Article

The Effect of Early Enteral Nutrition under the ERAS Model on Gastrointestinal and Immune Function Recovery in Patients Undergoing Gastric Tumor Surgery

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AIM: Patients with gastric malignant tumors usually undergo surgical treatment when indicated. Surgical intervention causes significant trauma and can lead to considerable stress responses in patients. These patients experience increased malnutrition along with reduced immune function, which ultimately leads to the occurrence of postoperative complications. Therefore, this study explored the effects of early enteral nutrition on gastrointestinal and immune function in patients undergoing gastric cancer surgery under the Enhanced Recovery After Surgery (ERAS) model, aiming to support early postoperative recovery.
METHODS: A retrospective analysis was conducted on the clinical data obtained from gastric tumors patients who underwent surgery in the Affiliated Hospital of Jiangsu University, between January 2019 and December 2022. Based on the gastrointestinal management approaches, the patients were divided into a control group (n = 92) and an observation group (n = 92). The control group received routine gastrointestinal management and parenteral nutrition support, while the observation group underwent early enteral nutrition support under the ERAS model. The initial postoperative flatulence, the first instance of eating, and the initial bowel movement, as well as serum nutritional indicators [albumin (Alb), prealbumin (PA), hemoglobin (Hb)], immune markers [immunoglobulin G (IgG), immunoglobulin M (IgM), immunoglobulin A (IgA)], inflammatory markers [white blood cell (WBC), hypersensitive C-reactive protein (hs-CRP), interleukin-6 (IL-6)] were evaluated at different time points before and after surgery. Furthermore, the incidence of postoperative complications (abdominal distension, diarrhea, and infection) and the length of post-surgery hospitalization were documented for both patient cohorts.
RESULTS: The observation group showed shorter time to first postoperative flatus, earlier food consumption, and an advanced first bowel movement than the control group ($p < 0.05$). On the third day after surgery, the serum concentrations of Alb, PA, Hb, IgG, IgM, and IgA were diminished in both groups compared to their preoperative levels ($p < 0.05$). Moreover, on the 7th day after surgery, the serum levels of Alb, PA, Hb, IgG, IgM, and IgA increased in both groups compared to the 3rd day ($p < 0.05$) but remained lower than before surgery levels ($p < 0.05$). Additionally, the serum Alb, PA, Hb, IgG, IgM, and IgA levels were significantly higher in the observation group than in the control group on the 3rd and 7th postoperative days ($p < 0.05$). Three days following surgery, WBC, hs-CRP, and IL-6 levels were elevated in both groups compared to their preoperative levels ($p < 0.05$). On the 7th day after surgery, WBC, hs-CRP, and IL-6 levels decreased in both groups compared to the 3rd day after surgery ($p < 0.05$) but remained higher than preoperative levels ($p < 0.05$). Moreover, WBC, hs-CRP, and IL-6 levels were relatively lower in the observation group than in the control group on the 3rd and 7th postoperative days ($p < 0.05$). Furthermore, the observation group exhibited a decreased overall frequency of postoperative complications compared to the control group ($p < 0.05$), along with shorter hospitalization following the surgery ($p < 0.05$).
CONCLUSIONS: Our findings indicate that early enteral nutrition under the ERAS model can better promote the recovery of gastrointestinal and immune functions in patients undergoing gastric tumor surgery while reducing postoperative complications and facilitating early discharge of patients.

Keywords: gastric tumors; accelerated rehabilitation surgery; enteral nutrition; gastrointestinal function; immunologic function

Introduction

Gastric tumors can be benign or malignant; the benign tumors generally do not require surgical intervention, while the malignant type usually requires surgical treatment when the surgical indications are fulfilled. Since the patients are in a state of high energy breakdown due to stress factors like illness and surgical trauma, they are prone to malnutrition and compromised immune function, leading to a series of complications such as infection [1, 2]. Nutritional support is a crucial intervention for patients who undergoing gastric tumors surgery. It is currently believed that early enteral nutrition support through tube feeding is the preferred perioperative nutritional support method. While providing the pa-

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tient with the required energy, it can stimulate the secretion of gastrointestinal hormones, and preserve the architecture and functionality of the intestinal mucosa [3, 4].

