ISSN (electrónico): 1699-5198 - ISSN (papel): 0212-1611 - CODEN NUHOEQ S.V.R. 318

Nutrición Hospitalaria

Trabajo Original

Valoración nutricional

Association between nutritional status and platelet-to-lymphocyte ratio in patients with hepatocellular carcinoma undergoing transcatheter arterial chemoembolization

Asociación entre el estado nutricional y el índice plaquetas-linfocitos en pacientes con carcinoma hepatocelular sometidos a quimioembolización transarterial

Hongyan Duan[1], Jianfeng Zhang[1], Peng Wang[2], Jie Zhang[3], Jianwei Jiang[3]

[1]Wuxi School of Medicine. Jiangnan University. Wuxi, Jiangsu Province. China. [2]Department of Medical Imaging. The Affiliated Hospital of Jiangnan University. Wuxi, Jiangsu Province. China. [3]Department of Interventional Radiology. The Affiliated Hospital of Jiangnan University. Wuxi, Jiangsu Province. China

Abstract

Introduction: nutritional status and platelet-to-lymphocyte ratio (PLR) have been found to be associated with prognosis in patients with hepatocellular carcinoma (HCC) undergoing transcatheter arterial chemoembolization (TACE).

Objectives: to evaluate the association between nutritional status and PLR in patients with HCC undergoing TACE.

Methods: a total of 152 HCC patients received TACE were enrolled. The nutritional status was evaluated by Patient-Generated Subjective Global Assessment (PG-SGA). Patients with PG-SGA A and PG-SGA (B or C) were classified as the well-nourished and malnourished groups.

Results: according to the PG-SGA, 130 (85.5 %) patients were malnourished. The median PLR was significantly different between well-nourished and malnourished groups (p = 0.008). A positive correlation was found between PLR and PG-SGA score (r = -0.265, p = 0.001). The optimal PLR cutoff value was 102.165 to predict malnutrition, with a sensitivity of 65.4 %, specificity of 72.7 %, and an area under the curve (AUC) of 0.677 (95 % confidence interval (CI): 0.550-0.804; p = 0.008). A logistic stepwise regression model showed that the PLR was associated with nutritional status in Model 1 without adjustment, as well as if adjusted by age, sex, type of TACE (c-TACE/DEB-TACE) and Child–Pugh stage (odds ratio, 0.190; 95 % CI: 0.062-0.582; p = 0.004).

Conclusions: nutritional status measured by PG-SGA was significantly associated with PLR in patients with HCC undergoing TACE.

Keywords:

Hepatocellular carcinoma. Transcatheter arterial chemoembolization. Nutritional status. Platelet-to-lymphocyte ratio. Inflammation.

Received: 20/09/2022 • Accepted: 28/10/2022

Author contributions: Hongyan Duna: study conception/design; acquisition of clinical data; formal analysis and investigation; writing-original draft preparation; writing-reviewing and editing. Jianfeng Zhang; Jie Zhang: acquisition of clinical data; formal analysis and investigation. Peng Wang: study conception/design; formal analysis and investigation; writing-reviewing and editing. Jianwei Jiang: validation and supervision.

Acknowledgments: we would like to thank all patients who participated in this study. Authors are also grateful for the grants received from the Project of Wuxi Institute of Translational Medicine (LCYJ202222).

Funding: this study was supported by the Project of Wuxi Institute of Translational Medicine (LCYJ202222).

Conflicts of interest: the authors declare no conflicts of interest.

Institutional Review Board Statement: the protocol was approved by our hospital (JNU20220310IRB23).

Informed consent statement: informed consent was obtained from all subjects involved in the study.

Data availability statement: the data presented in this study are available on request from the corresponding author.

Duan H, Zhang J, Wang P, Zhang J, Jiang J. Association between nutritional status and platelet-to-lymphocyte ratio in patients with hepatocellular carcinoma undergoing transcatheter arterial chemoembolization. Nutr Hosp 2023;40(5):1009-1016

DOI: http://dx.doi.org/10.20960/nh.04447

Correspondence:

Jianwei Jiang. Department of Interventional Radiology. The Affiliated Hospital of Jiangnan University. Wuxi, 214000 Jiangsu Province. China
e-mail: Weij85@163.com

Resumen

Introducción: se ha encontrado que el estado nutricional y el índice plaquetas-linfocitos (PLR) se asocian con el pronóstico en pacientes con carcinoma hepatocelular (CHC) sometidos a quimioembolización transarterial (TACE).

Objetivos: evaluar la asociación entre el estado nutricional y la PLR en pacientes con CHC sometidos a TACE.

Métodos: se evaluaron 152 pacientes con CHC que recibieron TACE. El estado nutricional fue evaluado por Evaluación Global Subjetiva Generada por el Paciente (PG-SGA). Los pacientes con PG-SGA A y PG-SGA (B o C) se clasificaron como los grupos bien nutridos y desnutridos.

