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ORIGINAL ARTICLE

Difference in the effects of three nutritional pathways on postoperative rehabilitation in patients with gastric cancer and type 2 diabetes mellitus*

Yan Li (✉), Yan Zhou, Mao Chen

Department of General Surgery, Mianyang Central Hospital, Mianyang 621000, China

Abstract

Objective To explore the difference in the effects of three nutritional pathways on the rehabilitation of patients with gastric cancer and diabetes mellitus after operation.

Methods Overall, 120 patients were randomly divided into the partial parenteral nutrition (PPN), early enteral nutrition (EEN), and diabetes mellitus special enteral nutritional emulsion (DEN) groups. The differences in the effects of three nutritional modes were compared.

Results (1) On postoperative day four, the total protein level in the EEN and DEN groups was significantly higher than that in the PPN group ($P < 0.05$). On postoperative day ten, body mass index, lymphocyte count, total protein level, and pre-albumin level in the DEN group were significantly higher than those in the PPN group ($P < 0.05$). (2) On postoperative day four, there was no significant difference in the fasting blood glucose level between the EEN and DEN groups ($P > 0.05$), but this level was significantly lower than that in the PPN group ($P < 0.05$). On postoperative day ten, fasting and postprandial blood glucose levels in the DEN group were significantly lower than those in the PPN group. (3) On postoperative day four, the C-reactive protein level in the DEN group was significantly lower than that in the other groups ($P < 0.05$). (4) The incidence rates of complications in the PPN, EEN, and DEN groups were 25.0%, 10.0%, and 5.0%, respectively. The incidence of complications in the PPN group was significantly higher than that in the other groups. However, there was no significant difference in perioperative indexes among the three groups ($P > 0.05$).

Conclusion Enteral nutrition is more conducive to the recovery of patients with gastric cancer and type 2 diabetes mellitus after operation; the special enteral nutrition emulsion for diabetes mellitus is more effective than the conventional nutrition solution in stabilizing blood sugar levels and reducing the degree of inflammation.

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Key words: gastric cancer; type 2 diabetes mellitus; enteral nutrition; parenteral nutrition

Gastric cancer is one of the most common malignant tumors of the digestive tract, and surgery is the main treatment. Reasonable perioperative treatment and nursing are important factors affecting the rehabilitation process of patients [1, 2]. Owing to changes in lifestyle and food spectrum, the incidence rate of type 2 diabetes mellitus (T2DM) is increasing rapidly in China [3, 4]. Many elderly patients with gastric cancer have T2DM. Such patients often experience poor basic nutrition and poor treatment compliance. Inappropriate postoperative nutrition can lead to unstable blood glucose levels, slow wound healing, immune imbalance, and other complications. Therefore, it is necessary to develop more targeted nutritional interventions. This study collected 120 elderly patients as the research object to prospectively explore the differences in the effects of three nutritional pathways on the postoperative rehabilitation of elderly patients with gastric cancer complicated with T2DM, to provide a basis for clinical rational selection.

✉ Correspondence to: Yan Li. Email: 495543950@qq.com
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Materials and methods

Materials

From January 2017 to April 2021, a total of 120 elderly patients with gastric cancer complicated with T2DM were selected from the Department of General Surgery of Mianyang Central Hospital. The inclusion criteria were as follows: (1) The patient's first diagnosis was primary gastric cancer with a clear pathological basis; (2) The patient should have met the diagnostic criteria for T2DM published in the 2017 edition of the American Diabetes Association [5]; (3) Gastric cancer was divided into stages I-III, and the patient should have undergone radical surgery of D2 and above; (4) Age ≥ 60 years old; (5)Informed consent was provided by the patient and the family. The exclusion criteria were as follows: (1) Presence of Roux-en-Y gastrointestinal anastomosis; (2) Presence of dysfunction of other important organs, such as cardiac insufficiency, renal insufficiency, and so on; (3) Before operation, the patient received anticancer treatment such as radiotherapy, chemotherapy, or immunotherapy. Finally, 120 patients were included in the study. There were 78 males and 42 females, with an average age of 71.7 ± 5.4 years.