Enhanced Recovery After Surgery (ERAS) is a concept of surgical patient rehabilitation proposed by Professor Kehlet [5] in the 1990s, and has been in constant exploration. It optimizes surgical pathways through multi-team collaboration, aiming to minimize the adverse effects of surgical intervention on patients and promote early postoperative health recovery [6, 7]. Due to the widespread application of the ERAS concept in clinical practice, this approach is commonly applied to patients undergoing gastrointestinal surgery and has achieved promising outcomes [8, 9].

However, there is limited research on applying early enteral nutrition guided by the ERAS concept in patients undergoing gastric tumor surgery. We hypothesized that early enteral nutrition guided by the ERAS concept could promote gastrointestinal and immune function recovery in patients undergoing gastric cancer surgery. Based on this, this study explored the effect of early enteral nutrition under the ERAS model on the recovery of gastrointestinal tract and immune function in patients undergoing gastric tumor surgery, in order to provide a basis for guiding the clinical promotion of early postoperative health recovery in patients undergoing gastric tumor surgery.

Materials and Methods

Study Participants and Sample Size Calculations

This study retrospectively assessed the clinical data obtained from patients who underwent gastric tumors surgeries in the Affiliated Hospital of Jiangsu University between January 2019 and December 2022. The patients diagnosed with gastric tumors through pathological examination, individuals who underwent gastric tumor resection surgeries, and those with complete clinical data were included in this study. Furthermore, exclusion criteria were as follows: ① gastric tumor patients diagnosed with other malignant tumors, ② those with severe vital organ dysfunction, ③ patients with the acute infection before surgery, ④ those with immune system diseases; ⑤ patients with a history of alcohol and drug abuse, ⑥ patients with concomitant mental illness, ⑦ patients affected with diabetes, and ⑧ those with severe anemia before surgery.

The sample size was calculated using the following formula: $n = [(Z_\alpha + Z_\beta)^2 \times 2\sigma]/\delta^2$. For a two-sided $\alpha = 0.05$ and power of 90%, β is set to 0.1. Based on the Z-score table, $Z_\alpha = 1.96$ and $Z_\beta = 1.28$, σ indicates the standard deviation, and δ represents the mean difference between the two groups. Albumin (Alb) was selected as the outcome observation measure. Based on the literature review and preliminary findings [10], the mean Alb water in the control group was (30.48 ± 3.50) g/L, and the Alb level in the observation group was expected to increase by 1.8 g/L, so $\sigma = 3.5$, $\delta = 1.8$. Using these values in the formula, sample size was calculated as n = 79.38. After a 15% projected dropout rate, the minimum sample size per group was 92 cases.

This study was approved by the Ethics Committee of the Affiliated Hospital of Jiangsu University (KY2024K0601) and study design adhered to the Declaration of Helsinki. Additionally, informed consent was obtained from each patient.

This study included 615 patients who underwent gastric cancer surgery in the Affiliated Hospital of Jiangsu University, between January 2019 to December 2022. Out of the total patients, 248 did not meet the inclusion criteria, while 93 met the exclusion criteria, resulting in a final study cohort of 274 patients. Among the included cohort of patients, 109 cases underwent early enteral nutrition support under the ERAS model, and 165 received routine gastrointestinal management and parenteral nutrition support.

Following the 1:1 matching principle based on baseline characteristics (gender, age, body mass index, Tumor Node Metastasis (TNM) stage, and surgical type), with the caliper value set at 0.1, propensity score matching was conducted. This process matched patients in the observation group (n = 92) with those in the control group (n = 92). Before propensity score matching, baseline characteristics of the two groups were imbalanced, with significant differences in age and body mass index ($p < 0.05$). However, after propensity score matching, no significant differences were found across all baseline characteristics between the two groups ($p > 0.05$, Fig. 1, Tables 1,2).

Treatment Protocol

The control group received routine gastrointestinal management and parenteral nutrition support. After admission, nutritional status was evaluated, and the patients were provided with targeted nutritional support and preoperative health education. The patient underwent bowel cleaning and conventional fasting one day before surgery. Following surgery, parenteral nutrition support was provided, supplying energy at 100 kJ/(kg·day) and amino acids at 0.945 g/(kg·day), with a total nutrient solution volume of 50 mL/(kg·day). The nutrient solution was administered through the central vein over 18–24 hours daily and continued for 7 days after surgery. Upon the first gas passage after surgery, the patient was given a small amount of water and liquid food. The patients were encouraged to consume a quality diet alongside early mobilization and engage in gentle activities, as tolerated by the patient, to promote gastrointestinal recovery.

