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World Journal of Surgical Oncology (2024) 22:284
https://doi.org/10.1186/s12957-024-03524-0

World Journal of Surgical Oncology

RESEARCH

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Fibrinogen to pre-albumin ratio is an independent prognostic index for patients with pancreatic ductal adenocarcinoma after radical resection

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Abstract

Background This study aims to elucidate the significance of the preoperative fibrinogen to pre-albumin ratio (FPR) in predicting the prognosis of pancreatic ductal adenocarcinoma (PDAC), a correlation not extensively explored previously.

Methods A cohort of 563 patients diagnosed with PDAC and subjected to radical surgical resection was examined. We meticulously documented a range of inflammatory markers, clinical-pathological features, and oncological outcomes. The prognostic value of preoperative FPR was assessed using Kaplan–Meier survival analysis and Cox proportional hazards regression modeling. Furthermore, the predictive accuracy of FPR was evaluated through time-dependent receiver operating characteristic (ROC) curves and decision curve analyses (DCA).

Results The determined optimal threshold for FPR was 14.77, which facilitated the stratification of patients into groups with low and high FPR levels. Notably, patients in the high FPR cohort exhibited significantly reduced recurrence-free survival (RFS) and overall survival (OS) rates compared to their low FPR counterparts. Multivariate Cox regression analysis underscored FPR as an independent prognostic indicator for both RFS and OS. In comparison to the neutrophil-to-lymphocyte ratio (NLR), FPR demonstrated superior prognostic accuracy and clinical utility.

Conclusion The preoperative fibrinogen to pre-albumin ratio serves as an independent prognostic marker for RFS and OS among PDAC patients undergoing radical resection. Our findings suggest that FPR could be a valuable addition to the current prognostic models, potentially guiding therapeutic decision-making and patient management strategies in PDAC.

Keywords Fibrinogen to pre-albumin ratio, Pancreatic cancer, Prognosis, Overall survival

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Introduction

Pancreatic cancer, as a highly lethal malignancy, exhibits an increasing incidence globally coupled with relatively low survival rates, posing a significant challenge in the field of medicine today. This malignancy ranks as the 11th most prevalent cancer globally yet is the 7th leading cause of cancer-related mortality [1]. Pancreatic ductal adenocarcinoma (PDAC) constitutes approximately 90% of all pancreatic cancer cases [2]. Surgical interventions such as the Whipple procedure and distal pancreatectomy are the cornerstone treatments for early-stage disease; however, the predominance of late-stage diagnoses limits the feasibility of such approaches [3, 4]. Despite significant strides in surgical and chemotherapeutic strategies over recent years, which have marginally improved survival rates, the overall outlook for pancreatic cancer patients remains bleak [5]. Consequently, the identification of robust prognostic markers for tailoring individualized treatment strategies is critically needed.

In recent years, the potential of preoperative inflammatory biomarkers as prognostic tools for pancreatic cancer has gained considerable interest. The preoperative inflammation biomarkers offer advantages in terms of non-invasiveness, rapid assessment, and cost efficiency. Among these biomarkers, neutrophil to lymphocyte ratio (NLR), platelet to lymphocyte ratio (PLR), CRP to albumin ratio pancreatic and fibrinogen to albumin ratio have garnered significant attention [6–9]. Elevated pretreatment plasma fibrinogen levels significantly correlate with decreased survival rates in patients with solid tumors [10]. Furthermore, the nutritional status of patients profoundly impacts their prognosis. To a certain extent, the levels of albumin (ALB) and prealbumin (PALB) serve as indicators of the patient's nutritional status [11]. Our previous research has established a significant association between prealbumin levels and PDAC prognosis [12]. There is a growing body of evidence indicating that the fibrinogen-to-prealbumin ratio (FPR) is a noteworthy prognostic marker in different cancer types, with higher FPR values correlating with reduced survival durations [13, 14]. However, the relationship between FPR and PDAC survival has been insufficiently explored. This study aims to delve into the prognostic value of FPR in PDAC patients undergoing radical resection, leveraging a comprehensive retrospective cohort analysis that integrates vital clinical parameters.

Materials and methods

Patients

We conducted a retrospective analysis of patients who were histopathologically confirmed to have pancreatic ductal adenocarcinoma (PDAC) and underwent radical pancreatectomy with curative intent (R0 resection) at the Tianjin Medical University Cancer Institute and Hospital (TUCH) during the period from January 2013 to December 2021. The cohort screening process diagram is depicted in Supplementary Fig. 1. The study excluded individuals presenting with distant metastases or those who had received neoadjuvant therapy prior to surgery. Furthermore, patients who survived less than 90 days post-surgery or succumbed to their condition while hospitalized were also omitted from the analysis. The cohort encompassed patients who had undergone surgical procedures such as distal pancreatectomy, pancreaticoduodenectomy, or total pancreatectomy. The Ethical Review Committees of TUCH sanctioned this study, ensuring adherence to the ethical standards delineated in the Declaration of Helsinki.