Intervention methods and grouping

According to the different nutritional modes, patients were randomly divided into the partial parenteral nutrition (PPN) group, early enteral nutrition (EEN) group, or diabetes mellitus special enteral nutritional emulsion (DEN) group. The specific measures were as follows: PPN group: meeting the nitrogen demand of 0.2 g/(kg·d) and non-protein heat card of 22 kcal/(kg·d) as the standard; considering factors such as the enhancement of postoperative insulin resistance and systemic stress response, it was finally determined that 70% of energy was supplied by fat emulsion and 30% by glucose solution—vitamins, electrolytes, and trace elements were added simultaneously. Insulin was prepared as follows: 1 U: (4-8) g sugar neutralization solution. The above nutrients were mixed into a parenteral nutrition solution, which was continuously injected through the peripheral vein for 24 h. According to the actual recovery status of the patient, there was a gradual change from a liquid diet to a normal diet one week after the operation. In the EEN group, 250 mL of normal saline was injected through the nasal feeding tube 12 h after the operation, and the patient's reaction was observed. If there was no obvious discomfort, then the enteral nutrient solution was injected. In the DEN group, similar to that in the EEN group, 250 mL of normal saline was injected through the nasal feeding tube 12 h after the operation, and the patient's reaction was observed. If there is no obvious discomfort, use enteral nutrition infusion pump, the speed should be slow to fast, injection of 500 mL special nutrition emulsion (Chinese medicine approved J20140077, Fresenius Kabihuaru Pharmaceutical Co., LTD.), with a tube feeding speed of approximately 20 mL/h. After that, there was an increase of approximately 20 mL/h every day, but the maximum dropping speed should not exceed 120 mL/h, which was adjusted according to the actual situation of the patient.

Test indicators

(1) Nutritional indexes: body mass index (BMI), lymphocyte count (LYM), total protein level, pre-albumin level, and other indexes were repeatedly measured before the operation and on the first, fourth, and tenth day after the operation. BMI was not measured on the first day after the operation because of the inconvenience of lying on bed. (2) Blood glucose level and inflammatory indexes: fasting and 2 h postprandial blood glucose levels, leukocyte count, and C-reactive protein levels were repeatedly measured before the operation and on the first, fourth, and tenth day after the operation. Blood samples were collected by full-time nurses of our department. The blood sample indexes were tested in the laboratory department of our hospital. (3) Perioperative indicators: postoperative hospital stay, postoperative exhaust time, incidence of complications, and types of complications were recorded objectively.

Statistical analysis

All data were analyzed using SPSS 20.0 software package. The collected data were repeatedly entered, checked, and corrected by two people. The measurement data are expressed as $\bar{\chi} \pm s$, and the statistical inference was analyzed using one-way analysis of variance. The counting data are expressed as frequency and rate, and the chi-square test or Fisher exact probability test was used for comparison. $P < 0.05$ was considered to indicate a statistically significant difference.

Results

Comparison of nutritional indexes between the three groups

There was no significant difference in the nutritional indexes between the three groups before the operation and on the first day after the operation ($P > 0.05$). On postoperative day four, the total protein level in the EEN and DEN groups was significantly higher than that in the PPN group ($P < 0.05$), but there was no significant difference in the other indexes ($P > 0.05$). On postoperative day ten, BMI, LYM, and total protein and pre-albumin levels in the DEN group were significantly higher than those in the PPN group ($P < 0.05$; Table 1).

Comparison of fasting blood glucose and 2-h postprandial blood glucose levels among the three groups

On postoperative day four, there was no significant difference in the fasting blood glucose level between the EEN and DEN groups ($P > 0.05$), but this level was significantly lower than that in the PPN group ($P < 0.05$). On postoperative day ten, fasting and 2-h postprandial blood glucose levels in the DEN group were significantly lower than those in the PPN group, but there was no significant difference between the DEN and EEN groups ($P > 0.05$; Table 2).

Comparison of leukocyte count and C-reactive protein level among the three groups

Before and 1 day after the operation, there was no significant difference in the leukocyte count and C-reactive protein (CRP) level among the three groups ($P > 0.05$). On postoperative days four and ten, the white blood cell count and CRP level in the DEN group were significantly lower than those in the PPN and EEN groups ($P < 0.05$; Table 3).

Comparison of perioperative indexes among

Table 1 Comparison of nutritional indicators among the three groups

Index	PPN (n = 40)	ENN (n = 40)	DEN (n = 40)	F	P
Preoperative					
BMI	24.14 ± 3.76	25.91 ± 3.05	24.85 ± 3.08	1.446	0.244
LYM	1.85 ± 0.68	1.84 ± 0.79	1.80 ± 0.79	2.106	0.131
total protein	62.08 ± 8.38	64.74 ± 9.97	63.48 ± 6.45	0.502	0.607
Pre- -albumin	200.22 ± 54.97	232.61 ± 88.10	221.58 ± 70.65	1.031	0.363
The first day after surgery					
LYM	1.03 ± 0.53	1.21 ± 0.69	1.17 ± 0.81	0.379	0.686
total protein	53.26 ± 5.08	57.39 ± 6.18	55.83 ± 5.34	2.821	0.067
Pre-albumin	162.05 ± 43.81	185.01 ± 50.77	178.63 ± 41.57	1.354	0.266
The fourth day after surgery					
BMI	23.18 ± 3.43	25.15 ± 3.01	24.14 ± 3.06	1.929	0.154
LYM	0.97 ± 0.35	1.35 ± 0.44	1.71 ± 0.71	10.020	0.000
total protein	50.98 ± 5.13	54.57 ± 4.79[a]	54.89 ± 4.75[a]	3.937	0.025
Pre-albumin	127.38 ± 31.17	139.21 ± 37.71	148.34 ± 46.99	1.440	0.245
The tenth day after surgery					
BMI	22.70 ± 3.39	24.64±2.94	25.07 ± 3.07[a]	3.236	0.046
LYM	0.97 ± 0.35	1.35±0.44[a]	1.71 ± 0.71[ab]	10.020	0.000
total protein	50.23 ± 11.28	52.59±15.76	61.22 ± 15.98[ab]	3.183	0.048
Pre-albumin	113.38 ± 28.35	134.46±25.36[a]	157.00 ± 40.68[ab]	9.205	0.000

