THE MECHANISM THROUGH WHICH THE DIETARY FIBER-BASED ENTERAL NUTRITION SUPPORT PROGRAM AFFECTS INTESTINAL FUNCTION RECOVERY IN PATIENTS UNDERGOING DIFFERENT GYNECOLOGICAL ABDOMINAL SURGERIES

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ABSTRACT

Objective*: This study aims to examine the mechanism through which the dietary fiber-based enteral nutrition support program affects intestinal function recovery in patients undergoing different gynecological abdominal surgery.*

Methods: *A total of 208 patients undergoing gynecological abdominal surgery from March 16, 2019 to March 15, 2020 were enrolled in this study and divided into four groups. Accordingly, the groups included group A (open surgery + dietary fiber-based enteral nutrition support, n=52), group B (open surgery + routine diet, n=52), group C (laparoscopic surgery + dietary fiber-based enteral nutrition support, n=52), and group D (laparoscopic surgery + routine diet, n=52). After admission, a fixed dietitian conducted an assessment. After the surgery, trained professional nurses were responsible for observing the main symptoms and signs reflecting postoperative intestinal function recovery, such as abdominal pain, abdominal distension, nausea, and vomiting. Postoperative exhaust time, first defecation time after the surgery, and postoperative hospital stay were recorded.*

Results: *There were no differences in general statistics of age, BMI, ratio of menopausal status, diabetes ratio, and surgical classification ratio among the four groups (P>0.05).Comparisons between group A and group B, and between group C and group D showed no statistical differences in the surgery time and intraoperative blood loss (P>0.05); however, decreased bowel sound recovery, exhaust time, defecation time, hospital stay, hospitalization expenses, incidence of abdominal distension, and incidence of intestinal obstruction were observed (P>0.05). Compared to group A and group B, group C and group D experienced a decrease in surgery time, intraoperative blood loss, bowel sound recovery, exhaust time, defecation time, hospital stay, hospitalization expenses, incidence of abdominal distension, and incidence of intestinal obstruction (P<0.05). Comparisons between group A and group B, and between group C and group D showed that the effective rate and total effective rate increased, inefficiency decreased, the relative satisfaction rate and total satisfaction increased, yet dissatisfaction decreased (P>0.05). Besides, comparisons between group C and group A, and between group D and group B showed that the effective rate and total effective rate increased, inefficiency decreased, the relative satisfaction rate and total satisfaction increased, yet dissatisfaction decreased (P<0.05).*

Conclusion: *Application of dietary fiber-based enteral nutrition support in patients undergoing gynecological abdominal surgery can promote intestinal function recovery, protect intestinal mucosa barrier function, and prevent postoperative infectious complications.*

Keywords: *Dietary fiber, enteral nutrition support, gynecological abdominal surgery, intestinal function.*

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Introduction

In most cases, gynecological surgery is the lower abdomen surgery prone to postoperative intestinal paralysis due to surgical anesthesia suppression, interference with abdominal organs, and gastrointestinal stress. Manifestations include abdominal distension, pain caused by weakened intestinal peristalsis, sometimes intestinal obstruction, and pelvic adhesions. Therefore, swift recovery of intestinal function after surgery has become effective in rapid recovery after abdominal surgery[1-5]. Rapid rehabilitation has been highly taken into account around the world since its appearance more than a decade ago. Nutritional support is the basic guarantee for rapid rehabilitation

of patients after fast track surgery[6]. In recent years, as humans have made in-depth research on dietary fiber, its physiological activity and function, and its mechanism of action have gradually turned into the research focus for many scholars. It is worth noting that dietary fiber is known as the seventh human nutrient[7, 8]. Domestically, although the majority of medical staff have gained a certain degree of understanding of the importance of dietary fiber, its clinical application is not yet standardized[9].

Through dietary fiber interventions, this study investigates effects of dietary fiber on intestinal function recovery in patients after gynecological surgery to provide a basis for clinical enteral nutrition interventions in intestinal function recovery in patients after gynecological abdominal surgery, thereby benefiting the majority of them.