Data extraction and follow-up

The collected clinicopathological variables encompassed demographic details (age and gender), preoperative serum levels of cancer antigen 19–9 (CA19-9) and carcinoembryonic antigen (CEA), complete blood count components including lymphocytes, neutrophils, and platelets, pre-albumin levels, as well as oncological characteristics such as tumor location, degree of differentiation, staging according to the eighth edition of the Union for International Cancer Control (UICC) for both primary tumor (pT) and regional lymph nodes (pN), and evidence of perineural, resectability status, lymphovascular, and extrapancreatic invasion. Furthermore, information regarding the administration of adjuvant chemotherapy and the occurrence of postoperative complications was documented. The primary endpoints of this investigation were recurrence-free survival (RFS) and overall survival (OS), with RFS being delineated as the duration from surgical resection to the detection of tumor recurrence or metastasis, and OS defined as the interval from the date of surgery to the date of death. The neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) were calculated as the quotient of neutrophil and platelet counts to lymphocyte count, respectively. The fibrinogen to pre-albumin ratio (FPR) for this study was quantified using the formula: (serum fibrinogen concentration in g/L) / (pre-albumin concentration in g/L).

Statistical analysis

Statistical analyses within this study were meticulously executed utilizing R software (version 4.1.5) alongside SPSS (version 22.0). Categorical variables were delineated through frequencies and percentages, with inter-group disparities assessed via the chi-square test. Continuous variables, conversely, were articulated as medians alongside interquartile ranges, and their comparative analyses

were facilitated by the Rank Sum Test. The determination of optimal cutoff values for the NLR, PLR, and FPR in relation to OS was accomplished through the utilization of the "survminer" package within R software. Survival analysis was conducted employing the Kaplan–Meier method, while both univariate and multivariate Cox proportional hazards regression models were employed to ascertain independent prognostic factors. We use a 1:1 propensity score matching (PSM) technique to balance patient baseline characteristics. The assessment of predictive efficacy and clinical utility of NLR and FPR was conducted through time-dependent receiver operating characteristic (ROC) curves and decision curve analysis (DCA). Statistical significance was established at p-values less than 0.05, employing a two-tailed testing approach.

Result

Clinicopathological characteristics

The distribution of fibrinogen, pre-albumin, neutrophils, and lymphocytes for the entire cohort are provided in the Supplementary Table 1. The optimal cutoff point of FPR was established at 14.77, leading to the stratification of the study cohort into two distinct groups: a high FPR group (FPR ≥ 14.77) and a low FPR group (FPR < 14.77), as depicted in Fig. 1. The demographic and clinical profiles of the 563 participants incorporated in this analysis are comprehensively tabulated in Table 1. A comparative evaluation revealed that the high FPR cohort predominantly comprised patients with tumors located in the pancreatic head ($p < 0.001$) and exhibited adverse clinical features, as evidenced by higher pN stages ($p = 0.010$), elevated NLR ($p < 0.001$), and increased PLR ($p < 0.001$).

Survival analysis of RFS and OS across two groups

The Kaplan–Meier method was employed to assess and contrast the survival outcomes between patients stratified into high and low FPR groups. Analysis encompassing the entire cohort revealed a significantly poorer prognosis associated with the high FPR group, as evidenced by both diminished RFS (median RFS: 9 months for the high FPR group vs. 16 months for the low FPR group, $p < 0.001$, Fig. 2A) and reduced OS (median OS: 18 months for the high FPR group vs. 29 months for the low FPR group, $p < 0.001$, Fig. 2B). Next, we will employ PSM to balance the baseline data of two groups (Supplementary Table 2). In the PSM cohort, survival analysis reaffirmed that patients exhibiting high FPR were associated with inferior outcomes in terms of RFS (median