Resultados: según la PG-SGA, 130 (85,5 %) pacientes estaban desnutridos. La mediana de PLR fue significativamente diferente entre los grupos bien nutridos y desnutridos (p = 0,008). Se encontró una correlación positiva entre PLR y la puntuación PG-SGA (r = -0,265, p = 0,001). El valor de corte óptimo de PLR fue de 102,165 para predecir la malnutrición, con una sensibilidad del 65,4 %, una especificidad del 72,7 % y un área bajo la curva (AUC) de 0,677 (intervalo de confianza [IC] del 95 %: 0,550-0,804; p = 0,008). Un modelo de regresión logística escalonada mostró que el PLR se asoció con el estado nutricional en el Modelo 1 sin ajuste, así como cuando se ajustó por edad, sexo, tipo de TACE (c-TACE/DEB-TACE) y etapa Child-Pugh (*odds ratio*, 0,190; IC 95 %: 0,062-0,582; p = 0,004).

Conclusiones: el estado nutricional medido por PG-SGA se asoció significativamente con PLR en pacientes con CHC sometidos a TACE.

Palabras clave:

Carcinoma hepatocelular. Quimioembolización transarterial. Estado nutricional. Índice plaquetas-linfocitos. Inflamación.

INTRODUCTION

Hepatocellular carcinoma (HCC) is one of the most common cancers worldwide, and the leading cause of mortality in cancer patients (1-3). About 30 % of HCC patients are detected in the early stage, which can be benefit from surgical resection (4). However, for patients with unresectable intermediate and advanced HCC, transcatheter arterial chemoembolization (TACE) is considered a widely used treatment (3).

Currently, malnutrition is more common in patients with HCC undergoing TACE, resulting in a negative impact on quality of life, increased rate of complications, postoperative recurrence, and shortened survival (5-7). Therefore, early assessment of nutritional status is necessary to diagnose and prevent malnutrition and further improve clinical outcomes (8). The Patient-Generated Subjective Global Assessment (PG-SGA) was recommended to assess nutritional status in patients with cancer (8,9). In addition, we found that PG-SGA has been proven to be reliable for assessing the nutritional status in HCC patients, but few studies have used it to assess nutritional status in these patients undergoing TACE (10,11).

Inflammatory factors (the platelet-to-lymphocyte ratio (PLR), the neutrophil-to-lymphocyte ratio (NLR), the Glasgow Prognostic Score (GPS), the modified GPS, the systemic immune-inflammation index, etc.) has shown to be a pathogenic in the cancer-associated malnutrition, which can be used to predict poor clinical outcomes in patients with HCC (12-15). Among them, the PLR is a more effective prognostic marker than other inflammatory factors in patients with HCC (15-17). Previous studies found that nutritional status and inflammation scores can predict clinical outcomes, whereas no studies examine the associations between nutritional status and inflammation scores (PLR) in patients undergoing TACE (5,6,14).

Therefore, the aims of the present study were to evaluate the prevalence of malnutrition and to investigate the relationship between PLR and nutritional status in patients with HCC undergoing TACE.

MATERIALS AND METHODS

STUDY DESIGN AND SUBJECTS

This prospective study was conducted at our institution, which recruited 235 patients with HCC undergoing TACE from January 2022 to August 2022. HCC was diagnosed based on the European Society for Medical Oncology (ESMO) guideline [18]. The inclusion criteria were as follows: 1) HCC patients treated with TACE; 2) liver function categorized as Child-Pugh class A or B; 3) complete PG-SGA questionnaire independently, and 4) Provision of informed consent. Patients were with extrahepatic metastases (n = 45), with liver function categorized as Child–Pugh class C (n = 26), and with incomplete critical baseline data (n = 12) were excluded from the study. In total, 152 patients were included in this study (Fig. 1).

CLINICAL AND LABORATORY DATA

Sociodemographic (sex, age), type of TACE, Child–Pugh classification (Child-Pugh A and B), hypertension, diabetes, and laboratory data (red blood cell (RBC), hemoglobin, albumin, white blood cell (WBC), neutrophil count, lymphocyte count, platelets count, alanine aminotransferase (ALT), aspartate aminotransferase (AST), and albumin) were collected. Chemoembolization type included the conventional TACE (c-TACE) and drug-eluting bead TACE (DEB-TACE).

ASSESSMENT OF ANTHROPOMETRY AND NUTRITIONAL STATUS

Body weight and height were measured by standing in light clothes and without shoes. The body mass index (BMI) was calculated as the weight (kilograms) divided by the height square (meters). Furthermore, the BMI results were stratified into underweight (< 18.5 kg/m^2), normal weight (≥ 18.5 kg/m^2, < 25.0 kg/m^2), overweight (≥ 25.0 kg/m^2, < 30.0 kg/m^2) and obese (≥ 30.0 kg/m^2).

