ORIGINAL

Significance of the geriatric nutrition risk index (GNRI) in colorectal cancer surgery patients

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Abstract : Background : Japan's aging population presents significant healthcare challenges, particularly in colorectal cancer care, where nutritional assessment is vital for improving outcomes. This study evaluated the prognostic value of the geriatric nutritional risk index (GNRI) in patients undergoing curative colorectal cancer surgery. Methods : We retrospectively analyzed 113 patients with stage II/III colorectal cancer who underwent curative surgery. Patients were categorized into GNRI Low (≤92) and High (>92) groups. Clinicopathological characteristics, immunonutritional indicators, postoperative complications, and survival outcomes were compared. Results : The GNRI Low group (24.8%) had significantly older age, lower BMI, poorer ASA classification, frailty, and larger tumor size compared with the GNRI High group. Immunonutritional indicators, including albumin, CRP, NLR, and PNI, were also worse in the GNRI Low group. However, no significant difference in perioperative complications was observed between the groups. Five-year OS was 76.0% in GNRI Low versus 89.2% in GNRI High (p=0.05), and 5-year DFS was 53.8% versus 74.2% (p=0.04). Conclusion : Low GNRI was associated with poor prognosis in colorectal cancer patients, despite no increase in surgical complications. Preoperative nutritional assessment using GNRI may help identify high-risk patients and support targeted interventions.
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Keywords **:** *colorectal cancer, GNRI, prognosis*

INTRODUCTION

Japan has an advanced aging society, with malignancies as the leading cause of death among the elderly, a trend that is expected to continue (1). Elderly individuals frequently experience protein energy malnutrition (PEM) (2, 3), which may affect cancer-related deaths : it is widely acknowledged that host factors, in addition to tumor-related and treatment-related factors, hold significant importance in cancer prognosis (4, 5). In this context, nutritional assessment of patients becomes crucial ; evidence from numerous studies indicates that nutritional status before cancer treatment and during therapy is associated with resistance to comprehensive treatment, the incidence of complications, and, notably, oncological prognosis (6-10).

To establish nutritional therapy for cancer patients, it is imperative to promptly develop prognostic predictions and related nutritional assessment methods, along with nutrition therapy based on these assessments. While various assessment methods for PEM have been devised in the past, diagnosing PEM using a single indicator remains challenging, and standardized assessment methods have not yet been established.

Traditionally, indexes used to predict the risk of postoperative complications have included parameters such as the PNI (11-13). However, recently, the geriatric nutrition risk index (GNRI) has been proposed as an indicator for estimating the prognosis of elderly individuals with nutritional disorders during hospitalization. GNRI is a simple nutritional assessment method using the ratio of ideal body weight to serum albumin levels (14-16). Although its significance as a risk factor for cancer patients is not well known, there have been reports that the GNRI is a complication and prognostic indicator for patients with colorectal cancer (11, 17, 18). Colorectal cancer was chosen as the focus of this study because it is one of the most prevalent cancers in Japan and frequently affects elderly patients who undergo surgery. Preoperative nutritional assessment is particularly important in this patient population. This study examined the significance of preoperative GNRI in colorectal cancer patients admitted to our department for surgery.

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PATIENTS AND METHODS

The study was conducted in 113 patients diagnosed with stage II/III colorectal cancer who underwent curative upfront surgery at our department.

Informed consent statement

All procedures were performed in compliance with the ethical standards of the Responsible Commission on Human Experimentation (institutional and national) and the Declaration of Helsinki revised in 1964 and later revisions. Informed consent or alternatives were obtained from all patients included in the study. The study protocol was approved by the institutional review board of Tokushima University Hospital (approval number from the Tokushima Clinical Trial Management System : 3215-3).

Statistical analysis

Univariate analysis of differences between groups was determined with the log-rank test, and multivariate analysis was performed with the chi-square test. Survival curves were plotted using the Kaplan–Meier method to analyze overall survival (OS) and disease-free survival (DFS) rates. Two-sided p-values <0.05

were considered statistically significant. All statistical analyses were performed with JMP version 13 statistical software (SAS, Cary, NC, USA).

