomes and measured outcomes are still being debated. On the other hand, seven studies have explained the effects of gum chewing in patients with an open colectomy.[12-18] The intervention in those studies were similar, but there were differences in terms of frequency, duration, period, and the termination date of chewing gum. The interventions were difficult to replicate due to a lack of detail in the procedures and few resource methodology explanations in the four studies.[12,13,15,16] Previous studies reported different measured clinical outcomes. For instance, the time to first postoperative flatus and defecation are common outcomes that are reported in all of the studies.[12-18] Six studies reported the length of stay.[12,14-18] One study showed the time to be hungry.[12] One study presented the time at which the patient was ready for discharge.[14] The colonic transit time and gut hormones were illustrated in one study.[18] Those studies did not evaluate the nursing outcomes. Specific outcomes that measure indications of bowel motility are bowel sounds, time to first postoperative flatus and defecation.[3,19,20] Therefore, bowel sounds should be added to the outcome because it is easy to evaluate as part of the everyday routine.

We performed a randomized controlled trial to compare bowel sounds, time to the first postoperative flatus and defecation as the measured nursing outcomes of bowel motility in this study. We hypothesized that the patients who chew gum would have an increase in bowel sounds and a reduced time to the first postoperative flatus and defecation.

MATERIALS AND METHODS

Participants

102 participants enrolled in this study, from one university affiliated hospital in Bangkok, Thailand, from October, 2012 through to June, 2013. Only 67 met the criteria of being: colorectal cancer patients who underwent an elective open colectomy, were aged 18 years old or older, and received general or combined regional-general anesthesia. 35 participants were excluded because they had had previous abdominal radiotherapy, had received total colectomy or colostomy, had had severe postoperative complications, had been admitted to a critical care unit, had an abnormal sense of taste and smell, had had cold sore or had declined to participate in this study. This study was approved by the Siriraj Institutional Review Board, Mahidol University.

We designed this randomized controlled trial to evaluate the effects of gum chewing on bowel motility in colorectal cancer patients after an open colectomy. 67 eligible patients who had already completed written informed consent forms were assigned into two groups; 34 in the experimental group and 33 in the control group; using a computer-generated randomized method. However, 3 patients (2 from experimental group and 1 from control group) withdrew from the study because they had anxiety, suffered from pain and would like bed rest. In the final analysis, the total number of patients who took part in this study and were included in the analysis numbered 64 in both the experimental group (n = 32) and the control group (n = 32) (Fig 1).

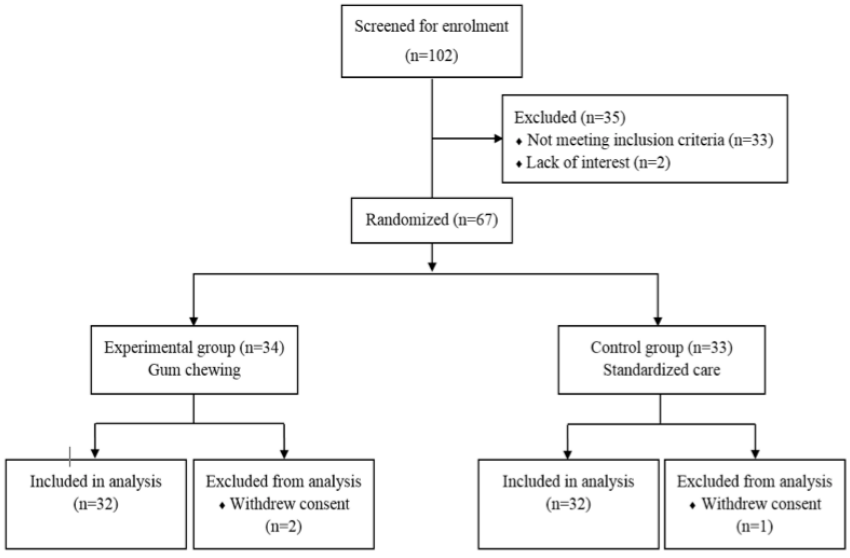

Fig 1. Flow of the patients in the study.

Study design

A single blind technique was used so the surgeon didn't know who had received the intervention. The inter-rater was evaluated between the research assistant and the surgeon specializing in gastrointestinal surgery as being equal to 0.90. The maintenance and carination of the stethoscopes used were done throughout the study.

Interventions

In both groups, all of the patients received both preoperative and postoperative standard nursing care. Patients in the experimental group chewed pieces of sugar-free gum with a fruity flavor. It contained 35% sorbitol, 30% gum base, 19% erythritol, 4% xylitol, 3.4% mannitol, 2% maltitol syrup, 0.4% lacitine, 0.24% aspartame, and 0.15% sucralose. They chewed three times a day; in the morning (8 a.m.), at noon (12 a.m.), and in the evening (4 p.m.), for 20 minutes each, from the first postoperative day until the oral intake of a liquid diet. Meanwhile the patients in the control group did not chew gum.