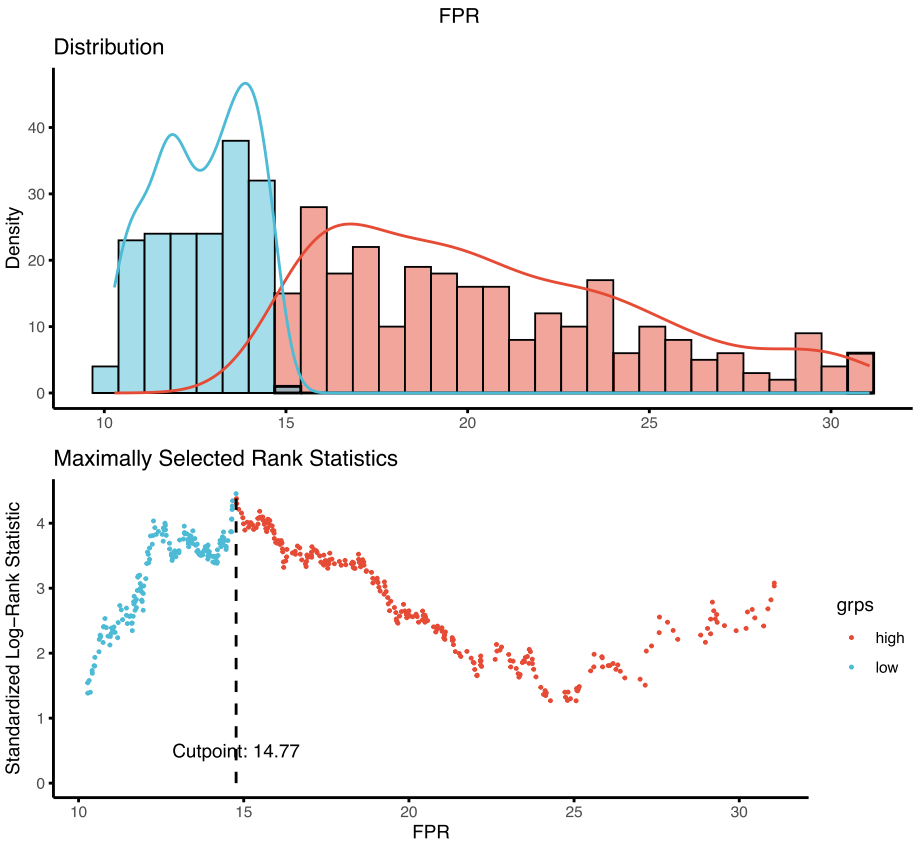

Fig. 1 The optimal cutoff point of fibrinogen-to-prealbumin ratio

Table 1 Characteristics of the 575 patients with PDAC

Characteristics	FPR High (N = 335)	FPR Low (N = 228)	*P* value
Age			0.240
< 65	214 (63.9%)	157 (68.9%)	
≥ 65	121 (36.1%)	71 (31.1%)	
Gender			0.863
Female	145 (43.3%)	101 (44.3%)	
Male	190 (56.7%)	127 (55.7%)	
CA199			0.161
< 100 (U/ml)	125 (37.3%)	99 (43.4%)	
≥ 100 (U/ml)	210 (62.7%)	129 (56.6%)	
CEA			0.706
< 5 (U/ml)	236 (70.4%)	164 (71.9%)	
≥ 5 (U/ml)	99 (29.6%)	64 (28.1%)	
pT stage			0.660
T1	38 (11.3%)	30 (13.2%)	
T2	212 (63.3%)	136 (59.6%)	
T3	85 (25.4%)	62 (27.2%)	
pN stage			0.035
N0	217 (64.8%)	171 (75.0%)	
N1-N2	118 (35.2%)	48 (25.0%)	
Location			< 0.001
Body/Tail	74 (22.1%)	104 (45.6%)	
Head	261 (77.9%)	124 (54.4%)	
Differentiation			0.033
Moderate	123 (36.7%)	101 (44.3%)	
Poor	162 (46.6%)	105 (46.1%)	
Well	57 (16.7%)	22 (9.6%)	
Extrapancreatic invasion			0.387
No	140 (41.8%)	104 (45.6%)	
Yes	195 (58.2%)	124 (54.4%)	
Lymphovascular invasion			0.592
No	271 (80.9%)	180 (78.9%)	
Yes	64 (19.1%)	48 (21.1%)	
Neural invasion			0.117
No	130 (38.8%)	104 (45.6%)	
Yes	205 (61.2%)	124 (54.4%)	
Adjuvant chemotherapy			0.262
No	126 (37.6%)	77 (33.8%)	
Gemcitabine-based	175 (52.2%)	118 (51.8)	
(m)-FOLFIRINOX	34 (10.1%)	33 (14.5%)	
Resectability status			0.581
Resectable	297 (88.7%)	206 (90.4%)	
Borderline resectable	38 (11.3%)	22 (9.6%)	
Preoperative NLR			< 0.001
< 1.80	88 (26.3%)	98 (43.0%)	
≥ 1.80	247 (73.7%)	130 (57.0%)	
Preoperative PLR			< 0.001
< 170.8	184 (54.9%)	180 (78.9%)	
≥ 170.8	151 (45.1%)	48 (21.1%)	

RFS: 9 months for the high FPR group vs. 16 months for the low FPR group, $p < 0.001$, Fig. 2C) and OS (median OS: 20 months for the high FPR group vs. 28 months for the low FPR group, $p < 0.001$, Fig. 2D). Further exploratory subgroup analyses elucidated that patients within the high FPR cohort consistently exhibited inferior RFS and OS compared to their low FPR counterparts across tumor stages pT1 to pT3 (Fig. 3A-3F, all $p < 0.05$). These findings underscore the pronounced prognostic significance of FPR within the PDAC patient population, highlighting its potential as a pivotal prognostic marker.

Univariate and multivariate cox regression analyses of FPR and other prognostic factors for RFS and OS

Optimal cutoff points for the NLR and PLR were established at 1.82 and 170.8, respectively, as illustrated in Supplemental Fig. 2. The subsequent univariate and multivariate Cox regression analyses, aimed at elucidating the prognostic implications of various clinical parameters for RFS and OS within the entire patient cohort, are delineated in Tables 2 and 3. The univariate analysis pertaining to RFS identified significant associations with several variables, including preoperative levels of CA19-9, CEA, NLR, and PLR, alongside tumor differentiation, pN stage, lymphovascular and extrapancreatic invasion, perineural invasion, resectability status, and the administration of adjuvant chemotherapy. Subsequent multivariate analysis refined these findings, pinpointing preoperative CA19-9 and CEA levels, NLR, FPR, tumor differentiation, lymphovascular invasion, resectability status, and adjuvant chemotherapy as independent prognostic indicators for RFS.