The PG-SGA is recommended as the nutrition assessment tool by several oncology practice societies and its validity and reliability have been demonstrated in cancer patients (8,19). The PG-SGA nutrition assessment includes two parts. The first part consists of weight history, food intake, symptoms, and functional status, which were completed by the patients. The second part was assessed by medical staff and includes nutrition-related disease status, metabolic status, and physical examination results (20). The sum of scores was categorized as 0-1 (PG-SGA A, well-nourished), 2-8 (PG-SGA B, suspected or moderately malnourished) and ≥ 9 (PG-SGA C, severely malnourished). Patients with PG-SGA A were classified as well-nourished group, and patients with PG-SGA B or C were classified as malnourished group (21).

ASSESSMENT OF PLR

The PLR was calculated as platelet count (10^9/L) divided by lymphocyte count (10^9/L). The Spearman correlation was used to examine the association of PLR and PG-SGA score. The receiver operating characteristic (ROC) curve were generated and to identify cut-off values of the PLR.

ETHICAL STATEMENT

The present study was approved by the Research Ethics Committee of our hospital (JNU20220310IRB23), and all participants voluntarily gave written informed consent.

STATISTICAL ANALYSIS

All continuous variables are described as the means ± standard deviations or medians (quartiles), and were compared between the well-nourished and malnutrition groups by using the independent samples t-tests or Mann-Whitney *U*-test. Categorical variables are described as the number and the percentages of cases, and were compared between these two groups using the Chi-squared test or Fisher's exact test. The Spearman rank correlation coefficient was used to assess the association between PLR and nutritional parameters. The PLR cut-off value was calculated using a receiver operating characteristic (ROC) curve. Binary logistic regression analyses were done to assess the association between nutritional status and PLR. We used the Model 1 without adjustment and Model 2 adjusted by age, sex, type of TACE (c-TACE/DEB-TACE) and Child-Pugh stage. All statistical analysis was performed with SPSS version 24.0 (IBM, Chicago, IL, United States). A p-value of less than 0.05 was considered a significant difference.

RESULTS

DEMOGRAPHIC AND CLINICAL CHARACTERISTICS

A total of 152 patients were included in this study. The demographic and clinical characteristics of the enrolled patients were summarized in table I. The male accounts for 84.2 %, and mean age was 62.55 ± 9.71 years. Regarding the liver function classification, 86 (56.6 %) patients were classified as Child-Pugh class A and 66 (43.3 %) patients were Child-Pugh class B. The c-TACE treatment was performed in 99 patients (65.1 %). According to the PG-SGA, 85.5 % of the patients were malnourished (46.7 % PG-SGA B, 38.8 % PG-SGA C) and the median PG-SGA score was 7.00 (range: 3.25-10.00). The median body weight was 60.00 kg (range: 54.00-70.00 kg), and the median BMI was 21.88 kg/m^2 (range: 19.58-24.58 kg/m^2). In addition, 22 patients (12.5 %) were underweight (BMI < 18.50 kg/m^2). The median PLR was 138.00 (range: 76.25-233.53), and the median levels for serum liver markers such as AST, ALT, and bilirubin were 46.50 U/L (range: 28.00-68.75 U/L), 47.00 U/L (range: 25.00-74.50 U/L), and 23.05 g/dL (range: 15.03-35.38 g/dL), respectively.

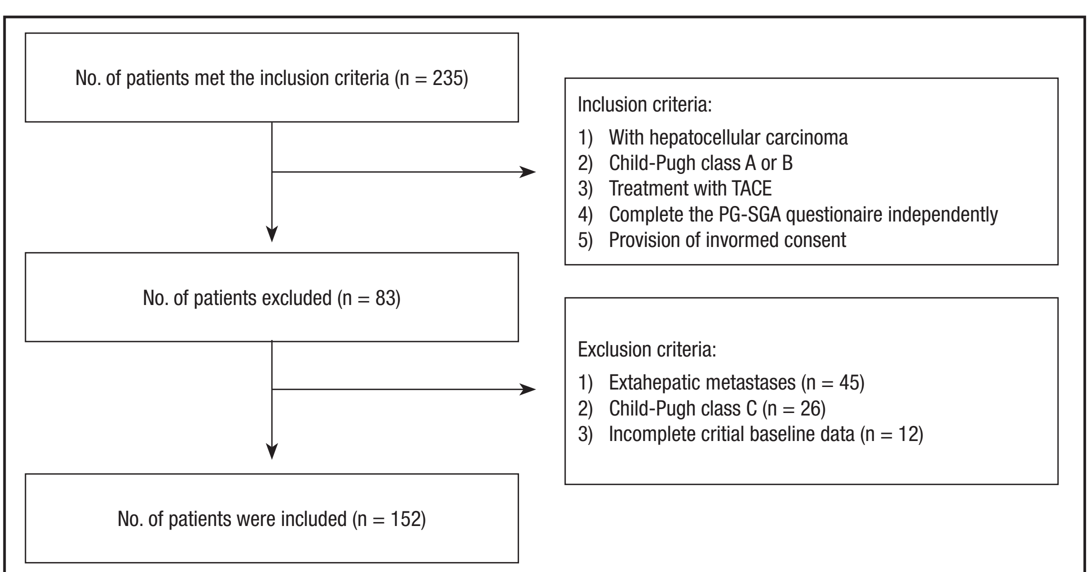

Figure 1.
Study flowchart.