Experimental method

General information

A total of 208 patients undergoing gynecological abdominal surgery from March 16, 2019 to March 15, 2020 were enrolled, which included 104 patients undergoing open surgery (groups A and B) and 104 patients undergoing laparoscopic surgery (groups C and D). The two groups were randomly divided into the observation group with dietary fiber-based enteral nutrition support (groups A and C) and the control group (groups B and D) with routine dietary education, according to different nutritional support programs.

For 52 cases in the observation group, 6 hours after surgery, one bag of dietary fiber (5g) was dissolved into 30ml of warm water, and the patient was allowed to gradually drink it up in about 5 minutes, with a bag every 4 hours and a total of 4 bags. For 52 cases in the control group, they gradually drank 30ml of warm water 6 hours after surgery by drinking it once every 4 hours and 4 times in total.

Inclusion criteria

Women with benign gynecological diseases (ovarian cystectomy, oophorectomy, laparoscopic myomectomy, and the maximum uterine fibroid size of less than 7cm) having undergone open surgery or laparoscopic surgery were included in this study. Other inclusion criteria were being 18-65 years, having a body mass index of 18 to 30 kg/m^2, having no previous history of abdominal surgery (except appendectomy), and having no existing or previous clinically important systemic diseases.

Exclusion criteria

Patients with suspected malignant tumors, relevant non-gynecological surgical pathology, severe endometriosis (in stage III or IV according to the classification by the American Society for Reproductive Medicine), previous history of abdominal surgery, and mental illnesses were excluded from the study.

Medical ethics approval

The research program received approval from the research ethics committee of the hospital, with informed consent obtained from all patients.

Methods

Random criteria

During the research period, 237 women were considered eligible for the study. A total of 208 women (87.76%) accepted the study and went through randomization. The computer generated a random number pool, with even and odd numbers assigned to the instructions "Group A", "Group B", "Group C", and "Group D". The instructions were transferred to the cards in their original random order. Next, each card was placed in a sealed opaque envelope.

The study was masked by the surgeons, and the surgeons would not know to which group the patient was assigned. In the preoperative consultation, eligible patients were invited to participate in the study approximately 2 weeks before the surgery. Upon the patient's consent for participation in the study, a nurse wrote the patient's name on the next envelope in a series of consecutively numbered envelopes and then opened it. After the assignment, the nurse provided detailed instructions on the preoperative diet to the patients in the study groups.

Surgical procedure

All surgical operations were performed by researchers of the same level, who had extensive experience in laparoscopic surgery. Accordingly, each surgeon had performed more than 1,000 laparoscopic surgeries. Two surgeons were present in the operating room for each surgical operation. Laparoscopic surgery was performed under general anesthesia induced with propofol at a dose of 2.5 mg/kg + atracurium 0.5 mg/kg + fentanyl 0.05 mg. During the surgery, atracurium 0.01 mg/kg/30 minutes + remifentanil 0.2 0.5 0.5 g/kg/minute + sevoflurane 1 MAC (60% air and 40% O_2) were used to maintain anesthesia. There was no prescribed anesthetic. The laparoscopic technique

was used for laparoscopy, and a 10mm port was inserted through the umbilical cord to introduce the laparoscope. Next, pneumoperitoneum was realized by carbon dioxide injection (heated and humidified gas). Besides, two other 5mm ports were inserted for the introduction of surgical instruments. In addition, uterine manipulators were used to allow anteversion, lateral movement of the uterus, and organ exposure.

After the surgery, all patients underwent infusion of 2,000mL of the sterile saline solution (1,000mL NaCl 0.9% and 1,000mL lactated Ringer's solution) within 24 hours. The analgesic consisted of 30 mg of ketorolac administered intravenously in 0 and 8 hours after surgery.