Similarly, the univariate analysis for OS established significant correlations with preoperative CA19-9 and CEA levels, NLR, PLR, FPR, tumor differentiation, pT stage, pN stage, lymphovascular and extrapancreatic invasion, resectability status, and the use of adjuvant chemotherapy. Further refinement through multivariate analysis highlighted preoperative CA19-9 levels, NLR, FPR, tumor differentiation, resectability status, and adjuvant chemotherapy as independent determinants of OS. Thus, the analyses conclusively demonstrate the FPR as an independent prognostic factor affecting both RFS and OS in patients undergoing resection for PDAC, underscoring its potential utility in the prognostic stratification and management of PDAC patients.

Evaluating the prognostic predictive efficacy of FPR relative to NLR

Within this study, the NLR, a conventional marker of inflammation, emerged as an independent prognostic variable influencing both RFS and OS. To ascertain the relative prognostic precision of the FPR vs NLR, we

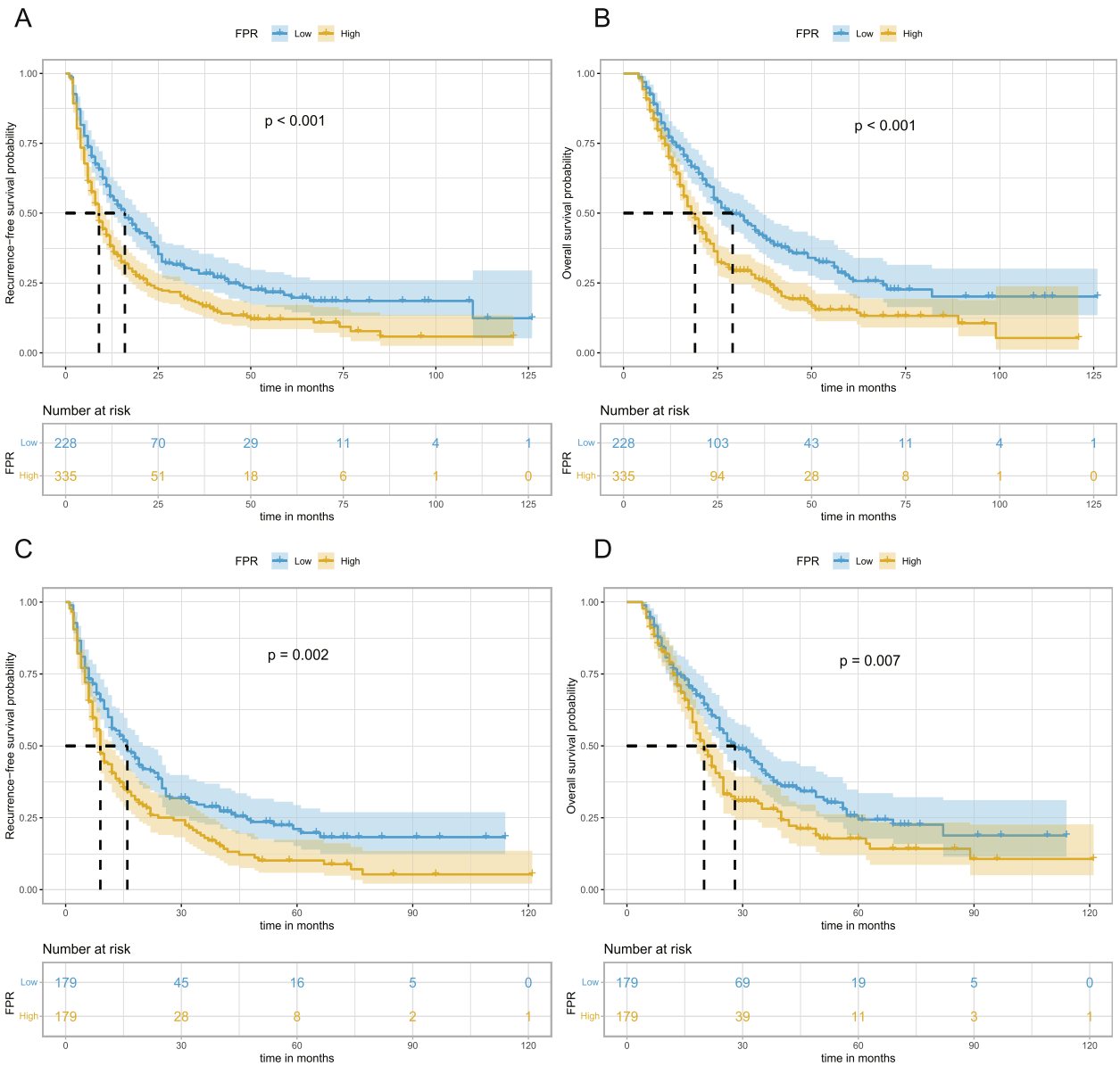

Fig. 2 The Kaplan–Meier curves of recurrence-free survival (**A**) and overall survival (**B**) according to preoperative level of fibrinogen-to-prealbumin ratio in the whole cohort before propensity score matching analysis; The Kaplan–Meier curves of recurrence-free survival (**C**) and overall survival (**D**) according to preoperative level of fibrinogen-to-prealbumin ratio in the whole cohort after propensity score matching analysis

employed time-dependent ROC curve analyses. These analyses illuminated that FPR consistently exhibited a superior area under the curve (AUC), indicative of enhanced predictive capability for 2-year RFS and 3-year OS, in comparison to NLR (Fig. 4A-B).