BMI, body mass index; LYM, lymphocyte count; PPN, partial parenteral nutrition; EEN, early enteral nutrition; DEN, diabetes mellitus special enteral nutritional emulsion. [a] compared with PPN group, $P < 0.05$; [b] compared with EEN group, $P < 0.05$

Table 2 Comparison of fasting and 2-hour postprandial blood glucose levels among the three groups

Index	PPN (n = 40)	ENN (n = 40)	DEN (n = 40)	F	P
Fasting blood-glucose					
Before surgery	7.3 ± 1.2	6.7 ± 1.3	7.2 ± 0.9	1.574	0.216
1d postoperatively	10.2 ± 2.8	10.6 ± 2.8	9.9 ± 3.4	0.271	0.763
4d postoperatively	10.3 ± 1.8	8.7 ± 2.5[a]	8.7 ± 2.4[a]	3.357	0.041
10d postoperatively	8.8 ± 1.3	7.8 ± 1.7[a]	6.9 ± 1.0[a]	9.713	0.000
After 2h postprandial blood glucose					
Before surgery	9.3 ± 1.3	8.5 ± 2.4	8.4 ± 1.5	1.505	0.230
1d postoperatively	10.5 ± 2.4	9.9 ± 2.8	9.5 ± 3.6	0.572	0.567
4d postoperatively	10.5 ± 2.5	9.4 ± 2.7	8.9 ± 2.1[a]	2.240	0.115
10d postoperatively	10.5 ± 2.2	9.3 ± 2.7	7.9 ± 1.4[a]	7.211	0.001

PPN, partial parenteral nutrition; EEN, early enteral nutrition; DEN, diabetes mellitus special enteral nutritional emulsion. [a] compared with PPN group, $P < 0.05$; [b] compared with EEN group, $P < 0.05$

Table 3 Comparison of leukocyte count and C-reactive protein level among the three groups

Index	PPN (n = 40)	ENN (n = 40)	DEN (n = 40)	F	P
Preoperative					
WBC	6.21 ± 1.54	5.95±1.40	5.92±1.72	0.209	0.811
CRP	8.42 ± 11.34	10.15±10.74	10.71±17.83	0.152	0.859
1d postoperatively					
WBC	12.15 ± 3.58	11.83±2.52	12.58±3.03	0.299	0.742
CRP	68.15 ± 44.37	58.94±39.01	61.51±47.31	0.236	0.790
4d postoperatively					
WBC	8.24 ± 2.44	7.66±1.99	6.76±1.79[ab]	2.544	0.087
CRP	36.27 ± 33.97	22.62±15.66[a]	18.74±12.78[ab]	3.255	0.045
10d postoperatively					
WBC	9.40 ± 5.82	7.53±2.47	6.57±1.36[ab]	2.971	0.059
CRP	29.84 ± 31.53	18.89±19.47	12.53±8.23[ab]	3.192	0.048

WBC, white blood cell; CRP, C-reactive protein; PPN, partial parenteral nutrition; EEN, early enteral nutrition; DEN, diabetes mellitus special enteral nutritional emulsion. [a] compared with PPN group, $P < 0.05$; [b] compared with EEN group, $P < 0.05$

Table 4 Comparison of perioperative indicators among the three groups

Index	PPN (n = 40)	ENN (n = 40)	DEN (n = 40)	F/χ^2	P
Postoperative hospital stay	17.64 ± 7.14	15.66 ± 4.41	14.25 ± 3.87	2.037	0.139
Post-operative exhaust time	4.03 ± 1.25	3.75 ± 0.98	3.39 ± 1.07	3.074	0.054
The incidence of complications	25.0% (10/40)	10.0% (4/40)	5.0% (2/40)	7.500	0.024
Complications type				15.000	0.059
Acute cholecystitis	3	0	0		
Anastomotic fistula	1	2	0		
Infection of incisional wound	4	2	0		
Hypostatic pneumonia	2	0	2		

PPN, partial parenteral nutrition; EEN, early enteral nutrition; DEN, diabetes mellitus special enteral nutritional emulsion

the three groups

The incidence rates of complications in the PPN, EEN, and DEN groups were 25.0% (10/40), 10.0% (4/40), and 5.0% (2/40), respectively. The incidence of complications was significantly higher in the PPN group than in the other groups. However, there was no significant difference in the perioperative indexes, including postoperative hospital stay, postoperative exhaust time, and complication type composition among the three groups ($P > 0.05$; Table 4).