The success rate of dietary fiber-based enteral nutrition and recovery of gastrointestinal function

The primary endpoint criterion was the success rate of dietary fiber-based enteral nutrition, defined as the proportion of the patients tolerating provision of 80% of complete nutritional requirements via dietary fiber-based enteral nutrition in 7 days after surgery without digestive symptoms, including vomiting, diarrhea, and abdominal distension. In the first 7 days after surgery, the first bowel movement, flatulence, bowel sounds, abdominal distension, postoperative intestinal obstruction, and the tolerance time required for full nutrition provision were recorded.

The first auscultation recording time for bowel sounds was 6 hours after surgery, with auscultation performed every 4 hours until the symptom was normal. Postoperative intestinal obstruction is defined as temporary cessation of coordinated bowel movements after surgery, which prevents effective transport of intestinal contents or tolerance of oral intake. If neither criterion (unobstructed intestine, stomach, or defecation and oral diet tolerance) was met before the 4th day after surgery, it could be diagnosed as postoperative intestinal obstruction. Prolonged postoperative intestinal obstruction is defined as the postoperative intestinal obstruction in which open surgery lasts more than 5 days, or laparoscopic surgery lasts more than 3 days.

Postoperative recurrent intestinal obstruction is defined as the intestinal obstruction occurring after the postoperative intestinal obstruction significantly disappears.

Enteral malnutrition of dietary fiber is defined as:

• When vomiting, diarrhea, abdominal distension, and intestinal obstruction occur after oral administration, with oral intake stopping;

• When dietary fiber-based enteral nutrition is unable to meet 80% of nutritional needs within 24 hours.

Hospital stay

Postoperative hospital stay is defined as the duration between the date of surgery and the day when discharge criteria are met. Discharge criteria include being able to manage personal care and toilet activities, with no fever and venous access. When a patient's conditions meet the abovementioned objective criteria, hospitalization is no longer considered sensitive to nutritional support, with the patient being considered to have gotten rid of nutritional awareness; thus, the actual hospital stay can be recorded.

Hospitalization expenses

Costs of dietary fiber-based enteral nutrition were calculated based on total costs of all items related to dietary fiber-based enteral nutrition on the account statement, which included nutritional products, disposal materials, consulting fees, infusion pumps, and catheters.

Besides, costs of the routine diet group were calculated based on total costs of all items related to the plan.

Statistical analysis

The data in this study were processed by SPSS 20.0 (statistical analysis software) (IBM, USA). Besides, the measurement data were expressed by "mean±standard deviation" ($\bar{x}\pm s$), with comparisons between the groups performed by one-way analysis of variance or repeated measurement analysis of variance. In addition, the LSD-t test was used for pairwise comparisons between the groups.

The count data were expressed by percentage (%), with comparisons between the groups analyzed by χ^2. In addition, $P<0.05$ was considered statistically significant.

Results

Comparison of general patient information

This study involved a total of 208 patients undergoing gynecological abdominal surgery in our hospital.

There was no difference in the general statistics of age, BMI, menopausal state proportion, diabetes ratio, and surgical classification ratio in the four groups ($P>0.05$) (Table 1).

Group	Age (years)	BMI (kg/m^2)	Menopausal status (Yes: No)	Diabetes (Yes: No)	Surgical classification (Ovarian cystectomy: Ovariectomy: Laparoscopic hysterectomy)
Group A (n=52)	42.75±3.16	23.87±1.62	13 (25.00%)	7 (13.46%)	32:17:3
Group B (n=52)	43.78±6.26	24.72±0.15	15 (28.85%)	8 (15.38%)	30:18:4
Group C (n=52)	41.18±5.75	22.17±1.13	14 (26.92%)	6 (11.54%)	31:18:3
Group D (n=52)	42.84±6.78	23.78±1.82	15 (28.85%)	8 (15.38%)	31:17:4
F/χ^2 value	1.927	1.728	0.715	0.725	0.827
P-value	0.715	0.328	0.263	0.617	0.181

Table 1: General information of clinical patients.