The observation group received early enteral nutrition support under the ERAS model. Following admission, the nutritional status of each patient was evaluated, and the patient and their family were briefed on the ERAS concepts, surgical procedure, and early enteral nutrition to ensure their cooperation. During the preoperative fasting, patients were restricted from solid and semi-liquid foods

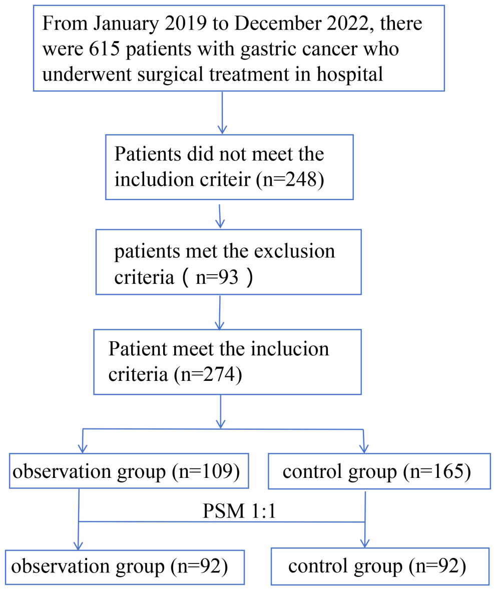

Fig. 1. A flow chart of patients' recruitment and categorization. PSM, Propensity Score Matching.

Table 1. A comparison of baseline characteristics between the two groups before propensity score matching.

Baseline characteristics	Observation group (n = 109)	Control group (n = 165)	χ^2/t	*p*-value
Gender (male/female)	58/51	90/75	0.047	0.828
Age (year)	63.08 ± 7.95	60.43 ± 8.04	2.682	0.008
Body mass index (kg/m^2)	23.22 ± 2.50	24.07 ± 2.41	2.815	0.005
TNM staging (I/II/III)	22/50/37	29/78/58	0.295	0.863
Surgical type (laparoscopic surgery/open abdominal surgery)	95/14	146/19	0.109	0.741

TNM, Tumor Node Metastasis.

for 6 hours and complete fasting for 2 hours. They orally consumed 400 mL of carbohydrate-rich drinks (such as maltodextrin-fructose) before the fasting period to supplement energy levels and enhance surgical endurance. A nasogastric tube was inserted, and 250 mL of 5% glucose was injected at a constant rate of 20 mL/h using a nutrition pump. For well-tolerated patients, 500 mL of enteral nutrition suspension (H20010285, Baptioli, Nutricia Pharmaceutical (Wuxi) Co., Ltd., Wuxi, China) was administered at a rate of 30–40 mL/h after 24 hours, gradually increasing to achieve standard nutritional needs. Enteral nutrients provided the patient with 100 kJ/(kg·d) of energy and 0.945 g/(kg·d) of amino acids. Moreover, this infusion was continued for days 7 post-surgery. After that, the nutrient solution and a small amount of liquid diet was orally administered. Patients were encouraged for early mobilization as tolerated to enhance gastrointestinal function recovery.

Observation Indicators

Patients were monitored by assessing the following observation indicators.

(1) Gastrointestinal recovery indicators: These indicators were assessed by the time of first postoperative gas passage, first oral consumption, and first defecation.

(2) Nutritional indicators: This included evaluating serum nutritional markers, including albumin (Alb), prealbumin (PA), and hemoglobin (Hb), before surgery and on postoperative days 3 and 7 in both groups.

(3) Immunological indicators: Immunoglobulin levels, including immunoglobulin G (IgG), immunoglobulin M (IgM), and immunoglobulin A (IgA) were determined before surgery and on days 3 and 7after the procedure.

(4) Inflammatory markers: White blood cell (WBC) count, hypersensitive C-reactive protein (hs-CRP), and interleukin-6 (IL-6) levels were assessed before the surgery, as well as on days 3 and 7 post-surgery. Leukocyte count was detected using a hemocyte analyzer, while hs-CRP and IL-6 levels were determined using enzyme-linked immunosorbent assays.

(5) Complications and postoperative hospital stay: Postoperative complications, such as abdominal distension, diarrhea, infection, and vomiting, were monitored in both patient groups, along with their postoperative hospitalization length.