Subsequently, DCAs were conducted to meticulously assess and juxtapose the clinical applicability and advantages proffered by FPR and NLR. The DCAs revealed that, across a spectrum of risk thresholds, FPR conferred greater net benefits in terms of 2-year RFS and 3-year OS predictions relative to NLR (Fig. 4C-D), thereby underscoring the superior prognostic utility of FPR in the context of PDAC. Finally, we integrated NLR and FPR to stratify patients into four distinct groups. As depicted in the Supplementary Fig. 3A-B, patients characterized by elevated FPR and NLR demonstrated significantly shorter RFS and OS. This trend was followed by those with high FPR and low NLR, then individuals exhibiting high NLR and low PLR, with the group having low FPR and NLR showing the most favorable outcomes.

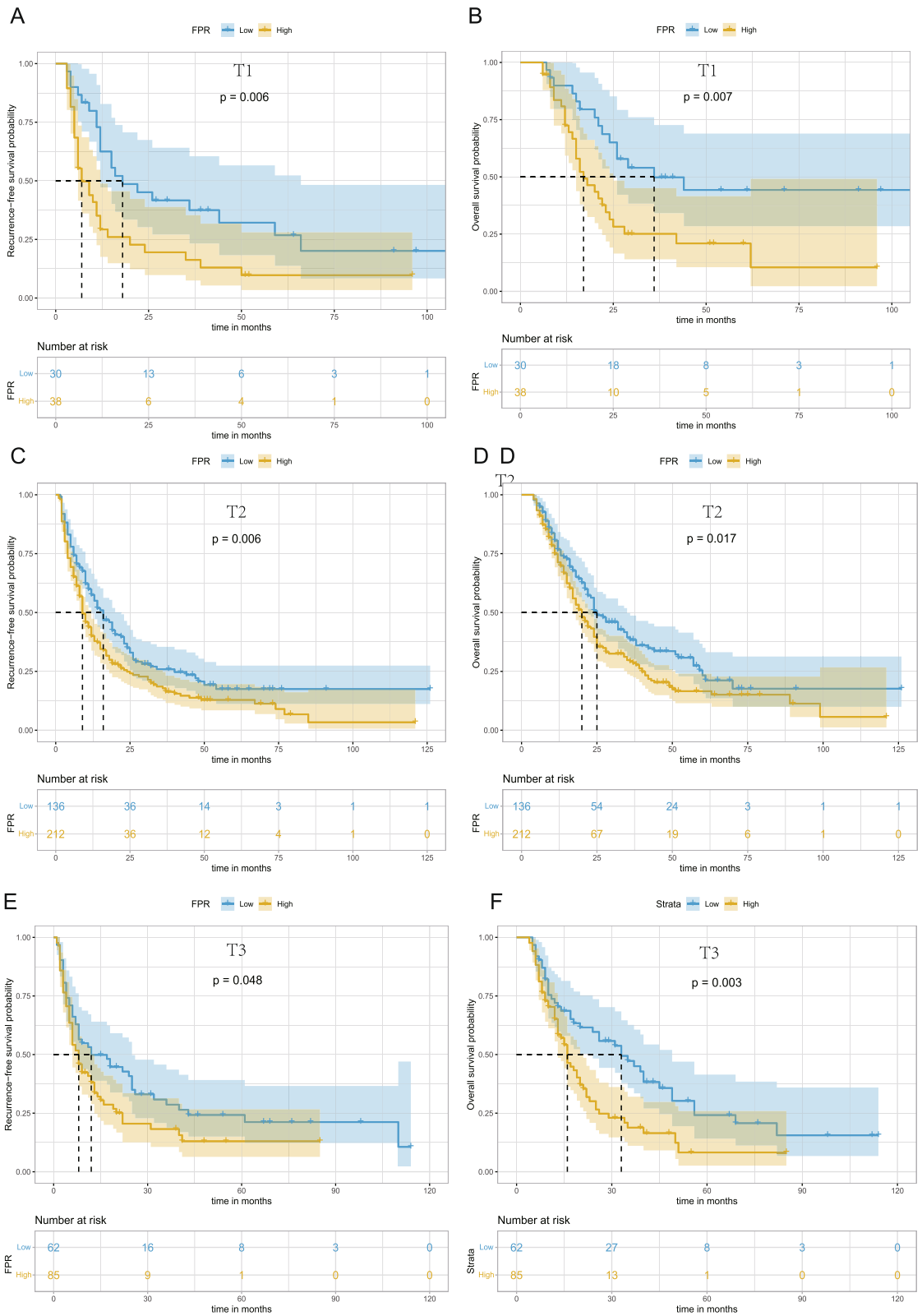

Fig. 3 The Kaplan–Meier curves of recurrence-free survival and overall survival according to preoperative level of fibrinogen-to-prealbumin ratio in pT1 stage (**A**-**B**), pT2 stage (**C**-**D**), and pT3 stage (**E**–**F**)

Table 2 Univariate and multivariate Cox regression of prognostic variables for recurrence-free survival in the cohort

