Original Article
The predictive value of the prognostic nutritional index to postoperative prognosis and nursing intervention measures for colorectal cancer

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Abstract: Objectives: This study discussed and analyzed the predictive value of the prognostic nutritional index (PNI) to postoperative prognosis and nursing intervention measures for colorectal cancer. Methods: 196 patients with colorectal cancer who underwent radical resection in gastrointestinal surgery were retrospectively analyzed. The patients' data and follow-up results were collected and classified into two groups based on the PNI, i.e., the high PNI group (≥45.61, 107 cases) and the low PNI group (<45.61, 89 cases) by reregarding PNI 45.61 as the threshold value. The differences in clinical materials and prognosis between the two groups were compared, and the multivariate analysis of 5-year survival after radical resection of colorectal cancer was conducted by Cox proportional hazard model. Results: The incidence of postoperative complications and severe complications in low PNI group was critically higher than those in high PNI group (*P<0.05*). Besides, the postoperative disease-free survival and overall survival of the high PNI patients were obviously superior to those of the counterpart (*P<0.05*). In addition, the results of univariate and multivariate analysis showed that age, TNM staging and PNI were independent risk factors that affected the postoperative survival of patients with colorectal cancer (*P<0.05*). Conclusion: The preoperative PNI is an independent risk factor that affects the survival of colorectal cancer patients after radical resection. PNI assessment of patients with colorectal cancer helps predict the clinical prognosis of patients. At the same time, the corresponding nursing countermeasures were provided according to the PNI score to improve patients' nutritional status and immune function, which may eventually improve the clinical prognosis.

Keywords: Prognostic nutritional index, colorectal cancer, postoperative prognosis, predictive value, nursing strategy

Introduction

Colorectal cancer (CRC) is a common malignant tumor of the digestive tract. If it is not effectively treated and controlled, as the patient's condition further develops, it will become colorectal cancer with liver or other organs metastasis, which will seriously threaten the life of the patient [1, 2]. The key to clinical treatment is to clarify the patient's disease progression in time and give targeted therapeutic and nursing schedules [3]. Therefore, the accurate postoperative prognosis for colorectal cancer patients before surgery is of great significance for guiding the clinical treatment and nursing work [4]. Studies have shown [5] that patients' preoperative nutrition, immune and inflammatory status are related to the surgical risk and the progression of malignant tumors. The prognostic nutritional index (PNI), in particular, is a simple but effective index that reflects the preoperative nutritional status and immune function of patients [5, 6]. In order to further improve the postoperative prognosis of patients with colorectal cancer, this study explored and analyzed the predictive value of PNI to postoperative prognosis and nursing intervention strategies for colorectal cancer.

Materials and methods

Research subjects

196 patients with colorectal cancer who underwent radical resection in gastrointestinal surgery from March 2013 to May 2015 were

enrolled as subjects for retrospectively analysis. This study was approved by the ethics committee of our hospital.

Inclusion and exclusion criteria

Inclusion criteria: (1) Patients underwent radical resection of colorectal cancer; (2) The patients were diagnosed as colorectal tumor by histopathology; (3) No radiotherapy or chemotherapy was performed before operation; (4) No distant metastasis; (5) No other infectious diseases; (6) Patients had complete blood test result for the first admission; (7) Patients received at least 2 rounds of chemotherapy after surgery; and (8) The patients and their family member were informed and consented.

Exclusion criteria: (1) The tumor cannot be resected or had distant metastasis; (2) Patients with diseases of blood or immune system; (3) Preoperative radiotherapy and chemotherapy were performed; (4) Patients with intestinal obstruction, perforation, bleeding or other emergency operations; (5) Patients with incomplete clinical data; or (6) Patients who did not receive chemotherapy or radiotherapy after surgery or the treatment duration was less than 2 rounds.

Data collection

Clinicopathological data such as gender, age, body mass, size of tumor, TNM staging, histological typing, and embryonic antigen (CEA)/CA19-9 were collected and recorded.

Postoperative complications

The postoperative complications involved in this study referred to various complications related to surgery or treatment that occurred within 30 days after surgery. The complications were classified by using Clavien-Dindo classification method [7]: Grade I: Slightly deviated from the normal postoperative rehabilitation process, but no treatment is required; Grade II: Complications that require drug intervention; Grade III: Complications that require surgical, endoscopic, or radiotherapy intervention; Grade IV: Complications that require intensive care and the complications threaten the lives of patients; Grade V: Death. Grade II indicates complications and Grade III or above indicates severe complications.