Comparison of surgery time and intraoperative blood loss in different groups

Comparisons between group A and group B, and also between group C and group D showed no statistical differences in surgery time and intraoperative blood loss (P>0.05). Besides, compared to group A and group B, group C and group D had a shorter surgery time and less intraoperative blood loss (P<0.05) (Figure 1, Table 2).

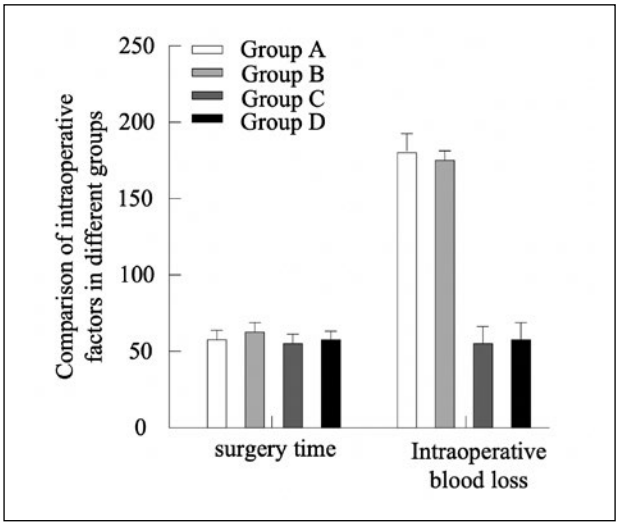

Figure 1: Comparison of surgery time and intraoperative blood loss in different groups.

Group	Surgery time (min)	Intraoperative blood loss (ml)
Group A (n=52)	62.33±5.62	178.92±16.90
Group B (n=52)	62.93±6.27	177.53±14.72
Group C (n=52)	58.37±4.26	56.38±16.85
Group D (n=52)	58.36±4.65	58.26±17.93
F-value	15.280	38.213
P-value	0.016	0.001

Table 2: Comparison of surgery time and intraoperative blood loss in different groups.

Comparison of bowel sound recovery, exhaust time, and defecation time in different groups

Comparisons between group A and group B, and between group C and group D showed that the bowel sound recovery time, exhaust time, and defecation time decreased (P>0.05). Besides, comparisons between group C and group A, and between group D and group B showed that bowel sound recovery time, exhaust time, and defecation time decreased (P<0.05) (Figure 2, Table 3).

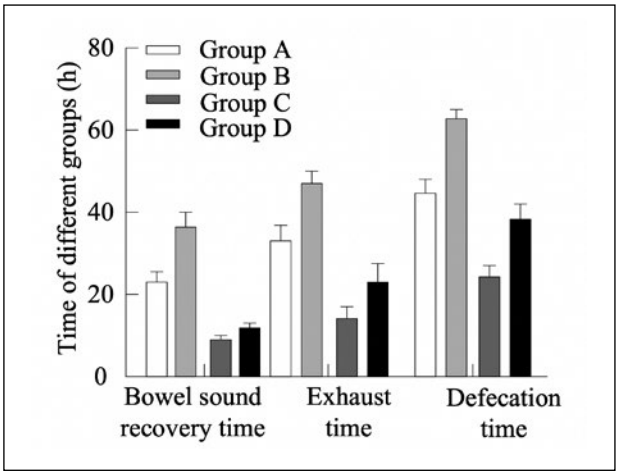

Figure 2: Comparison of bowel sound recovery, exhaust time, and defecation time in different groups.

Group	Bowel sound recovery time (h)	Exhaust time (h)	Defecation time (h)
Group A (n=52)	24.26±2.81	32.71±3.72	49.22±3.72
Group B (n=52)	35.27±4.82	52.61±2.15	62.17±4.82
Group C (n=52)	11.16±2.26	17.27±2.37	28.16±2.82
Group D (n=52)	17.78±1.53	26.16±2.16	36.16±3.27
F-value	22.738	46.281	25.293
P-value	0.016	0.001	0.012

Table 3: Comparison of bowel sound recovery, exhaust time, and defecation time in different groups.