Discussion

With improvements in comprehensive treatment, the survival rate of patients with gastric cancer has improved significantly. However, some patients with gastric cancer, especially those with early gastric cancer, will still have recurrence or metastasis in the short term even if they receive standard radical surgery. Some researchers believe that [6] this may be related to tumor-related malnutrition or immune deficiency. T2DM is a common endocrine disease that has an impact on the metabolism of important nutrients such as sugar, fat, and protein. The resulting high-glucose environment is a good culture medium for bacterial growth. Concomitantly, when the patient is in a state of stress, the chemotaxis of leukocytes is weakened and, consequently, opportunistic pathogenic bacteria enter the patient's body owing to being weak, inducing infection [7]. Disordered homeostasis has a significant negative impact on the postoperative rehabilitation of patients with malignant tumors, which can lead to slow recovery of intestinal peristalsis and delayed or nonunion of incision healing and can even promote recurrence [8]. Therefore, it is necessary to develop and implement more targeted postoperative interventions in patients with gastric cancer complicated with T2DM.

The concept of rapid rehabilitation surgery affirms the positive role of EEN in the surgical rehabilitation of patients with gastric cancer [9], but there are only few reports on the significance of EEN in patients with gastric cancer complicated with T2DM. In this study, we randomly divided patients into the PEN group, EEN group, and DEN group. After the intervention, on postoperative day four, the total protein levels in the EEN and DEN groups were significantly higher than that in the PPN group. On postoperative day ten, BMI,

LYM, and total protein and pre-albumin levels in the DEN group were significantly higher than those in the PPN group. This indicates that enteral nutrition can play a more supportive role than parenteral nutrition, and the effectiveness of enteral nutritional emulsion for diabetes is stronger than that of general nutrition. This may be related to the following advantages of enteral nutrition [10, 11]: (1) it has a stronger stimulatory effect on the recovery of gastrointestinal function; (2) it is more conducive to the recovery of "intestinal liver circulation" and promotes the synthesis of liver-derived protein; and (3) it maintains the function of intestinal mucosa and stabilizes the intestinal flora. There are microvascular lesions in the gastrointestinal tissue of diabetes patients, which becomes a negative factor affecting the recovery of gastrointestinal function postoperatively. Hyperglycemia is not conducive to the postoperative rehabilitation of patients with [12]. The current research also supports the fact that enteral nutrition-based interventions should be carried out as soon as possible for patients undergoing intestinal surgery without contraindications. Enteral nutrition is safer and cheaper for patients than parenteral nutrition, which requires placing and maintaining a central venous catheter. Enteral nutrition also helps maintain the integrity of the intestinal mucosal structure and function and prevent secondary complications, while long-term parenteral nutrition can lead to steatohepatitis. After starting treatment, patients with enteral nutrition do not need continuous monitoring, while patients with parenteral nutrition need regular monitoring. In this study, on postoperative day four, there was no significant difference in the fasting blood glucose level between the EEN and DEN groups, but this level was significantly lower than that in the PPN group. On postoperative day ten, fasting and 2-hour postprandial blood glucose levels in the DEN group were significantly lower than those in the PPN group, but these levels showed no significant difference between the DEN and EEN groups. This indicates that enteral nutritional emulsion may play a role in stabilizing the blood glucose level in the early postoperative stage. Blood glucose control was poor in the PPN group. For patients who must undergo a parenteral nutrition-based intervention in the clinic, the possibility of hyperglycemia should be fully considered with timely interventions. Because of the advantage of special enteral nutrition emulsion in controlling the blood glucose level, the CRP level in the DEN group was also significantly lower on the fourth and tenth day after the operation.

Alternative, this study found that enteral nutrition is more conducive than parenteral nutrition for the postoperative recovery of patients with gastric cancer complicated with T2DM, and that enteral nutritional emulsion for diabetes is more effective in stabilizing the blood glucose level and reducing the degree of inflammation than the conventional nutrition solution. However, this study has some shortcomings: (1) the samples were collected from a single center; hence, there may have been some sampling bias; (2) the sample size is limited. In the future, results from multicenter research with a larger sample size may generate more conclusive findings.

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Conflicts of interest

The authors indicated no potential conflicts of interest.

Author contributions

Not applicable.

Data availability statement

Not applicable.

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