Statistical Analysis

Statistical analysis was conducted using SPSS 26.0. (IBM SPSS Statistics 26, International Business Machines Cor-

Table 2. A comparison of baseline characteristics between the two groups after propensity score matching.

Baseline characteristics	Observation group (n = 92)	Control group (n = 92)	χ^2/t	p-value
Gender (male/female)	49/43	51/41	0.088	0.767
Age (year)	62.53 ± 8.24	61.25 ± 7.82	1.081	0.281
Body mass index (kg/m^2)	23.07 ± 2.41	23.14 ± 2.36	0.199	0.842
TNM staging (I/II/III)	18/44/30	15/45/32	0.349	0.840
Surgical type (laparoscopic surgery/open abdominal surgery)	84/8	82/10	0.246	0.620

Table 3. Comparative analysis of gastrointestinal recovery between the two groups ($\bar{x} \pm$ s).

Gastrointestinal function recovery	Observation group (n = 92)	Control group (n = 92)	t	p-value
Postoperative first exhaust time (d)	2.03 ± 0.58	2.41 ± 0.66	4.148	<0.001
Postoperative first mealtime (d)	2.61 ± 0.69	3.04 ± 0.74	4.076	<0.001
Postoperative first bowel movement time (d)	3.32 ± 0.64	3.76 ± 0.80	4.119	<0.001

poration, Armonk, NY, USA) Postoperative complications and other count data were expressed as percentages (%), with inter-group comparisons conducted using the χ^2 test. The Shapiro-Wilk and Levene's tests were employed to determine normal distribution and homogeneity of variance for measurement data. If measurement data, like gastrointestinal recovery indicators, serum nutrition markers, and immune markers, conformed the criteria for the normal distribution and homogeneity of variance, they were expressed as mean ± standard deviation ($\bar{x} \pm$ s). Paired sample -tests and independent sample t-tests were used for intra-group and inter-group comparisons, respectively. Data with non-normal distribution or unequal variances were expressed as median (P_{25}, P_{75}) and compared using the Mann Whitney U test. Parameters across different time points were assessed using repeated measures Analysis of Variance (ANOVA), and the Bonferroni's test was employed for pairwise comparisons. A p-value of <0.05 indicated a statistically significant difference.

Results

Comparative Analysis of Gastrointestinal Function Recovery between the Two Groups

The observation group exhibited a shorter duration to first postoperative flatus, meal initiation, and bowel movement than the control group ($p < 0.05$, Table 3).

Comparison of Serum Nutritional Index Levels between Two Groups

The comparison of Alb, PA, and Hb levels at different time points between the two groups indicated significant time effects (F = 18.293, F = 11.256, F = 13.064), group effects (F = 62.411, F = 40.152, F = 48.639), and interaction effect (F = 10.657, F = 7.692, F = 8.543) (all $p < 0.05$). Before surgery, there was no significant difference in serum Alb, PA, and Hb levels between the two groups ($p > 0.05$). By 3rd day after the operation, serum Alb, PA and and Hb levels decreased in both groups ($p < 0.05$). However, by 7th day post-surgery, serum levels of Alb, PA, and Hb in both groups had elevated compared to the 3rd day ($p < 0.05$) but remained lower than preoperative levels ($p < 0.05$). Additionally, the serum Alb, PA, and Hb levels were significantly higher in the observation group than in the control group on the 3rd and 7th postoperative days ($p < 0.05$, Table 4).

Comparison of Immune Index Levels between Two Groups

The comparison of IgG, IgM, and IgA levels at different time points between the two groups demonstrated significant time effects (F = 12.187, F = 14.963, F = 10.856), group effects (F = 47.639, F = 50.122, F = 42.084), and interaction effects (F = 9.274, F = 9.036, F = 7.128) (all $p < 0.05$). Before surgery, there was no significant difference in the IgG, IgM, and IgA levels between the two groups ($p > 0.05$). Moreover, by the third day post-surgery, a significant reduction was observed in the concentrations of IgG, IgM, and IgA within both groups ($p < 0.05$). However, by the seventh day post-surgery, these immunoglobulin levels—IgG, IgM, and IgA—increased in both groups when compared to their levels on the 3rd day post-surgery ($p < 0.05$) but remained lower than preoperative levels ($p < 0.05$). Additionally, the IgG, IgM, and IgA levels were significantly higher in the observation group than in the control group on the 3rd and 7th postoperative days ($p < 0.05$, Table 5).