Variables	Univariate COX		Multivariate COX	
	HR (95%CI)	*p* value	HR (95%CI)	*p* value
Age		0.449		
< 65	1 (reference)			
≥ 65	1.079 (0.886–1.315)			
Gender		0.439		
Female	1 (reference)			
Male	1.078 (0.891–1.304)			
Preoperative CA19-9		< 0.001		0.042
< 100U/mL	1 (reference)		1 (reference)	
≥ 100U/mL	1.507 (1.239–1.833)		1.229 (1.009–1.514)	
Preoperative CEA		< 0.001		0.012
< 5U/mL	1 (reference)		1 (reference)	
≥ 5U/mL	1.449 (1.180–1.780)		1.328 (1.064–1.657)	
Preoperative NLR		< 0.001		0.006
< 1.80	1 (reference)		1 (reference)	
≥ 1.80	1.588 (1.289–1.956)		1.387 (1.099–1.750)	
Preoperative PLR		0.001		0.493
< 170.8	1 (reference)		1 (reference)	
≥ 170.8	1.374 (1.133–1.668)		1.357 (0.869–1.338)	
Preoperative FPR		< 0.001		0.003
< 14.77	1 (reference)		1 (reference)	
≥ 14.77	1.532 (1.261–1.861)		1.355 (1.107–1.665)	
Location		0.753		
Head	1 (reference)			
Body or Tail	0.968 (0.783–1.187)			
Tumor differentiation		< 0.001		0.001
Well or Moderate	1 (reference)		1 (reference)	
Poor	1.439 (1.193–1.735)		1.366 (1.128–1.665)	
pT stage				
T1	1 (reference)			
T2	0.898 (0.831–1.492)	0.472		
T3	1.160 (0.838–1.605)	0.370		
pN stage		0.045		0.458
N0	1 (reference)		1 (reference)	
N1-N2	1.229 (1.004–1.504)		1.083 (0.877–1.339)	
Lymphovascular invasion		< 0.001		0.006
No	1 (reference)		1 (reference)	
Yes	1.502 (1.202–1.877)		1.389 (1.101–1.752)	
Extrapancreatic invasion		0.006		0.073
No	1 (reference)		1 (reference)	
Yes	1.306 (1.078–1.582)		1.198 (0.984–1.459)	
Perineural invasion		0.019		0.657
No	1 (reference)		1 (reference)	
Yes	1.260 (1.039–1.528)		1.048 (0.851–1.291)	
Resectability status		0.020		0.043
Resectable	1 (reference)		1 (reference)	
Borderline resectable	1.432 (1.058–1.939)		1.383 (1.011–1.892)	
Adjuvant chemotherapy				
No	1 (reference)		1 (reference)	
Gemcitabine-based	0.897 (0.723–0.958)	0.042	0.876 (0.712–0.966)	0.046
(m)-FOLFIRINOX	0.782 (0.562–0.863)	0.037	0.748 (0.538–0.898)	0.031

HR Hazard ratio, *CI* Confidence interval

Table 3 Univariate and multivariate Cox regression of prognostic variables for overall survival in the cohort

Variables	Univariate COX		Multivariate COX	
	HR (95%CI)	*p* value	HR (95%CI)	*p* value
Age		0.250		
< 65	1 (reference)			
≥ 65	1.130 (0.918–1.392)			
Gender		0.638		
Female	1 (reference)			
Male	1.049 (0.859–1.282)			
Preoperative CA19-9		0.003		0.002
< 100U/mL	1 (reference)		1 (reference)	
≥ 100U/mL	1.367 (1.113–1.678)		1.437 (1.137–1.819)	
Preoperative CEA		< 0.001		0.324
< 5U/mL	1 (reference)		1 (reference)	
≥ 5U/mL	1.486 (1.198–1.844)		1.191 (0.886–1.366)	
Preoperative NLR		< 0.001		0.068
< 1.80	1 (reference)		1 (reference)	
≥ 1.80	1.457 (1.170–1.815)		1.257 (0.983–1.607)	
Preoperative PLR		0.007		0.581
< 170.8	1 (reference)		1 (reference)	
≥ 170.8	1.320 (1.078–1.617)		1.067 (0.848–1.343)	
Preoperative FPR		< 0.001		< 0.001
< 14.77	1 (reference)		1 (reference)	
≥ 14.77	1.631 (1.326–2.007)		1.489 (1.196–1.854)	
Location		0.834		
Head	1 (reference)			
Body or Tail	0.977 (0.788–1.212)			
Tumor differentiation		0.002		0.013
Well or Moderate	1 (reference)		1 (reference)	
Poor	1.367 (1.122–1.666)		1.290 (1.056–1.577)	
pT stage				
T1	1 (reference)		1 (reference)	
T2	1.263 (0.913–1.748)	0.158	1.139 (0.818–1.586)	0.441
T3	1.451 (1.019–2.067)	0.039	1.291 (0.898–1.855)	0.167
pN stage		0.048		0.188
N0	1 (reference)		1 (reference)	
N1/N2	1.258 (1.002–1.453)		1.124 (0.931–1.298)	
Lymphovascular invasion		0.046		0.224
No	1 (reference)		1 (reference)	
Yes	1.329 (1.003–1.561)		1.164 (0.911–1.489)	
Extrapancreatic invasion		0.044		0.096
No	1 (reference)		1 (reference)	
Yes	1.232 (1.006–1.509)		1.194 (0.969- 1.472)	
Perineural invasion		0.156		
No	1 (reference)			
Yes	1.158 (0.946–1.417)			
Resectability status		0.001		0.004
Resectable	1 (reference)		1 (reference)	
Borderline resectable	1.661 (1.224–2.254)		1.589 (1.157–2.181)	
Adjuvant chemotherapy				
No	1 (reference)		1 (reference)	
Gemcitabine-based	0.693 (0.560–0.858)	< 0.001	0.671 (0.540–0.834)	< 0.001
(m)-FOLFIRINOX	0.591 (0.412–0.846)	0.004	0.539 (0.372–0.782)	0.001