Outcome measures

The three main nursing outcomes that were measured in this study of bowel motility, were the bowel sounds after chewing gum, time to first postoperative flatus and time to first postoperative defecation. A research assistant, who had at least three years of experience in surgical nursing, was not privy to the assigned intervention. Bowel sounds were evaluated after the patients had finished chewing the gum for 10 minutes, 3 times a day in the morning (8.30 a.m.), afternoon (12.30 p.m.), and evening (4.30 p.m.) using a stethoscope (3M™, Littmann® Classic II S.E. Model), at the 4 quadrants of the abdomen, for one minute per quadrant. The patients' demographic data and clinical characteristics were recorded by the researcher.

Statistical analysis

The sample size was calculated using a power analysis based on the study conducted by Quah *et al*,[15] in which the timings of the first defecation were compared. With the evaluated effect size equal to 0.70, the confidence level (α) equal to 0.05 and the power of test equal to 0.80 these gave a sample size of 64 subjects.

Data on the patients' demographics, clinical characteristics and measured outcomes were analyzed using a statistical computer software package and were examined by numbers (n), percentage (%), mean ($\bar{x}$) and standard deviation (SD). To examine the differences between groups; Chi-square was conducted for previous abdominal surgery, operations, analgesic routes and postoperative complications. Independent sample t-test was used to analyze the differences between body mass indexes, preoperative albumin levels, operative times, blood loss, amounts of intra-

TABLE 1. Patients' demographic data.

Characteristics	Experimental group (n = 32) n (%) or $\bar{x}$ ± SD	Control group (n = 32) n (%) or $\bar{x}$ ± SD	*p*-value
Age, years	59.91 ± 8.55	64.50 ± 9.89	0.05
Body mass index, kg/m^2	22.91 ± 3.17	23.70 ± 3.32	0.33
Preoperative albumin levels, g/dl	3.86 ± 0.41	3.67 ± 0.56	0.14
Previous abdominal surgery	8 (25.00)	8 (25.00)	1.00

venous opioid received, bowel sounds, time to the first flatus, and the time to the first defecation. The two-tailed test of statistical significance was considered to be the level of *p*-value < 0.05.

RESULTS

Patient's characteristic

There were no differences between the two groups in terms of the patient's demographic data; age, body mass index, preoperative albumin levels, and previous abdominal surgery (Table 1). Clinical characteristics were equivalent between the 2 groups. Three most common procedures for colorectal cancer were sigmoidectomy, lower anterior resection and anterior resection, respectively. There were no differences in the operative times and blood loss between the 2 groups. Three patients in the experimental group and 2 patients in the control group were prescribed epidural analgesia. Eighteen patients in the experimental group and 17 patients in the control group were

TABLE 2. Clinical characteristic.

Characteristics	Experimental group (n = 32) n (%) or $\bar{x}$ ± SD	Control group (n = 32) n (%) or $\bar{x}$ ± SD	*p*-value
Operation			
Sigmoid colectomy	10 (31.25)	7 (21.88)	
Low anterior resection	7 (21.88)	6 (18.75)	
Anterior resection	5 (15.63)	7 (21.88)	
Right hemicolectomy	5 (15.63)	3 (9.38)	
Extended right hemicolectomy	0 (0.00)	7 (21.88)	
Left hemicolectomy	3 (9.38)	1 (3.13)	
Subtotal colectomy	2 (6.25)	0 (0.00)	
Transverse colectomy	0 (0.00)	1 (3.13)	
Operative time, mins	175.47 ± 51.96	185.94 ± 64.46	0.47
Blood loss, ml	187.50 ± 149.19	209.06 ± 203.04	0.63
Analgesic route			0.82
Epidural	3 (9.38)	2 (6.25)	
Parenteral	18 (56.25)	17 (53.13)	
Combine	11 (34.38)	13 (40.63)	
Amount of intravenous opioid			
Morphine, mg	15.28 ± 24.61	24.92 ± 52.94	0.35
Pethidine, mg	27.50 ± 49.95	28.59 ± 51.23	0.93
Fentanyl, mcg	5.15 ± 13.28	1.25 ± 7.07	0.14
Postoperative complications			0.60
Nausea/Vomiting	6 (18.15)	7 (21.88)	
Anastomosis leakage	1 (3.13)	0 (0.00)	

prescribed parenteral analgesia. The remaining patients in each group were prescribed a combined analgesia postoperatively. The route and type of analgesia was chosen by the anesthesiologist's practice. There was no difference seen in the amount of parenteral opioids received between the 2 groups. Nausea/vomiting were common complications after surgery.

Postoperative complications occurred in 19 patients. Thirteen patients (6 in the experimental group and 7 in the control group) experienced nausea/vomiting which was controlled by medication. One patient in the gum-chewing group experienced anastomosis leakage and required a re-operation with a resolution (Table 2). No patient in either group required intensive care.