RESULTS

The clinicopathological features of the two groups are shown in Table 1. The median age was 69.4 (range 41–93) years ; 77 (68.1%) patients were male and 36 (31.9%) were female. The median body mass index (BMI) was 23.2 (range 16.0–32.0) kg/m^2 and there were 11 (9.7%) cases with frailty. GNRI was calculated using the following formula : 14.89 × serum albumin (g/dL) + 41.7 × (current weight (kg) ÷ ideal weight (kg)), with a cutoff value set at 92, referencing previous reports (10-12, 14). This resulted in GNRI Low (≤92) and High (>92) groups. Correlation between GNRI and various clinicopathological factors such as gender, age, BMI, American Society of Anesthesiologists (ASA) classification, frailty, stage, tumor size, lymphovascular invasion, pathological type, carcinoembryonic antigen levels and cancer antigen 19-9 levels are included. There was no significant difference in sex, tumor markers, lymphovascular invasion or pathological type between the two groups ; however, GNRI was significantly correlated with age ($p = 0.03$), BMI ($p<0.001$), ASA ($p<0.001$), frailty ($p = 0.03$), and tumor size ($p<0.001$).

Regarding the relationship between GNRI and immunonutritional indicators, in the GNRI Low group, albumin levels, C-reactive protein levels, modified Glasgow Prognostic Score (mGPS), neutrophil-to-lymphocyte ratio (NLR), and Prognostic Nutritional Index (PNI), were significantly lower than in the GNRI High group (Table 2). However, no significant difference in the incidence of postoperative complications was observed between the two groups, regardless of Clavien–Dindo classification (I–III) or overall. (Table 3).

Overall survival and disease-free survival

Survival curves of the 113 patients were plotted with the Kaplan–Meier method (Figure 1). The 5-year OS rates in the GNRI Low and High groups were 76.0% and 89.2%, respectively ($p = 0.05$), and the 5-year DFS rates were 53.8% and 74.2%, respectively ($p = 0.04$). The GNRI Low group had a significantly poorer prognosis.

Univariate and multivariate analyses of clinicopathological features associated with overall survival and disease-free survival

Table 4 shows univariate and multivariate analyses of clinicopathological features associated with OS. GNRI ($p = 0.03$), frailty ($p = 0.01$), NLR ($p = 0.03$), and total leukocyte count (<1660/μL) ($p = 0.03$) were significantly prognostic of 5-year OS. Table 5 shows univariate and multivariate analyses of clinicopathological features associated with DFS. mGPS ≥1 ($p = 0.03$) and total leukocyte count (<1660/μL) ($p = 0.01$) were significant prognostic factors for 5-year DFS in multivariate analyses in this patient cohort.

DISCUSSION

In this study, we investigated the utility of the GNRI in patients with colorectal cancer. Approximately 25 percent of the patients exhibited low GNRI values, which correlated with advanced age, low BMI, poor ASA classification, and frailty. Moreover, tumors in the GNRI Low group were larger. Additionally, correlations were observed between GNRI and immunonutritional indices such as mGPS, NLR, and PNI. However, there was no significant difference in the incidence of perioperative complications between the GNRI Low group and the GNRI High group.

In univariate analyses, low GNRI was significantly prognostic for both OS and DFS. However, in multivariate analyses, low GNRI was identified as an independent prognostic factor only for OS. The lack of impact of GNRI on short-term prognosis and its non-significance as an independent prognostic factor

Table 1. Clinicopathological factors

Parameters	GNRI<92 (n=28)	GNRI≥92 (n=85)	*p-value*
SEX (M/F)	21 / 7	56 / 29	0.36
Age	73 ± 9.9	68 ± 10.6	0.03
BMI (kg/m^2)	20.3 ± 2.6	24.1 ± 2.7	< 0.001
ASA (≤2 / ≥3)	17 / 11	81 / 4	< 0.001
Frail (- / +)	22 / 6	80 / 5	0.03
Stage (Ⅰ / Ⅱ)	18 / 10	38 / 47	0.07
CEA (ng/ml)	4.9 ± 6.7	4.2 ± 7.6	0.65
CA19-9 (U/μl)	47.2 ± 52.6	31.3 ± 57.1	0.24
Tumor size (cm)	6.1 ± 2.5	4.5 ± 1.9	< 0.001
v (- / +)	13 / 15	41 / 44	0.87
ly (- / +)	16 / 12	52 / 33	0.71
well, mod / poor	27 / 1	80 / 5	0.62

BMI, body mass index ; ASA, American Society of Anesthesiologists ; CEA, carcinoembryonic antigen ; CA19-9, carbohydrate antigen 19-9 ; ly, lymphatic invasion ; v, venous invasion.

Table 2. GNRI and immunonutritional indicators

Parameters	GNRI<92 (n=28)	GNRI≥92 (n=85)	*p-value*
TLC (/μl)	1672 ± 656	1657 ± 582	0.93
Alb (g/dl)	3.0 ± 0.5	3.9 ± 0.4	< 0.001
CRP (mg/dl)	1.9 ± 2.5	0.3 ± 0.6	< 0.001
mGPS (0/1, 2)	1 / 26	57 / 20	< 0.001
NLR	4.1 ± 2.9	2.8 ± 1.4	0.02
PNI	37.7 ± 6.6	47.1 ± 5.5	< 0.001

TLC, total lymphocyte count ; Alb, albumin ; CRP, C-reactive protein ; mGPS, modified Glasgow Prognostic Score ; NLR, neutrophil-to-lymphocyte ratio ; PNI, prognostic nutritional index.