Calculation of PNI

The neutrophil count, lymphocyte count, monocyte count and serum albumin concentration obtained from the first blood sampling before admission were taken as the criterion. NLR = neutrophil count ÷ lymphocyte count; LMR = lymphocyte count ÷ mononuclear cell count; and PNI = serum albumin concentration (g/L) + 5 × lymphocyte count (×10^9/L).

Subjects grouping

According to previous research results [8], patients were classified into high PNI group (≥45.61, 107 cases) and low PNI group (<45.61, 89 cases) by regarding PNI 45.61 as the threshold value.

Postoperative follow-up

Patients were followed up after surgery, and the follow-up deadline was October 1, 2020. The Overall survival (OS) and disease-free survival (DFS) of the subjects were recorded. OS is defined as: the time from the postoperative day to the death of the patient (for any reason); DFS is defined as the time between the beginning of the patient's postoperative day and the recurrence of the disease or (for any reason) death.

Nursing countermeasures plan

In order to further improve the clinical prognosis of colorectal cancer patients after surgery, our hospital summarized and analyzed the previous nursing experience, and put forward targeted nursing countermeasures as follows: (1) A nutrition intervention team was established, which was composed of clinicians with the title of attending or above, specialist nurse with over 5 years' working experience, and nutritionist who had acquired the qualification and worked in the field over 5 years. Guided by nutritionist, the study of PNI concept, the assessment of patients' nutritional status and the corresponding nutritional intervention methods were carried out by the team. The training was conducted twice a week for two consecutive weeks, and a unified assessment after the training wascarried out. (2) A nutritional intervention plan was constructed. When PNI≥50, patient needed to be instructed to consume foods with high protein and vitamins, and to avoid cold, spicy or pungent foods. When

Table 1. Comparison of clinical data between two groups of subjects

Clinical materials	High PNI group (n = 107)	Low PNI group (n = 89)	t/X^2	P
Gender				
Male	66	52	0.215	0.643
Female	41	37		
Age (years old, $\overline{x}$ ±s)	62.64±7.33	65.38±9.27	2.310	0.022
BMI (kg/m^2)				
<18.5	19	18	0.193	0.660
≥18.5	88	71		
Histological classification				
Adenocarcinoma	85	70	0.018	0.893
Others	22	19		
Site of tumor				
Colon	61	50	0.014	0.907
Rectum	46	39		
Size of tumor (cm)				
<5	67	48	1.511	0.219
≥5	40	41		
TNM staging				
I~II	86	57	6.567	0.010
II	21	32		
CEA (μg/ml)				
≥5	35	42	4.271	0.039
<5	72	47		
CA-199 (U/ml)				
≥37	26	35	5.118	0.024
<37	81	54		
Operation time (h)				
≤4	56	47	0.004	0.947
>4	51	42		
Intraoperative blood loss (ml)				
≤400	54	49	0.410	0.522
>400	53	40		

amino acid injection and fat milk injection would be injected intravenously. When necessary, enteral nutrition catheter shall be inserted through the nasal cavity for enteral nutrition. (3) The nutrition intervention program was implemented. The nutritional status of patient was evaluated by PNI on the first day after admission, and the nutritional intervention program was established based on the evaluation results. The evaluation was performed every 3 days postoperatively, and the program shall be adjusted promptly according to the evaluation results until the patient is discharged. After discharge, patients would be followed up by WeChat or telephone for diet guidance. Thereafter, a PNI evaluation would be conducted 1 day before each chemotherapy, and an individualized nutritional intervention program would be developed.

Statistical analysis

Data was settled and analyzed via statistical software SPSS 22.0. Measurement data were compared by *t* test, enumeration data were compared by X^2 test, Kaplan-Meier survival curve was drawn for survival analysis, and group comparison was by Log-rank test. Multivariate analysis of survival at 5 years after radical resection of colorectal cancer was performed by Cox proportional hazards model, and the test level was = 0.05. The figures were plotted by Graphpad Prism 8.0.