PATIENT CHARACTERISTICS BY NUTRITIONAL STATUS

The differences between PG-SGA A (well-nourished) and PG-SGA B + C (malnourished) group are shown in table II and table III. Among patients undergoing TACE, the prevalence of malnutrition was higher for patients with higher age than those well-nourished patients ($p < 0.001$). Patients in the PG-SGA A group had higher height, body weight, and BMI than those of PG-SG B + C group, but there is no significant difference among the groups (without significant difference, $p = 0.759$, $p = 0.356$, $p = 0.630$, respectively). Well-nourished patients have significantly higher levels of hemoglobin than that of malnourished patients ($p = 0.018$). There was a significant difference in PLR between PG-SGA A and PG-SGA B + C groups ($p = 0.008$). Patients with higher levels of bilirubin, AST and ALT had a higher rate of malnutrition than those with lower levels of bilirubin, AST and ALT, but the difference did not have statistical significance ($p = 0.722$, $p = 0.540$, $p = 0.518$, respectively) (Table II).

As shown in table III, a significant difference was observed between PG-SGA A and PG-SGA B + C groups in liver function Child-Pugh classification ($p = 0.011$), except for sex, hypertension, diabetes, and type of TACE ($p > 0.050$).

ASSOCIATION BETWEEN PLATELET-TO-LYMPHOCYTE RATIO (PLR) AND NUTRITIONAL PARAMETERS

Spearman's correlation revealed that the PLR was positively correlated with PG-SGA score (r = 0.208, $p = 0.010$), while negatively correlated with the hemoglobin level (r = -0.265, $p = 0.001$) (Table IV).

CALCULATION OF OPTIMAL CUTOFF VALUE FOR THE PLR

As is shown in figure 2, a PLR ≥ 102.165 was the optimal cutoff value using malnutrition as an endpoint in the ROC curve. The area under the curve (AUC), sensitivity, and specificity were 0.677 (95 % confidence interval (CI): 0.550-0.804; $p = 0.008$), 65.4 % and 72.7 %, respectively.

LOGISTIC BINARY REGRESSION WITH NUTRITIONAL STATUS AS A DEPENDENT VARIABLE

Table V shows the logistic regression analysis for the nutritional status (PG-SGA A vs. B + C) in HCC patients undergoing TACE. Age, sex, PLR ≥ 102.165 (categorical variable), type of TACE and Child-Pugh stage were enrolled in the regression model, which demonstrated that nutritional status was associated with the PLR in the Model 1 without adjustment (OR, 0.199; 95 % CI, 0.073-0.543; $p = 0.002$) and Model 2 adjusted for age, sex, type of TACE (c-TACE/DEB-TACE) and Child-Pugh stage (OR, 0.190; 95 % CI, 0.062-0.582; $p = 0.004$).

Table I. Demographic and clinical characteristics of the patients

Variable	Total (*n* = 152)	
	n (%)	Mean (SD)
Sex		
Male	128 (84.2)	
Female	24 (15.8)	
Age (years)		62.55 (9.71)
Hypertension (yes, %)	60 (39.5)	
Diabetes (yes, %)	31 (20.4)	
Child–Pugh stage (%)		
A	86 (56.6)	
B	66 (43.4)	
Type of TACE		
c-TACE	99 (65.1)	
DEB-TACE	53 (34.9)	
Classification of PG-SGA		
SGA-A	22 (14.5)	
SGA-B	71 (46.7)	
SGA-C	59 (38.8)	
Classification of BMI		
Underweight (18.5)	19 (12.5)	
Normal weight (≥ 18.5,+25)	99 (65.1)	
Overweight (≥ 25,+30)	25 (16.4)	
Obesity (≥ 30)	9 (5.9)	
Height (cm)		168.00 (162.00-172.00)
Body weight (kg)		60.00 (54.00-70.00)
BMI (kg/m^2)		21.88 (19.58-24.58)
PG-SGA score		7.00 (3.25-10.00)
RBC (× 10^9/L)		3.73 (0.61)
Hemoglobin (g/dL)		117.00 (107.00-129.00)
Albumin (g/L)		33.55 (4.43)
WBC (× 10^9/L)		5.50 (4.20-7.98)
Neutrophil count (mm^3)		4.20 (2.60-6.40)
Lymphocyte count (mm^3)		0.80 (0.60-1.20)
Platelets (× 10^3/µL)		113.50 (76.50-166.00)
PLR		138.00 (76.25-233.53)
AST (U/L)		46.50 (28.00-68.75)
ALT (U/L)		47.00 (25.00-74.50)
Bilirubin (g/dL)		23.05 (15.03-35.38)

Data are expressed as mean ± standard deviation, median (interquartile range). PG-SGA: Patient-Generated Subjective Global Assessment; TACE: transcatheter arterial chemoembolization; c-TACE: conventional TACE; DEB-TACE: drug-eluting beads TACE; BMI: body mass index; RBC: red blood cells; WBC: white blood cells; PLR: platelet-to-lymphocyte ratio; AST: aspartate aminotransferase; ALT: alanine aminotransferase.