HR Hazard ratio, *CI* Confidence interval

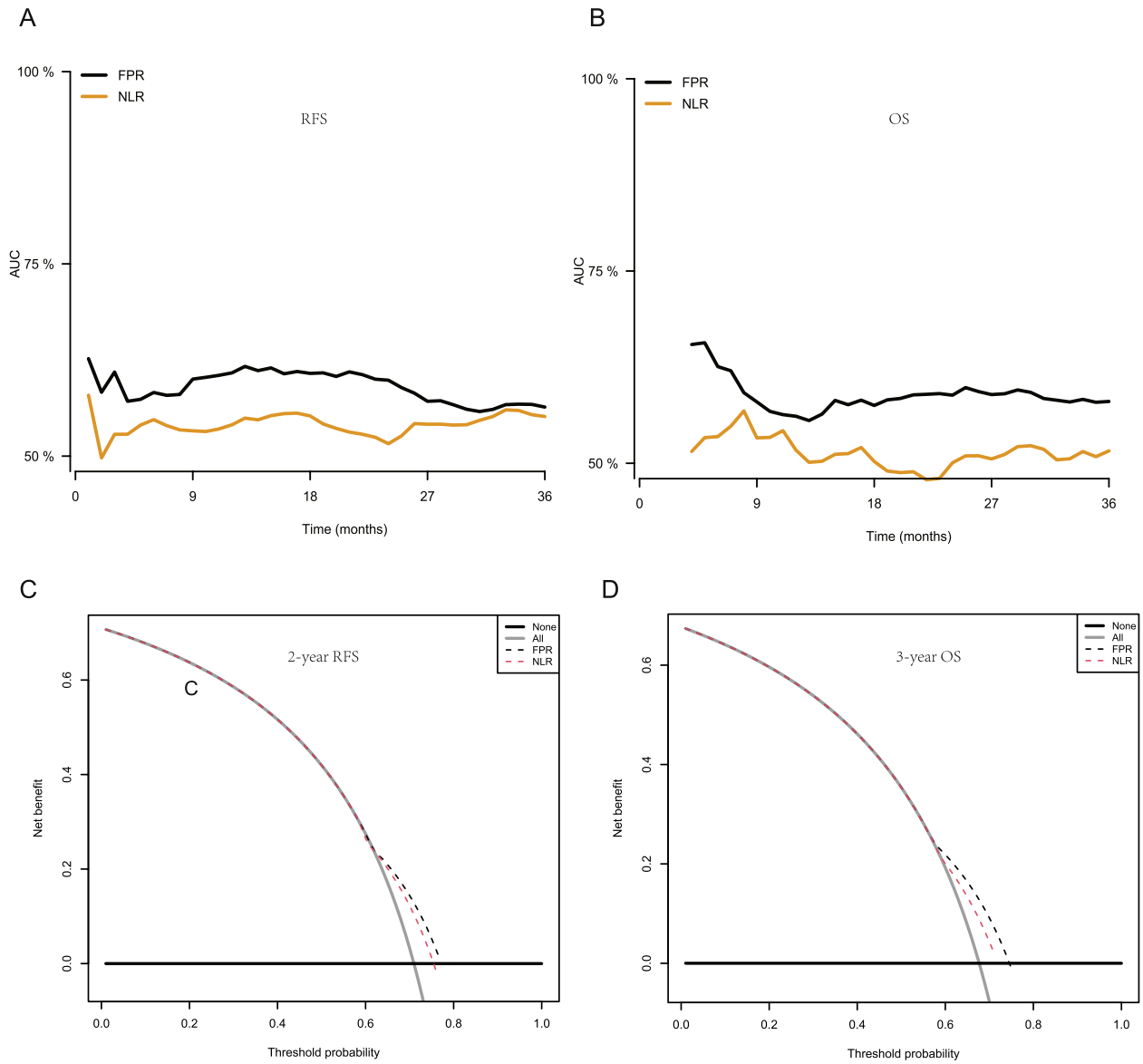

Fig. 4 **A-B** The time-dependent receiver operating characteristic curves of 2-year recurrence-free survival and 3-year overall survival for neutrophil-to-lymphocyte ratio and fibrinogen-to-prealbumin ratio. **C-D** The decision curve analysis of 2-year recurrence-free survival and 3-year overall survival for neutrophil-to-lymphocyte ratio and fibrinogen-to-prealbumin ratio

Discussion

In the context of pancreatic cancer treatment and prognostic evaluation, blood inflammation biomarkers play a pivotal role [15]. In our study, we focused on the preoperative peripheral blood FPR to assess its efficacy as a potential biomarker for predicting the survival after curative resection in PDAC patients. Fibrinogen, an acute-phase reactant protein found in plasma, is typically elevated in states of inflammation, tissue injury, and malignancy. Its role in tumor progression is primarily associated with angiogenesis, cellular proliferation, and the migration of tumor cells. Moreover, an increase in fibrinogen levels is closely linked to the inflammatory response within the tumor microenvironment, further facilitating tumor cell invasion and metastasis [10, 16, 17]. On the other hand, pre-albumin, an indicator of nutritional status, generally reflects the overall health condition of the patient. In cancer patients, pre-albumin levels are often reduced, correlating with malnutrition, tumor cachexia, and systemic inflammatory response. Therefore, a decrease in pre-albumin may indicate the systemic impact of the tumor and the potential risk of poor prognosis [18–20].