Comparisons of hospital stay, hospitalization expenses, incidence of abdominal distension, and incidence of intestinal obstruction in different groups

Comparisons between group A and group B, and between group C and group D showed that hospital stay, hospitalization expenses, incidence of abdominal distension, and incidence of intestinal obstruction decreased (P>0.05). Besides, comparisons between group C and group A, and between group D and group B showed that hospital stay, hospitalization expenses, incidence of abdominal distension, and incidence of intestinal obstruction decreased (P<0.05) (Table 4).

Group	Hospital stay (d)	Hospitalization expenses (yuan)	Incidence of abdominal distension	Incidence of intestinal obstruction
Group A (n=52)	12.87±1.56	6377.25±122.63	9 (17.31%)	4 (7.69%)
Group B (n=52)	14.34±1.13	6934.02±146.17	13 (25.00%)	6 (11.54%)
Group C (n=52)	7.62±0.86	5246.52±187.28	3 (5.77%)	0 (0.00%)
Group D (n=52)	9.13±1.25	5879.56±134.72	5 (9.62%)	1 (1.92%)
F/χ^2 value	13.547	45.356	6.324	6.547
P-value	0.015	0.001	0.014	0.002

Table 4: Comparison of hospital stay, hospitalization expenses, incidence of abdominal distension, and incidence of intestinal obstruction in different groups.

Comparison of effects of intestinal function recovery in different groups

Comparisons between group A and group B, and between group C and group D showed that the effective rate and total effective rate increased, yet inefficiency decreased (P>0.05). Besides, comparisons between group C and group A, and between group D and group B showed that the effective rate and total effective rate increased, yet inefficiency decreased (P<0.05) (Figure 3, Table 5).

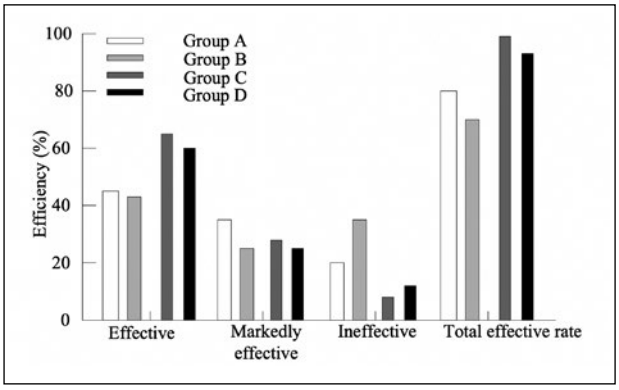

Figure 3: Effects of intestinal function recovery.

Group	Effective	Significantly effective	Ineffective	Total effective rate
Group A (n=52)	24 (46.15%)	17 (32.69%)	11 (21.15%)	41 (78.85%)
Group B (n=52)	22 (42.31%)	13 (25.00%)	17 (32.69%)	35 (67.31%)
Group C (n=52)	35 (67.31%)	14 (26.92%)	3 (5.77%)	49 (94.23%)
Group D (n=52)	31 (59.62%)	13 (25.00%)	8 (15.38%)	44 (84.62%)
F-value	12.458	11.635	12.247	9.641
P-value	0.001	0.004	0.001	0.002

Table 5: Effects of intestinal function recovery.

Comparison of satisfaction among different groups

Comparisons between group A and group B, and between group C and group D showed that the relative satisfaction rate and total satisfaction increased, yet dissatisfaction decreased (P>0.05). Besides, comparisons between group C and group A, and between group D and group B showed that the relative satisfaction rate and total satisfaction increased, yet dissatisfaction decreased (P<0.05) (Table 6).