Table II. Clinical characteristics of the patients according to the PG-SGA rank

Variable	PG-SGA A	PG-SGA (B + C)	*p*-value
	n = 22	*n* = 130	
Age (years)†	55.68 (6.99)	63.71 (9.65)	< 0.001*
Height (cm)†	167.55 (5.52)	167.05 (7.26)	0.759
Body weight (kg)	64.60 (10.80)	62.66 (12.23)	0.356
BMI (kg/m^2)	23.20 (4.42)	22.40 (3.73)	0.630
RBC (× 109/L)†	3.96 (0.67)	3.69 (0.60)	0.055
Hemoglobin (g/dL)†	126.68 (24.23)	115.63 (19.20)	0.018*
Albumin (g/L)	34.74 (4.19)	33.35 (4.45)	0.270
WBC (× 10^9/L)	6.57 (4.02)	6.48 (3.60)	0.668
Neutrophil count (mm^3)	5.00 (3.99)	5.02 (3.36)	0.547
Lymphocyte count (mm^3)	1.04 (0.42)	1.00 (0.76)	0.106
Platelets (× 10^3/μL)	108.05 (73.69)	130.88 (67.03)	0.022*
PLR	120.89 (97.51)	180.19 (141.98)	0.008*
AST (U/L)	61.73 (52.10)	80.94 (144.32)	0.540
ALT (U/L)	69.32 (59.98)	72.61 (109.12)	0.518
Bilirubin	25.43 (12.29)	30.30 (25.80)	0.722

*PG-SGA: Patient-Generated Subjective Global Assessment; BMI: body mass index; RBC: red blood cells; WBC: white blood cells; PLR: platelet-to-lymphocyte ratio; AST: aspartate aminotransferase; ALT: alanine aminotransferase. †Differences between groups for these variables were compared using the independent samples t-tests, while the other variables were compared using the Mann-Whitney U-test. *p < 0.05.*

Table III. Differences in clinical characteristics between the PG-SGA A and PG-SGA B + C groups

Variable	PG-SGA A	PG-SGA B + C	*p*-value
	n = 22	*n* = 130	
Sex†			
Female	3 (13.6)	21 (16.2)	1.000
Male	19 (86.4)	109 (83.8)	
Hypertension (yes, %)	8 (36.4)	52 (40.0)	0.747
Diabetes (yes, %)†	4 (18.2)	27 (20.8)	1.000
Type of TACE			
c-TACE	16 (72.7)	83 (63.8)	0.419
DEB-TACE	6 (27.3)	47 (36.2)	
Child-Pugh stage (%)			
A	7 (31.8)	79 (60.8)	0.011*
B	15 (68.2)	51 (39.2)	

*PG-SGA: Patient-Generated Subjective Global Assessment; TACE: transcatheter arterial chemoembolization; c-TACE: conventional TACE; DEB-TACE: drug-eluting beads TACE. †Differences between groups for these variables were compared using Fisher's exact test, while the other variables were compared using the chi-squared test. *p < 0.05.*

Table IV. Correlation between platelet-to-lymphocyte ratio (PLR) and nutritional parameters

Variables	PLR	
	Correlation coefficient	*p*-value
PG-SGA score	0.208	0.010*
Body weight (kg)	-0.135	0.096
BMI (kg/m^2)	-0.139	0.087
RBC (× 10^9/L)	-0.130	0.111
Hemoglobin (g/dL)	-0.265	0.001*
Albumin (g/L)	-0.126	0.121

*PLR: platelet-to-lymphocyte ratio; PG-SGA: Patient-Generated Subjective Global Assessment; BMI: body mass index; RBC: red blood cells. *p < 0.05.*

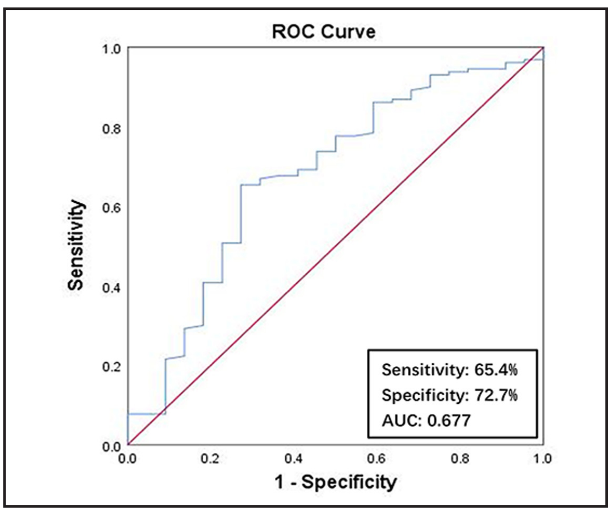

Figure 2.