A previous study has shown that FPR is a viable biomarker for predicting OS in PDAC patients [21]. They

selected their cutoff value using the ROC curve, which is more appropriate for binary outcomes. Therefore, we utilized maximally selected rank statistics to determine our cutoff value. Furthermore, while their study focused solely on evaluating FPR's prognostic role in OS, we conducted an additional analysis on RFS and found that FPR can independently predict both OS and RFS.

Combining these two biomarkers, the FPR provides a composite index that reflects both the biological characteristics of the tumor and the systemic condition of the patient [22]. In our study, we found that higher FPR values were significantly associated with poorer RFS and OS post-curative resection in patients with PDAC, potentially due to elevated fibrinogen levels reflecting the aggressive nature and inflammatory state of the tumor, while reduced pre-albumin levels indicate poor nutritional and immunological status of the patient. Meanwhile, FPR existed larger AUC and better clinical benefits compared to traditional inflammation marker NLR. Thus, as a non-invasive and readily accessible biomarker, FPR holds potential clinical utility in the prognostic assessment of pancreatic cancer, potentially aiding in guiding personalized treatment decisions and patient management.

Further research exploring the association of FPR with other clinical parameters and biomarkers, such as pathological markers and NLR, as well as its applicability across different types and stages of pancreatic cancer, remains an important avenue. Due to the poorer prognosis and increased risk of relapse among patients with high FPR, frequent follow-up examinations are crucial. Before surgery, interventions aimed at optimizing the patient's nutritional status and managing their coagulation status can be implemented to reduce the FPR value. Subsequently, we can observe whether these interventions have an impact on improving the patient's prognosis. These patients with high FPR may benefit significantly from more effective postoperative adjuvant therapy, such as FOLFRINOX. Additionally, considering neoadjuvant therapy for high FPR patients could potentially enhance prognosis. As neoadjuvant therapy becomes more widespread in pancreatic cancer treatment, patient selection for this approach remains an area of ongoing research [23]. Given the significance of FPR as a prognostic indicator, future studies can delve into its role in guiding decisions on the initiation of neoadjuvant therapy, offering critical clinical insights. Additionally, understanding the underlying mechanisms between FPR and the biological characteristics of pancreatic cancer, such as the tumor microenvironment, inflammatory response, and immune modulation, will provide deeper insights into the therapeutic and prognostic evaluation of pancreatic cancer.

While providing valuable insights into the prognostic value of the FPR in pancreatic cancer, this study is subject to several limitations that merit consideration. Firstly, the retrospective nature of our study inherently introduces the risk of selection bias. Despite rigorous criteria for patient selection and data collection, retrospective analyses cannot fully account for all potential confounding factors, which might influence the outcomes. Another significant limitation is the heterogeneity in the units of measurement for FPR across different laboratories and studies. This variability in measurement standards poses challenges for comparing results directly and can potentially affect the reproducibility and generalizability of our findings. Establishing a standardized method for FPR measurement is essential for its adoption in clinical practice. Furthermore, the determination of the optimal cutoff value for FPR as a prognostic indicator in pancreatic cancer remains an area for further research. Our study utilized a specific cutoff value determined through statistical analysis. Nevertheless, it is important to note that this value might not be universally applicable across various populations and clinical settings. Therefore, future studies are warranted to validate and optimize the cutoff value for FPR, ensuring its relevance and applicability in diverse clinical scenarios.

Conclusion

In conclusion, the findings of our investigation delineate the prognostic significance of the FPR in forecasting survival metrics for individuals undergoing curative resections for pancreatic cancer. The findings suggest that a higher preoperative FPR is significantly associated with poorer postoperative survival, highlighting the interplay between inflammatory processes, nutritional status, and tumor biology in influencing patient prognosis. These results advocate for integrating FPR into the preoperative assessment to aid in identifying high-risk patients who may benefit from more tailored therapeutic strategies.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12957-024-03524-0.

Suplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Authors' contributions

Conception and Design: YPZ, SFC, YXL, SG. Acquisition, statistical analysis, interpretation: SFC, YPZ. Redaction: YPZ, SFC, YXL. All authors reviewed the manuscript and approved the final version.

Funding

None.

Availability of data and materials
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The study was reviewed and approved by the Medical Ethics Committee of the Tianjin Medical University Cancer Institute and Hospital (n: bc2023010). Informed consent was obtained from all participating patients.

Competing interests
The authors declare no competing interests.

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Received: 10 May 2024 Accepted: 1 September 2024
Published online: 28 October 2024

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