Table 3. Postoperative complications according to Clavien–Dindo classification

Parameters	GNRI<92 (n=28)	GNRI≥92 (n=85)	*p-value*
Total complications (CD I-III)	7 (25%)	22 (25.9%)	0.62
SSI	1 (3.6%)	4 (4.7%)	0.80
Anastomotic leakage	3 (10.7%)	9 (10.6%)	0.74
Paralytic ileus	1 (3.6%)	0 (0%)	0.09
Pneumonia	1 (3.6%)	0 (0%)	0.09
Pleural effusion	1 (3.6%)	1 (1.2%)	0.44
Postoperative bleeding	0 (0%)	1 (1.2%)	0.45
Others	1 (3.6%)	6 (7.1%)	0.48

CD, Clavien–Dindo classification ; SSI, surgical site infection.

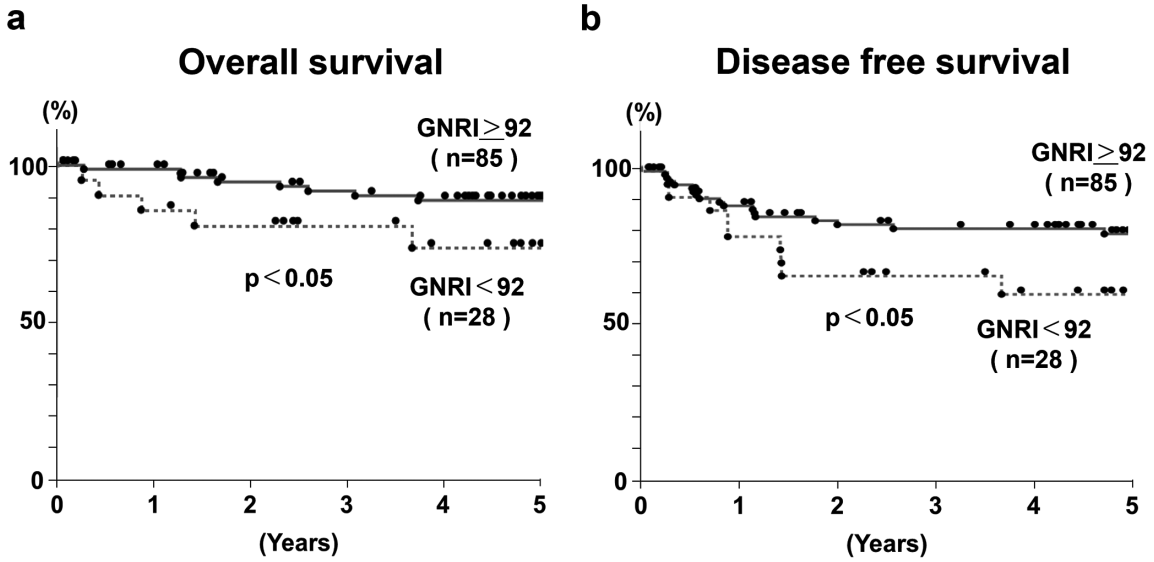

Fig 1. Overall survival and disease-free survival
Kaplan–Meier curves for (a) overall survival and (b) disease-free survival in patients with colorectal cancer and a GNRI >92 (GNRI High group) or ≤92 (GNRI Low group).

Table 4. Risk factors for overall survival

Parameters	Univariate analysis		Multivariate analysis		
	5-year OS (%)	*p*-value	H.R.	95%C.I	*p-value*
Age (<70 / ≥70)	84.6 / 84.3	0.65	0.65	0.01-1.75	0.81
Alb (≥4 / <4)	94.3 / 81.4	0.08	0.08	0.03-1.45	0.26
CEA (<5 / ≥5)	90.0 / 71.0	0.12	0.12	0.01-3.29	0.17
CA19-9 (<37 / ≥37)	92.5 / 71.6	0.03	0.03	0.32-3.11	0.12
Frailty (- / +)	89.6 / 33.3	< 0.01	< 0.01	0.03-0.70	0.01
GNRI (<92 / ≥92)	76.0 / 89.2	0.05	0.05	0.08-0.81	0.03
mGPS (0 / 1, 2)	91.9 / 79.3	0.08	0.08	0.03-0.83	0.51
PNI (<40 / ≥40)	90.7 / 77.9	0.32	0.32	0.27-3.97	0.95
ASA (1, 2 / 3, 4)	90.5 / 47.7	< 0.01	< 0.01	0.18-3.38	0.68
NLR (<2.4 / ≥2.4)	85.2 / 86.3	0.67	0.67	0.08-0.76	0.03
TLC (<1660 / ≥1660)	79.4 / 95.6	0.08	0.08	0.05-0.89	0.03