Performance of PLR levels in prediction of nutritional status in HCC patients undergoing TACE (ROC: receiver operating characteristic; PLR: platelet-to-lymphocyte ratio; AUC: area under the curve).

Table V. Logistic regression estimates of the association between nutritional status (PG-SGA A vs. B + C) and platelet-to-lymphocyte ratio (PLR)

Variables	OR	95 % CI	*p*-value
PLR × PG-SGA (A vs. B + C)			
Model 1#	0.199	0.073-0.543	0.002*
Model 2##	0.190	0.062-0.582	0.004*

*Note: nutritional status was entered as a dependent variable (PG-SGA A vs. B + C), and PLR ≥ 102.165 was entered as an independent variable. aNot adjusted. bAdjusted for age, sex, type of TACE (c-TACE/DEB-TACE), Child-Pugh stage. OR: odds ratio; CI: confidence interval; PLR: platelet-to-lymphocyte ratio; PG-SGA: Patient-Generated Subjective Global Assessment; TACE: transcatheter arterial chemoembolization; c-TACE: conventional TACE; DEB-TACE: drug-eluting beads TACE. *p < 0.05.*

DISCUSSION

The present study shown the higher prevalence of malnutrition according to the PG-SGA score in patients with HCC undergoing TACE. Additionally, there was a positive correlation between the PLR and nutritional status, which can be used as an indicator to evaluate nutritional status. Moreover, PLR was an independent predict variable of nutritional status, and its cutoff value above the 102.165 reveals the poor nutritional status in patients with HCC undergoing TACE.

In our study, 85.5 % of the HCC patients receiving TACE were malnourished, which was consistent with a previous study, which found similar prevalence rate of malnutrition (81 %) in surgical patients with cancer (22). The high prevalence of malnutrition may be explained by the fact that poor liver function (23) or the occurrence of postembolization syndrome (PES) (including fever, abdominal pain, vomiting, and nausea) (24). Another study also showed that HCC patients receiving TACE have poor nutritional status, which predicts shorter overall survival (OS) (5,6). Thus, high prevalence of malnutrition may occur among patients after TACE.

There were different inflammation-related factors among various type of cancer patients, such as lymphocyte-to-monocyte ratio (LMR), NLR, and PLR (25-27). PLR was a reliable inflammatory marker in patients with HCC (16,17). Platelets is essential for growth and metastasis in HCC via angiogenesis and protect tumor cells from lysis by natural killer cells (28). However, lymphocytes play a role in anti-tumoral immune response, and their reduction indicated the worse prognosis of HCC (29,30). Previous study has been shown that the PLR was a more powerful predictive factor than other inflammation-based scores in patients with HCC undergoing TACE (15). Additionally, two systematic reviews indicated that high PLR is a promising prognostic biomarker for patients with HCC (16,17). Thus, the PLR may be a useful inflammatory marker used in patients with HCC treated with TACE.

In addition, to our knowledge, there are no studies in investigating the association between nutritional status and PLR in HCC patients undergoing TACE. Previously, studies have investigated the association between NLR and nutritional status in geriatric patients, hospitalized cirrhosis, COVID-19 and hospitalized, unselected cancer patients (31-34). In this study, we found that the PLR significantly higher in malnourished patients than nourished patients, indicating that inflammatory response was associated with nutritional status, which was in line with previous studies in identifying the relationship between inflammation and nutritional status (31-34). In a previous study, Siqueira et al reported that high NLR values show an increase in nutritional risk in hospitalized, unselected cancer patients, suggesting that systemic inflammation was associated with nutritional risk, which was consistent with our study (34). Therefore, systemic inflammatory was associated with nutritional status, and the PLR can be used as an indicator in evaluating the nutritional status of HCC patients undergoing TACE. This study can be used as a screening test or a test to verify nutritional status, which may be useful for therapeutic care plans and improving clinical outcomes (33,35).

LIMITATION

There were some limitations in this study. Firstly, it was a cross-sectional design study, so no causal relationship between nutritional status and PLR could be established. Secondly, the single study setting may result in a lack of generalizability of research findings to other populations in different medical institutions. Lastly, the correlation between the PLR and post-chemoembolization complications or the outcome of chemoembolization was not evaluated, which should be confirmed in our further study.

CONCLUSIONS

The present study demonstrates that the prevalence of malnutrition was significantly higher in patients with HCC undergoing TACE. In addition, a higher PLR was associated with worse nutritional status, thus those with higher PLR might need to be performed nutritional assessment and management. Moreover, the PLR was a predictor in assessing nutritional status in patients with HCC undergoing TACE.