Comparison of Inflammatory Markers between Two Groups

The comparison of WBC, hs-CRP, and IL-6 levels at different time points between the two groups revealed substantial time effects (F = 15.126, F = 17.045, F = 19.363), group effects (F = 56.832, F = 60.258, F = 67.142), and interaction effects (F = 10.122, F = 11.904, F = 13.518) (all $p < 0.05$). Before surgery, there was no significant difference in WBC, hs-CRP, and IL-6 levels between the two groups ($p > 0.05$). On the third day after surgery, the WBC, hs-CRP, and IL-6 levels increased in both groups ($p < 0.05$). However, on the 7th day after surgery, WBC, hs-CRP, and IL-6 levels decreased in both groups compared to the 3rd day ($p < 0.05$), but remained higher than preoperative levels ($p < 0.05$). Furthermore, the WBC, hs-CRP, and IL-6

Table 4. A comparative analysis of serum nutritional index levels between the two groups ($\bar{x} \pm s$).

Serum nutritional index levels	Time	Observation group (n = 92)	Control group (n = 92)	t	p-value
Alb (g/L)	Preoperative	39.32 ± 3.45	40.21 ± 3.77	1.670	0.096
	Postoperative 3 d	31.91 ± 3.17*	28.57 ± 3.03*	7.306	<0.001
	Postoperative 7 d	35.74 ± 3.36*#	33.16 ± 3.19*#	5.341	<0.001
PA (mg/L)	Preoperative	134.72 ± 12.58	136.37 ± 11.58	0.926	0.356
	Postoperative 3 d	119.46 ± 10.76*	114.50 ± 10.97*	3.096	0.002
	Postoperative 7 d	127.15 ± 11.30*#	122.34 ± 11.14*#	2.907	0.004
Hb (g/L)	Preoperative	133.67 ± 10.64	131.96 ± 10.15	1.115	0.266
	Postoperative 3 d	122.58 ± 8.92*	117.48 ± 8.60*	3.948	<0.001
	Postoperative 7 d	128.41 ± 8.77*#	124.33 ± 9.18*#	3.082	0.002

When compared to the preoperative levels, $^{*}p < 0.05$ indicates a significant difference. Compared to the 3rd day after surgery, $^{\#}p < 0.05$ signifies a significant difference. Alb, albumin; PA, prealbumin; Hb, hemoglobin.

Table 5. A comparison of the immune index levels across two groups ($\bar{x} \pm s$).

Immune index levels	Time	Observation group (n = 92)	Control group (n = 92)	U	p-value
IgG (g/L)	Preoperative	7.65 (4.13, 9.28)	7.51 (4.05, 9.10)	0.501	0.618
	Postoperative 3 d	5.19 (3.20, 6.86)*	4.24 (2.89, 6.10)*	3.549	<0.001
	Postoperative 7 d	6.51 (4.03, 7.11)*#	5.32 (3.50, 6.71)*#	3.998	<0.001
IgM (g/L)	Preoperative	1.39 (0.96, 1.82)	1.35 (0.90, 1.76)	0.736	0.470
	Postoperative 3 d	0.85 (0.60, 1.04)*	0.69 (0.32, 0.82)*	4.002	<0.001
	Postoperative 7 d	1.09 (0.77, 1.43)*#	0.90 (0.58, 1.24)*#	3.314	<0.001
IgA (g/L)	Preoperative	1.78 (1.24, 2.36)	1.80 (1.19, 2.39)	0.270	0.785
	Postoperative 3 d	1.06 (0.63, 1.45)*	0.87 (0.50, 1.25)*	3.091	0.002
	Postoperative 7 d	1.40 (0.93, 1.89)*#	1.21 (0.70, 1.70)*#	2.887	0.005

When compared to the preoperative levels, $^{*}p < 0.05$ indicates a significant difference. Compared to the 3rd day after surgery, $^{\#}p < 0.05$ signifies a significant difference. IgG, immunoglobulin G; IgM, immunoglobulin M; IgA, immunoglobulin A.

levels were lower in the observation group than in the control group on the 3rd and 7th postoperative days ($p < 0.05$, Table 6).

Comparison of Postoperative Complications and the Duration of Hospital Stay across the Two Groups

The observation group exhibited a reduced overall occurrence of postoperative complications compared to the control group ($p < 0.05$), along with a shorter duration of the postoperative hospital stay ($p < 0.05$, Table 7).