Results

Clinical materials

The differences in gender, BMI, histological typing, tumor site, operation time and intraoperative blood loss in two sets of subjects were statistically insignificant (*P>0.05*). The age of sub-

45≤PNI<50, personalized recipes were customized according to patient's dietary habits and nutritional needs. Patients should take strictly according to the recipes with clear type and quantity of diets consumed. When 40≤PNI<45, professional on-site nutritional preparations for cancer patients will be added on the basis of the above-mentioned personalized diet plan. The preparation was taken orally 500 ml per day, 200-250 ml each time. When PNI<40, the patient would be given a personalized diet plan, oral enteral nutrition preparations and combined intervention of parenteral nutrition support. At the same time, nutrients such as water-soluble vitamins, compound

Table 2. Comparison of postoperative complications incidence between the two groups [n (%)]

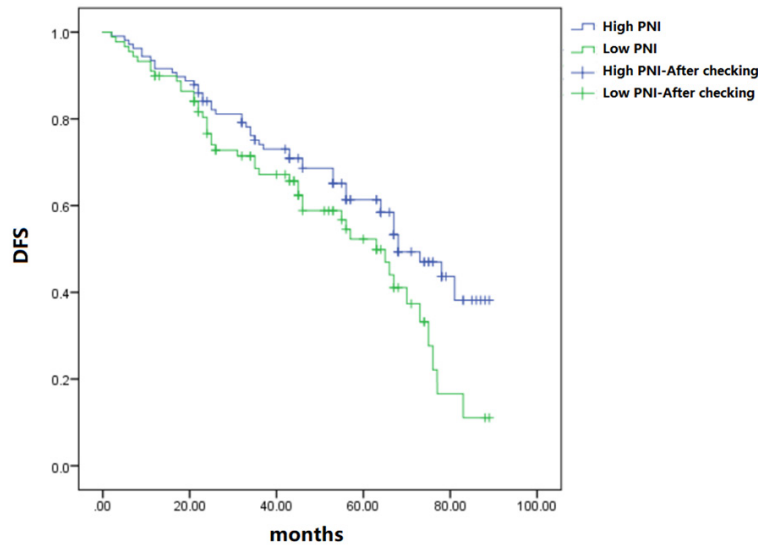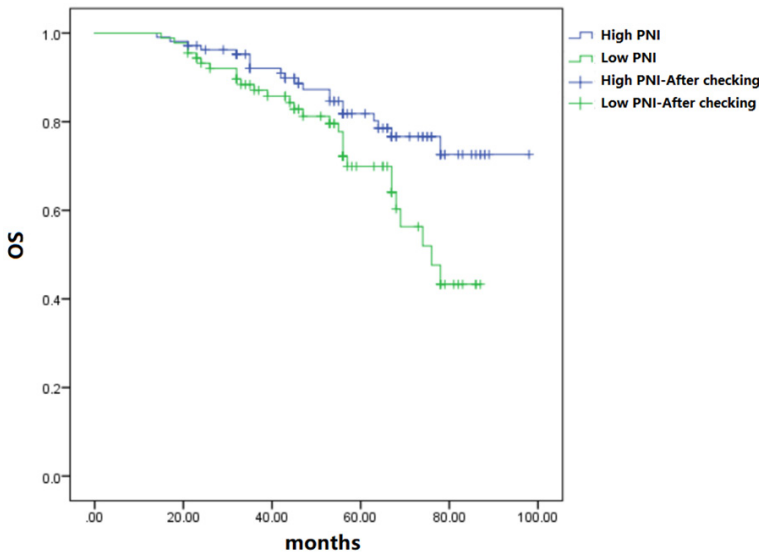| Group	Number of cases	Complications	Severe complications
High PNI group	107	26 (24.30)	5 (4.67)
Low PNI group	89	37 (41.57)	18 (20.22)
X^2	-	6.647	11.345
P	-	0.010	0.001

Figure 1. Comparison of postoperative DFS.

Figure 2. Comparison of postoperative OS.

jects in low PNI group was critically higher than that of the high PNI group (*P<0.05*), and the proportion of patients with TNM stage III, CEA≥5 µg/ml, CA-199≥37 U/ml in low PNI group was obviously higher than those of high PNI counterpart (*P<0.05*) (**Table 1**).

Comparison of postoperative complications

In the high PNI group, the incidence of postoperative complications was 24.30%, and the incidence of severe complications was 4.67%, while those in the low PNI group were 41.57%, and 20.22%, respectively. The incidence of postoperative complications and severe complications in low PNI group was critically higher than those in high PNI group (*P<0.05*) (**Table 2**).