Group	Relatively satisfied	Satisfied	Dissatisfied	Total satisfaction
Group A (n=52)	22 (42.31%)	16 (30.77%)	14 (26.92%)	38 (73.08%)
Group B (n=52)	20 (38.46%)	12 (23.08%)	20 (38.46%)	32 (61.54%)
Group C (n=52)	36 (69.23%)	15 (28.85%)	1 (1.92%)	51 (98.08%)
Group D (n=52)	32 (61.54%)	14 (26.92%)	6 (11.54%)	46 (88.46%)
F-value	13.546	15.234	17.326	16.331
P-value	0.014	0.003	0.006	0.015

Table 6: Satisfaction statistics.

Discussion

In this study, the dietary fiber-based enteral nutrition support program was randomly compared with the routine diet program for different gynecological abdominal surgeries. It was found out that the patients tolerated the dietary fiber-based enteral nutrition support well, with their intestinal function recovery rate and satisfaction increased.

Although ever-increasing in-depth research has been made on dietary fiber in recent years, its physiological activity, function, and mechanism of action have gradually become the research focus for many scholars. Being known as the seventh nutrient for humans, dietary fiber plays a major role in maintaining and promoting human health, as well as preventing diseases[10, 11]. Although dietary fiber has received a great deal of attention domestically and abroad, most researchers are biased towards its extraction and detection from different sources. Besides, they have been investigating its simple properties and physiological functions, without paying attention to role of dietary fiber in promoting postoperative intestinal function recovery, regardless of its role in promoting intestinal function recovery after gynecological abdominal surgery[12]. Dietary fiber is receiving ever-increasing attention and is used in postoperative enteral nutrition support more than ever. Clinicians in most hospitals in the province are still constrained by traditional concepts, given that patients are only allowed to receive food after gas passage by their anus, thereby leading to delayed intestinal function recovery, increased postoperative

complications, prolonged hospital stay, and increased total treatment costs[13-15]. However, according to the concept of fast track surgery, early postoperative food intake can promote intestinal function recovery. Therefore, after the small intestine's function is restored within a few hours after surgery, early dietary fiber-based enteral nutrition support can promote early physiological function recovery of the intestine, protect intestinal mucosa barrier function, prevent postoperative infectious complications, and provide a basis for clinical enteral nutrition interventions in rapid intestinal function recovery after gynecological abdominal surgery[16-18].

In past research, hospital stay was used as an evaluation index of early enteral nutrition. Since hospital stay is determined according to discharge criteria, many factors could affect it. Some of these factors include infection complications and changes due to nutritional support[19]. In the present study, hospital stay during the dietary fiber-based enteral nutrition support program was 2 days less than that in patients with a routine diet in both open surgery and laparoscopic surgery. This was consistent with the results of the two meta-analyses.

According to the results of this study, patients well tolerated the early enteral nutrition support program. This intervention led to other enhanced rehabilitation techniques, such as early mobilization and pain control optimization. Indeed, there is a significantly growing need for executing a structured and proactive enhanced recovery program in gynecological surgery. Routine diets have lower costs than dietary fiber-based enteral nutritional support, yet the latter exerts more therapeutic effects. Gastrointestinal function recovery can improve treatment of infectious complications, thereby reducing total treatment costs per patient. Hence, in contrast to past research, total costs of dietary fiber-based enteral nutrition support treatment were lower.

According to a comprehensive review of randomized controlled trials on the prevention of intestinal obstruction, effective techniques for preventing postoperative intestinal obstruction included epidural analgesia, local anesthesia, peripheral opioid antagonists, laxatives, intravenous and local anesthesia, which avoid routine nasal intubation and anesthesia[20]. However, to reduce the incidence of intestinal obstruction, there is no clear evidence verifying early enteral nutrition support and preferential use of laparoscopic surgery. In this study, both laparoscopic surgery and dietary fiber-based enteral nutritional support reduced the incidence of abdominal distension and intestinal obstruction in patients, thereby increasing the intestinal function recovery rate and patient satisfaction.

To sum it up, application of dietary fiber-based enteral nutrition support in patients undergoing gynecological abdominal surgery promotes intestinal function recovery, protects intestinal mucosa barrier function, and prevents postoperative infectious complications.

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