Discussion

Surgical treatment is the primary method to manage gastric tumors. However, this surgical intervention is a complex and invasive procedure that causes significant trauma and can lead to considerable stress responses in patients. These responses include increased inflammatory markers and gastrointestinal dysfunction after surgery, temporarily alleviating the quality of life [11]. After surgery, gastric tumor patients experience increased catabolism due to postoperative stress damage and an imbalanced internal environment. This condition increases nutrient consumption, nitrogen loss, and the risk of malnutrition, affecting the function of tissues and organs [12, 13]. Effective nutritional support is needed to meet elevated metabolic demands and promote postoperative recovery. Currently, the postoperative nutritional support methods used in clinical practice include enteral and parenteral nutrition. The former method aligns with the normal physiological structure and function of the body, helping to resume gastrointestinal peristalsis after surgery. However, the parenteral nutrition method, which does not require the placement of a nasogastric tube, makes it a relatively more convenient option. However, lacking gastrointestinal tract stimulation may result in intestinal mucosal atrophy and reduced intestinal peristalsis [14, 15]. Therefore, to support early recovery of gastrointestinal function after surgery, enteral nutrition support is usually preferred.

The aim of the ERAS pathway is to reduce the stress-induced damage from surgical trauma by optimizing perioperative measures and promoting early postoperative recovery [16, 17]. Essential ERAS practices include removing non-essential or unnecessary treatments and nursing measures to aid postoperative gastrointestinal recovery. Restoring normal peristalsis and enabling oral consumption to obtain sufficient energy and metabolic substrates are crucial in evaluating the postoperative recovery.

This study investigated the effects of early enteral nutrition within the ERAS model on postoperative gastrointestinal and immune function in patients undergoing gastric tumor

Table 6. A comparison of the inflammatory marker levels between the two groups ($\bar{x} \pm$ s).

Inflammatory marker levels	Time	Observation group (n = 92)	Control group (n = 92)	t	p-value
WBC ($\times 10^9$/L)	Preoperative	9.11 ± 1.25	8.79 ± 1.15	1.807	0.072
	Postoperative 3 d	12.34 ± 1.63*	13.47 ± 1.56*	4.804	<0.001
	Postoperative 7 d	10.26 ± 1.41*#	11.09 ± 1.50*#	3.867	<0.001
hs-CRP (mg/L)	Preoperative	5.96 ± 1.65	6.38 ± 1.77	1.665	0.098
	Postoperative 3 d	51.41 ± 9.39*	57.76 ± 10.18*	4.398	<0.001
	Postoperative 7 d	23.38 ± 5.27*#	29.04 ± 7.26*#	6.052	<0.001
IL-6 (pg/mL)	Preoperative	9.72 ± 2.85	10.15 ± 2.90	1.014	0.312
	Postoperative 3 d	16.55 ± 3.79*	20.23 ± 4.04*	6.372	<0.001
	Postoperative 7 d	11.93 ± 2.64*#	14.12 ± 3.09*#	5.168	<0.001

When compared to the preoperative levels, $^*p < 0.05$ indicates a significant difference. Compared to the 3rd day after surgery, $^\#p < 0.05$ signifies a significant difference. WBC, white blood cell; hs-CRP, hypersensitive C-reactive protein; IL-6, interleukin-6.

Table 7. Comparing the incidence of postoperative complications and the postoperative hospital stay across two groups.

Postoperative complications and the postoperative hospital stay		Observation group (n = 92)	Control group (n = 92)	χ^2/t	p-value
Postoperative complications	Abdominal distension	2 (2.17)	5 (5.43)		
	Diarrhea	2 (2.17)	5 (5.43)		
	Infection	4 (4.35)	7 (7.61)		
	Vomiting	4 (4.35)	6 (6.52)		
	Total occurrence	12 (13.04)	23 (25.00)	4.269	0.039
Postoperative hospital stay (d)		13.96 ± 2.03	15.55 ± 2.17	5.132	<0.001

surgery. Our findings indicated that the observation group experienced a shorter duration to first postoperative flatulence, meal consumption, and bowel movement than the control group ($p < 0.05$). Serum nutritional indicators (Alb, PA, Hb), immune markers (IgG, IgM, IgA), and inflammatory markers (WBC, hs-CRP, IL-6) were evaluated at different time points before and after surgery. We observed that compared to preoperative levels, both groups had decreased nutritional levels and immune function in the early postoperative phase, along with worsened inflammatory responses, mainly due to damage caused by surgical trauma.