REFERENCES

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018;68:394-424. DOI: 10.3322/caac.21492
2. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2019. CA Cancer J Clin 2019;69:7-34. DOI: 10.3322/caac.21551
3. Forner A, Reig M, Bruix J. Hepatocellular carcinoma. Lancet 2018;391:1301-14. DOI: 10.1016/s0140-6736(18)30010-2
4. Park JW, Chen M, Colombo M, Roberts LR, Schwartz M, Chen PJ, et al. Global patterns of hepatocellular carcinoma management from diagnosis to death: the BRIDGE Study. Liver Int 2015;35:2155-66. DOI: 10.1111/liv.12818
5. Deng J, He JJ, Xie LP, Zheng QW, Wu SL, Shao HY. Comprehensive nutritional index for predicting overall survival in hepatocellular carcinoma patients after multiple transarterial chemoembolization. Asia Pac J Clin Nutr 2021;30:7-14. DOI: 10.6133/apjcn.202103_30(1).0002
6. Müller L, Hahn F, Mähringer-Kunz A, Stoehr F, Gairing SJ, Foerster F, et al. Immunonutritive Scoring in Patients With Hepatocellular Carcinoma Undergoing Transarterial Chemoembolization: Prognostic Nutritional Index or Controlling Nutritional Status Score? Front Oncol 2021;11:696183. DOI: 10.3389/fonc.2021.696183
7. Man Z, Pang Q, Zhou L, Wang Y, Hu X, Yang S, et al. Prognostic significance of preoperative prognostic nutritional index in hepatocellular carcinoma: a meta-analysis. HPB (Oxford) 2018;20:888-95. DOI: 10.1016/j.hpb.2018.03.019
8. Bauer J, Capra S, Ferguson M. Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer. Eur J Clin Nutr 2002;56:779-85. DOI: 10.1038/sj.ejcn.1601412
9. Jager-Wittenaar H, Ottery FD. Assessing nutritional status in cancer: role of the Patient-Generated Subjective Global Assessment. Curr Opin Clin Nutr Metab Care 2017;20:322-9. DOI: 10.1097/mco.0000000000000389
10. Hung HC, Lee JC, Wang YC, Cheng CH, Wu TH, Lee CF, et al. Response Prediction in Immune Checkpoint Inhibitor Immunotherapy for Advanced Hepatocellular Carcinoma. Cancers (Basel) 2021;13:1607. DOI: 10.3390/cancers13071607
11. van Dijk AM, Coppens BJP, van Beers MA, Bruins Slot AS, Verstraete CJR, de Bruijne J, et al. Nutritional status in patients with hepatocellular carcinoma: Potential relevance for clinical outcome. Eur J Intern Med 2022. DOI: 10.1016/j.ejim.2022.07.002[in press]
12. Argilés JM, Busquets S, López-Soriano FJ. Cytokines in the pathogenesis of cancer cachexia. Curr Opin Clin Nutr Metab Care 2003;6:401-6. DOI: 10.1097/01.mco.0000078983.18774.cc
13. Schobert IT, Savic LJ, Chapiro J, Bousabarah K, Chen E, Laage-Gaupp F, et al. Neutrophil-to-lymphocyte and platelet-to-lymphocyte ratios as predictors of tumor response in hepatocellular carcinoma after DEB-TACE. Eur Radiol 2020;30:5663-73. DOI: 10.1007/s00330-020-06931-5
14. Zhou DS, Xu L, Luo YL, He FY, Huang JT, Zhang YJ, et al. Inflammation scores predict survival for hepatitis B virus-related hepatocellular carcinoma patients after transarterial chemoembolization. World J Gastroenterol 2015;21:5582-90. DOI: 10.3748/wjg.v21.i18.5582
15. Liu Y, Shi M, Chen S, Wan W, Shen L, Shen B, et al. Intermediate stage hepatocellular carcinoma: Comparison of the value of inflammation-based scores in predicting progression-free survival of patients receiving transarterial chemoembolization. J Cancer Res Ther 2021;17:740-8. DOI: 10.4103/jcrt.jcrt_29_21
16. Lin WF, Zhong MF, Zhang YR, Wang H, Zhao HT, Cheng BB, et al. Prognostic Role of Platelet-to-Lymphocyte Ratio in Hepatocellular Carcinoma with Different BCLC Stages: A Systematic Review and Meta-Analysis. Gastroenterol Res Pract 2018;2018:5670949. DOI: 10.1155/2018/5670949
17. Zhao Y, Si G, Zhu F, Hui J, Cai S, Huang C, et al. Prognostic role of platelet to lymphocyte ratio in hepatocellular carcinoma: a systematic review and meta-analysis. Oncotarget 2017;8:22854-62. DOI: 10.18632/oncotarget.15281
18. Vogel A, Cervantes A, Chau I, Daniele B, Llovet JM, Meyer T, et al. Hepatocellular carcinoma: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. Ann Oncol 2018;29:iv238-55. DOI: 10.1093/annonc/mdy308
19. Kubrak C, Jensen L. Critical evaluation of nutrition screening tools recommended for oncology patients. Cancer Nurs 2007;30:E1-6. DOI: 10.1097/01.Ncc.0000290818.45066.00
20. Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA, et al. What is subjective global assessment of nutritional status? JPEN J Parenter Enteral Nutr 1987;11:8-13. DOI: 10.1177/014860718701100108
21. Pham NV, Cox-Reijven PL, Greve JW, Soeters PB. Application of subjective global assessment as a screening tool for malnutrition in surgical patients in Vietnam. Clin Nutr 2006;25:102-8. DOI: 10.1016/j.clnu.2005.09.002
22. Viana E, Oliveira IDS, Rechinelli AB, Marques IL, Souza VF, Spexoto MCB, et al. Malnutrition and nutrition impact symptoms (NIS) in surgical patients with cancer. PLoS One 2020;15:e0241305. DOI: 10.1371/journal.pone.0241305
23. Cheung K, Lee SS, Raman M. Prevalence and mechanisms of malnutrition in patients with advanced liver disease, and nutrition management strategies. Clin Gastroenterol Hepatol 2012;10:117-25. DOI: 10.1016/j.cgh.2011.08.016
24. Vogl TJ, Naguib NN, Nour-Eldin NE, Rao P, Emami AH, Zangos S, et al. Review on transarterial chemoembolization in hepatocellular carcinoma: palliative, combined, neoadjuvant, bridging, and symptomatic indications. Eur J Radiol 2009;72:505-16. DOI: 10.1016/j.ejrad.2008.08.007
25. Zhang J, Zhang HY, Li J, Shao XY, Zhang CX. The elevated NLR, PLR and PLT may predict the prognosis of patients with colorectal cancer: a systematic review and meta-analysis. Oncotarget 2017;8:68837-46. DOI: 10.18632/oncotarget.18575
26. Mandaliya H, Jones M, Oldmeadow C, Nordman, II. Prognostic biomarkers in stage IV non-small cell lung cancer (NSCLC): neutrophil to lymphocyte ratio (NLR), lymphocyte to monocyte ratio (LMR), platelet to lymphocyte ratio (PLR) and advanced lung cancer inflammation index (ALI). Transl Lung Cancer Res 2019;8:886-94. DOI: 10.21037/tlcr.2019.11.16
27. Gupta V, Chaudhari V, Shrikhande SV, Bhandare MS. Does Preoperative Serum Neutrophil to Lymphocyte Ratio (NLR), Platelet to Lymphocyte Ratio (PLR), and Lymphocyte to Monocyte Ratio (LMR) Predict Prognosis Following Radical Surgery for Pancreatic Adenocarcinomas? Results of a Retrospective Study. J Gastrointest Cancer 2021;53:641-8. DOI: 10.1007/s12029-021-00683-1
28. Bihari C, Rastogi A, Shasthry SM, Bajpai M, Bhadoria AS, Rajesh S, et al. Platelets contribute to growth and metastasis in hepatocellular carcinoma. Apmis 2016;124:776-86. DOI: 10.1111/apm.12574
29. Byun HK, Kim N, Park S, Seong J. Acute severe lymphopenia by radiotherapy is associated with reduced overall survival in hepatocellular carcinoma. Strahlenther Onkol 2019;195:1007-17. DOI: 10.1007/s00066-019-01462-5
30. Sideras K, Biermann K, Verheij J, Takkenberg BR, Mancham S, Hansen BE, et al. PD-L1, Galectin-9 and CD8(+) tumor-infiltrating lymphocytes