Alb, albumin ; CEA, carcinoembryonic antigen ; CA19-9, carbohydrate antigen 19-9 ; GNRI, geriatric nutrition risk index ; mGPS, modified Glasgow Prognostic Score ; PNI, prognostic nutritional index ; ASA, American Society of Anesthesiologists ; NLR, neutrophil-to-lymphocyte ratio ; TLC, total lymphocyte count.

for DFS may be attributed to the exclusion of high-risk patients undergoing surgery. Nevertheless, the unfavorable OS despite these exclusions suggests the possibility that systemic conditions unrelated to surgery or the tumor may have adversely influenced the prognosis.

In recent years, there has been a steady increase in the number of elderly cancer patients, highlighting the growing importance of perioperative management and interventions for this demographic (19). Risk factors associated with aging include comorbidities, polypharmacy, cognitive impairment, dependency, and frailty, all of which are correlated with an increase in overall mortality rates. When elderly individuals with these risk factors undergo the stress of major cancer surgery, postoperative mortality and morbidity also increase (20). The indices utilized in this study, such as GNRI, underscore the necessity for a comprehensive management approach involving a multidisciplinary team, including physiotherapists and nutritionists, from the preoperative phase. In our previous study, we demonstrated the potential improvement in surgical outcomes for frail gastric cancer patients through a preoperative exercise and nutrition

Table 5. Risk factors for disease free survival

Parameters	Univariate analysis		Multivariate analysis		
	5-year DFS (%)	*p*-value	H.R.	95%C.I	*p-value*
Age (<70 / ≥70)	73.7 / 72.3	0.55	1.03	0.05-1.46	0.93
Alb (≥4 / <4)	77.3 / 72.1	0.23	2.11	0.06-3.39	0.05
CEA (<5 / ≥5)	76.5 / 57.4	0.06	1.79	0.01-1.75	0.14
CA19-9 (<37 / ≥37)	82.4 / 51.2	< 0.01	1.82	0.32-3.11	0.24
Frailty (- / +)	76.1 / 33.3	0.02	2.44	0.03-1.70	0.52
GNRI (<92 / ≥92)	53.8 / 74.2	0.04	2.05	0.08-1.81	0.15
mGPS (0 / 1, 2)	84.1 / 63.2	0.01	4.75	0.03-0.83	0.03
PNI (<40 / ≥40)	85.3 / 43.1	< 0.01	1.04	0.27-3.97	0.16
ASA (1, 2 / 3, 4)	77.5 / 30.3	< 0.01	1.35	0.18-3.38	0.34
NLR (<2.4 / ≥2.4)	77.6 / 75.3	0.91	1.86	0.08-3.76	0.51
TLC (<1660 / ≥1660)	72.5 / 81.8	0.21	7.97	0.05-0.89	0.01

Alb, albumin ; CEA, carcinoembryonic antigen ; CA19-9, carbohydrate antigen 19-9 ; GNRI, geriatric nutrition risk index ; mGPS, modified Glasgow Prognostic Score ; PNI, prognostic nutritional index ; ASA, American Society of Anesthesiologists ; NLR, neutrophil-to-lymphocyte ratio ; TLC, total lymphocyte count.

support program (10). This underscores the impact of optimizing treatment strategies and interventions through preoperative assessment of malignant tumor patients on clinical outcomes.

The advantage of GNRI lies in its ability to be calculated based solely on serum albumin levels, current weight, and ideal weight, enabling straightforward screening of all preoperative patients. The limitations of this study include the unclear mechanism by which GNRI becomes an independent prognostic factor for OS. Furthermore, future investigations should focus on verifying whether interventions during the perioperative period contribute to the improvement of both GNRI and prognosis.

In conclusion, low GNRI in patients with colorectal cancer did not increase complications but emerged as an independent prognostic factor OS. To enhance patient outcomes, interventions from a nutrition rehabilitation team starting in the preoperative phase are required. Further investigation into the effects of such interventions is warranted in future studies.

CONFLICT OF INTERESTS

The authors declare no conflict of interest for this article.

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ETHICS STATEMENTS

Approval of the research protocol : N/A.
Informed Consent : N/A.
Registry and the Registration No. of the study/trial : N/A.
Animal Studies : N/A.

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