Comparison of postoperative DFS

The median disease-free survival time of high PNI group and low PNI group was 62 months and 58 months, respectively. The postoperative disease-free survival of patients with high PNI was obviously superior to that of the low group (*P<0.05*) (**Figure 1**).

Comparison of postoperative OS

The postoperative overall survival of patients with high PNI was obviously superior to that of the low PNI group (*P<0.05*) (**Figure 2**).

Analysis of risk factors that affected survival and prognosis of patients

The factors that had an impact on the prognosis of patients were included in Cox proportional hazard model for univariate and multivariate analysis. The results of univariate and multivariate analysis showed that age, TNM staging and PNI were independent risk factors that affected postoperative

Table 3. Analysis of univariate and multivariate factors that affected the survival and prognosis of patients

Factor	Single factor analysis			Multivariate analysis		
	HR	95% CI	P	HR	95% CI	P
Gender (female)	1.089	0.527~1.983	0.738	-	-	-
Age (≥60 years old)	2.173	1.462~3.876	0.001	1.897	1.287~3.426	0.010
BMI (≥18.5 kg/m^2)	0.722	0.334~1.273	0.364	-	-	-
Histological type (adenocarcinoma)	1.082	0.573~1.462	0.783	-	-	-
Tumor site (colon)	1.673	0.978~2.374	0.088	-	-	-
Tumor size (≥5 cm)	1.583	0.734~1.658	0.102	-	-	-
TNM staging (III)	1.895	0.762~1.732	0.032	1.705	1.387~4.207	0.039
CEA (≥5 μg/ml)	1.574	0.755~1.827	0.073	-	-	-
CA-199 (≥37 U/ml)	1.337	0.812~1.695	0.082	-	-	-
Operation time (>4 h)	1.042	0.663~2.174	0.092	-	-	-
Intraoperative blood loss (>400 ml)	1.306	0.387~1.930	0.117	-	-	-
PNI (<45.61)	3.074	1.937~5.672	0.000	1.937	1.271~4.263	0.019

survival of patients with colorectal cancer (*P<0.05*) (**Table 3**).

Discussion

Colorectal cancer is one of the most common gastrointestinal malignancies clinically. Colorectal cancer morbidity has been increasing year by year in recent years, and becomes the third cause of tumor-related death [9, 10]. Due to the gastrointestinal symptoms, which affect the appetite and eating, most of the CRC patients have varying degrees of malnutrition risk [11, 12]. Studies have revealed that immune function and nutritional status of human body are crucial indicators for evaluating the patients' prognosis after surgery [13, 14]. Preoperative PNI, which is related to the serum albumin level and peripheral blood lymphocyte count, can reflect the preoperative nutritional status and immune status of patients [15, 16]. Literature reports demonstrated that patients with high lymphocyte counts had a higher 5-year survival rate than those with low lymphocyte counts; and the low serum albumin levels partially reflect the poor nutritional status of the host and insufficient defense system capabilities, which may be related to the poor prognosis of patients [17, 18].

We have shown that the incidence of postoperative complications and severe complications in low PNI group was critically higher than those in high PNI group; and the postoperative disease-free survival and overall survival of the high PNI patients were obviously superior to those of the control group. The results, which were similar to the relevant studies by other reserachers [19, 20], indicate that PNI is tightly correlated with the early postoperative complications and long-term prognosis of colorectal cancer patients. The overall survival and disease-free survival of patients with low PNI decreased remarkably, possibly due to the poor nutritional status and immune function of patients. Moreover, several studies have shown [21, 22] that PNI is an independent predictor of postoperative prognosis in colorectal cancer patients, which is consistent with the results of this study. The state of low PNI is related to the degree of tumor invasion, lymph node metastasis and other invasive clinicopathological features in colorectal cancer patients, which may be an important cause of the poor prognosis.

However, due to the limited quantity of objects included, deviation may exist in the results of the study. At the same time, we did not conduct a prospective study on the countermeasures of nursing intervention in this study, suggesting that further expansion of the sample size is needed in subsequent studies to acquire more reliable research data.

In summary, the preoperative PNI is an independent risk factor that affects the survival of colorectal cancer sufferers after radical resection. The conduction of PNI assessment in colorectal cancer patients is beneficial to predict their clinical prognosis. At the same time,

the corresponding nursing countermeasures were provided according to the PNI score, and the improvement of nutritional status and immune function of patients may be crucial measures that promoting the clinical prognosis of patients.

Disclosure of conflict of interest

None.

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