are associated with survival in hepatocellular carcinoma. Oncoimmunology 2017;6:e1273309. DOI: 10.1080/2162402x.2016.1273309
31. Kaya T, Açıkgöz SB, Yıldırım M, Nalbant A, Altaş AE, Cinemre H. Association between neutrophil-to-lymphocyte ratio and nutritional status in geriatric patients. J Clin Lab Anal 2019;33:e22636. DOI: 10.1002/jcla.22636
32. Wang X, Feng H, Hui Y, Yu Z, Zhao T, Mao L, et al. Neutrophil-to-lymphocyte ratio is associated with malnutrition risk estimated by the Royal Free Hospital-Nutritional Prioritizing Tool in hospitalized cirrhosis. JPEN J Parenter Enteral Nutr 2022;46:123-9. DOI: 10.1002/jpen.2097
33. Martins PM, Gomes TLN, Franco EP, Vieira LL, Pimentel GD. High neutrophil-to-lymphocyte ratio at intensive care unit admission is associated with nutrition risk in patients with COVID-19. JPEN J Parenter Enteral Nutr 2022;46:1441-8. DOI: 10.1002/jpen.2318
34. Siqueira JM, Soares JDP, Borges TC, Gomes TLN, Pimentel GD. High neutrophil to lymphocytes ratio is associated with nutritional risk in hospitalised, unselected cancer patients: a cross-sectional study. Sci Rep 2021;11:17120. DOI: 10.1038/s41598-021-96586-z
35. McClave SA, Taylor BE, Martindale RG, Warren MM, Johnson DR, Braunschweig C, et al. Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). JPEN J Parenter Enteral Nutr 2016;40:159-211. DOI: 10.1177/0148607115621863