However, with postoperative nutritional support, the nutritional levels and immune function of both groups increased, along with a decrease in inflammatory response. Moreover, compared to the control group, the observation group exhibited better recovery in nutritional and immune function and demonstrated a milder inflammatory response. This observation indicates that early enteral nutrition within the ERAS model significantly promotes gastrointestinal function recovery, reduces the inflammatory response, and improves nutritional and immune function in patients undergoing gastric tumor surgery. Introducing the ERAS model, surgical procedures, the concept of ERAS, and early enteral nutrition to patients and their families can enhance their understanding and compliance. This promotion of awareness plays a significant role in increasing the enthusiasm of patients and their families for compliance with gastrointestinal management. Additionally, reducing postoperative fasting and fluid intake times before surgery, along with taking oral carbohydrates (such as maltodextrin fructose drinks) before fasting, helps provide essential nutrients to meet high metabolic demands, increase energy levels, and enhance surgical endurance. Early postoperative infusion of 5% glucose through a nutrient pump at a constant speed and temperature, with a gradual increase in nutrient solution until it reaches the normal required level, supports progressive improvement in peristalsis, promotes postoperative recovery of gastrointestinal function, prevents ectopic gut microbiota, inhibits the entry of intestinal toxins into the bloodstream, and reduces the level of inflammatory markers [18, 19]. Encouraging patients to mobilize as early as tolerable further promotes gastrointestinal clearance and intestinal peristalsis, allowing them to early return to normal eating, which improves their nutritional status and supports immune function recovery. This process helps lower the cost of treating complications and reduces hospitalization expenses, resulting in more efficient use of medical resources and economic benefits. These advantages may extend to other digestive disease surgeries.

Patients undergoing gastric surgery experience impaired digestive system function and are prone to related complications, such as diarrhea and vomiting, after surgery. Enteral nutrition support mainly targets the digestive system, making digestive-related complications crucial to be observed. Research indicated that enteral nutrition support is associated with different issues, such as detachment, blockage, and displacement of the nasogastric tube, with long-term tube retention increasing the risk of infection [20]. Thus, we also compared postoperative complications and hospitalization duration between the two patient cohorts. The data revealed that the observation group had a reduced overall rate of postoperative complications, and a shorter hospital stay than the control group ($p < 0.05$).

These findings imply that employing early enteral nutrition within the Enhanced Recovery After Surgery (ERAS) framework can effectively diminish the postoperative complications in patients undergoing gastric tumor surgery, fostering their well-being and faster rehabilitation. Early enteral nutrition in the ERAS model promotes gastrointestinal peristalsis, which is beneficial in regulating gut microbiota, restoring normal gut microbiota and expelling intestinal gas, stabilizing the gut environment, ultimately reducing complications such as diarrhea, bloating, and infections. Moreover, better nutritional and immune function recovery can further reduce the risk of postoperative infection, supporting early recovery and earlier discharge from the hospital. This study has its limitations. It is a retrospective, single-center study with a small sample size, and the subjects are limited to patients with gastric tumors, which restricts the generalizability of the results. Future research could expand the sample size and conduct multicenter prospective analyses to enhance the applicability and value of the study.

Conclusions

In summary, applying early enteral nutrition within the ERAS model to patients undergoing gastric tumor surgery effectively improves their nutritional status, promotes recovery of gastrointestinal and immune functions, reduces postoperative complications, and facilitates early discharge. However, despite a number of promising findings, this study has some limitations. It is a single-center, retrospective analysis with a small sample size, which may have affected the accuracy of the results. Additionally, as the study focused on patients with gastric tumors, the application of early enteral nutrition under the ERAS model for intestinal tumor surgery remains unknown. Future studies should include a larger sample, multi-center prospective controlled studies to improve the accuracy and representativeness of the results, with extended follow-up time to understand long-term gastrointestinal function.

Availability of Data and Materials

The data analyzed was available on the request for the corresponding author.

Author Contributions

ZKW designed the research study. WRP and ZKW performed the research. JZ collected the data and provided help on the study. ZKW analyzed the data and drafted the manuscript. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Affiliated Hospital of Jiangsu University (KY2024K0601) and study design adhered to the Declaration of Helsinki. Additionally, informed consent was obtained from each patient.

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Conflict of Interest

The authors declare no conflict of interest.

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