Bowel motility

After chewing the gum, bowel motility was determined by bowel sounds, time to the first postoperative flatus and defecation. Patients in the experimental group had significantly more bowel sounds than those in the control group. The mean of bowel sounds was 2.57 times/min (S.D. = 0.91) in the experimental group, and 1.76 times/minute (S.D. = 0.75) in the control group (t = -5.29, $p = 0.00$). Furthermore, the times to the first postoperative flatus and defecation in the chewing gum group were significantly shorter than that in control group. The median times to the first postoperative flatus were as follows: in the gum chewing group it was 49 hours 55 minutes (S.D. = 20:12) and in the control group it was 60 hours 18 minutes (S.D. = 19:04) (t = 2.08, $p = 0.04$). The mean time to the first defecation was 70 hours 24 minutes (SD = 24:56), and 86 hours 56 minutes (S.D. = 28:03), respectively (t = 2.26, $p = 0.02$) (Table 3).

DISCUSSION

Regarding the research methodology in our study, we performed a calculation for a sufficiently large sample size. The routine nursing outcomes that were evaluated were chosen for being easy to measure in everyday practice. A randomized control trial research design was conducted. Then the errors were eliminated.

According to our hypothesis, we explained that the increase in bowel sounds, the decrease in the time to the first postoperative flatus and defecation (i.e. bowel motility) results from the three mechanisms of cephalic-vagal stimulation: the chewing mechanism, the taste perception mechanism, and the olfactory perception mechanism.[21] These three mechanisms generate nerve impulses that are sent to the cerebral cortex. As a result, the vagus nerve stimulates the gastrointestinal system during the cephalic phase. Neural and humoral hormones; gastrin, neurotensin, pancreatic polypeptide and duodenal alkaline secretions were secreted which stimulated the smooth muscles in the gastrointestinal tract causing bowel motility.[11,17,22] This bowel motility can be evaluated by observing bowel sounds. In our study, normal bowel sounds were detected after chewing gum. Therefore, the three mechanisms that occurred after chewing gum were similar to others in the general population.[20] To the best of our knowledge, this is the first study measuring and showing an association between gum chewing and bowel sounds in patients undergoing colectomy and using a randomized controlled trial.

In our study, the time to the first postoperative flatus and defecation decreased after chewing gum. This can be explained in that after a peristalsis movement has occurred, the gas

TABLE 3. Bowel motility.

Bowel motility	Experimental group (n = 32) $\bar{x} \pm SD$	Control group (n = 32) $\bar{x} \pm SD$	t	*p*-value
Bowel sounds, time/min	2.57 ± 0.91	1.46 ± 0.75	-5.29	0.00*
Time to first postoperative flatus, hrs:mins	49:55 ± 20:12	60:18 ± 19:04	2.08	0.04**
Time to first postoperative defecation, hrs:mins	70:24 ± 24:56	86:56 ± 28:03	2.26	0.02**

*p < 0.01, **p < 0.05

resulting from fermentation will then be sent to the lower part of the intestine. It will eventually be expelled through the anus as flatus.[23] Once the large bowel has had a peristalsis movement, the feces will move to the rectum. The mechanical receptors of the internal neurons were stimulated which resulted in an intrinsic defecation reflex. After that, the sphincter muscles of the rectum contract and relax so the feces are expelled, this is called defecation.[24]

This study showed that patients who chewed gum had a significantly shorter time to their first postoperative flatus and defecation. These findings were consistent with the findings from six systematic reviews and meta-analysis of randomized control trials that were published from 2007 to 2013.[25-30] All of those studies reported that gum chewing shortens the time to the first flatus and defecation. However, these studies put forward opposite results from three other studies.[15,17,18] One possible reason was that the durations of gum chewing were too short, which were between 5 and 15 minutes each. The time period of gum chewing might not be enough to stimulate the nerves in order to initiate bowel motility.

Since we conducted this research in colorectal patients with an open colectomy, the results might be limited to this group of patients. Therefore, the replication in patients with other abdominal surgery should be studied, such as those having undergone gastrectomy, gastrojejunostomy, lysis adhesion, cholecystectomy, pancreaticoduodenectomy and hepatectomy. In addition, studies should be carried out with patients undergoing laparoscopic and robotic abdominal surgery.

In a future study, we should control the time to start of oral feeding, because early feeding affects the stimulation of bowel motility. Bowel sounds, one of the outcomes of bowel motility, should be measured over the course of several studies.

In conclusion, gum chewing is helpful in stimulating bowel motility by cephalic-vagal stimulation assessed by an increase in bowel sounds and an earlier time to the first flatus and defecation. This nursing intervention may be used for enhancing the recovery from POI in patients with colorectal cancer after open colectomy because it is easy and convenient to implement, there is no need for special training, it is easy to monitor, inexpensive, safe for patients and can be done in everyday practice.

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