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ORIGINAL RESEARCH

The Fibrinogen-to-Albumin Ratio (FAR) Predicts Prognosis in Hepatocellular Carcinoma Patients After Liver Transplantation: Development and Validation of a Novel Nomogram

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Introduction: Hepatocellular carcinoma (HCC) is a common liver tumor. The fibrinogen-albumin ratio (FAR) combined inflammation and nutrition, may have value in the prognosis assessment of HCC patients undergoing liver transplantation.

Materials and Methods: A total of 239 patients were enrolled in the study and randomly divided into a training set and a validation set in a 7:3 ratio. The optimal cut-off value of FAR was determined by Maximally Selected Rank Statistics, and univariate and multivariate Cox regression analyses were conducted to evaluate the predictive value of FAR for overall survival (OS) and disease-free survival (DFS) in HCC patients after liver transplantation.

Results: FAR had a non-linear relationship with OS and DFS, with the optimal cut-off value being 0.0623. Patients in the high FAR group had significantly poorer prognosis ($P < 0.05$). Multivariate Cox regression analysis further demonstrated that microvascular invasion and FAR $\geq$ 0.0623 were independent risk factors for OS and DFS. The prognostic prediction model based on FAR and microvascular invasion had good predictive performance and clinical utility.

Conclusion: This preoperative FAR is an independent prognostic factor for OS and DFS in HCC patients undergoing liver transplantation. The Nomogram model based on FAR has good predictive performance.

Keywords: liver transplantation, hepatocellular carcinoma, fibrinogen-to-albumin ratio, prognosis, overall survival

Introduction

Hepatocellular carcinoma (HCC) ranks as the sixth most prevalent malignant tumor globally and stands as the fourth leading cause of cancer-related mortality,[1] with persistently high incidence and mortality rates. Currently, a variety of therapeutic approaches are available for early-stage HCC with preserved liver function, including partial hepatectomy[2] and radiofrequency ablation, among others. For HCC patients with end-stage liver disease and preserved liver function that does not meet the criteria for local treatment, liver transplantation is the only curative treatment modality. Nevertheless, the high recurrence rate of HCC post-liver transplantation poses significant challenges in clinical practice, particularly in patient pre-operative screening, post-operative recurrence monitoring, and prognostic evaluation. Consequently, identifying reliable biomarkers to accurately predict the prognosis of HCC patients holds substantial clinical significance.

In recent years, systemic inflammatory response has been regarded as one of the important characteristics of malignant tumors, and it is closely related to all stages of tumor occurrence and development.[3,4] Currently, various systemic inflammatory indicators - such as the neutrophil-to-lymphocyte ratio (NLR),[5] monocyte-to-lymphocyte ratio (MLR),[6] platelet-to-lymphocyte ratio (PLR),[7] and albumin-bilirubin score (ALBI)[8]- have been confirmed to be correlated

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with the prognosis of HCC. Fibrinogen, as an acute-phase reaction protein, significantly increases under inflammatory conditions,[9] and studies have shown that it can predict the prognosis of various cancers.[10,11] Compared with single inflammatory indicators such as NLR, MLR and PLR that only reflect the systemic inflammatory state, the ratio of fibrinogen to albumin (FAR) integrates integrates both inflammatory and nutritional status of the body, which can more comprehensively evaluate the host's tumor microenvironment and physical condition. NLR, MLR and PLR were not included in the present analysis because the study focused on exploring the prognostic value of the combined inflammatory-nutritional index FAR in HCC patients after liver transplantation.

Materials and Methods

Patient Selection

This study retrospectively collected patients who underwent allogeneic orthotopic liver transplantation at Beijing Chaoyang Hospital, Capital Medical University from April 2013 to July 2023 and whose postoperative pathological diagnosis was HCC.

Inclusion criteria were: (1) Pathological diagnosis of primary HCC; (2) No other malignancies or distant metastases; (3) Complete follow-up data; (4) Complete clinical and pathological records; (5) Complete hematological test results within one week before the surgery.

Exclusion criteria were: (1) Complicated with other malignancies or metastasis; (2) Death during the perioperative period; (3) Missing key clinical data (such as hematological indicators). After screening, a total of 239 patients were included in the final analysis.

Data Collection and Follow-Up

This study retrieved the list of patients who underwent allogeneic orthotopic liver transplantation due to HCC from the hospital information system. The system collected the preoperative hematological examinations, imaging data, and postoperative pathological data of the patients. The collected variables covered the following categories: demographic characteristics (gender, age); laboratory indicators (alpha-fetoprotein, preoperative blood cell counts including white blood cells, lymphocytes, monocytes, neutrophils, and platelet counts, as well as preoperative biochemical indicators such as albumin, globulin, and fibrinogen); pathological characteristics (T stage, N stage, TNM stage, number of intrahepatic tumors, maximum tumor diameter, total tumor diameter, gross tumor morphology, histological type, tumor differentiation degree, major vessel invasion and microvascular invasion(MVI)); clinical criteria compliance (Milan criteria, Hangzhou criteria); and follow-up information (survival outcome, total survival time, recurrence time). For the missing data in clinical and laboratory variables, this study employed the complete case analysis method, excluding patients with missing key variables (including survival outcome and survival time).

Fibrinogen-to-albumin ratio (FAR) was calculated as the ratio of plasma fibrinogen concentration (g/L) to serum albumin concentration (g/L).

All transplant recipients received close follow-up at the outpatient clinic. The follow-up period ranged from 4 to 134 months, with a median follow-up time of 53 months. The postoperative follow-up schedule was as follows: in the first 6 months after surgery, follow-up was conducted once a month; during the period from 6 months to 2 years after surgery, follow-up was conducted every 3 to 6 months; after 2 years or more after surgery, follow-up was conducted every 2 years. During the follow-up process, enhanced abdominal CT or enhanced MRI examinations were routinely performed every 6 months. If local recurrence or distant metastasis was suspected, targeted imaging examinations were further conducted, including CT, MRI, bone scan or PET-CT, etc. The overall survival period was defined as the time from the date of liver transplantation surgery to the patient's death or the last follow-up. The disease-free survival period was defined as the time from the date of liver transplantation surgery to tumor recurrence.

Statistical Analysis

This study employed R 4.4.2 software for statistical analysis. The patients were randomly divided into a training set and a validation set in a 7:3 ratio. Quantitative data that followed a normal distribution were expressed as mean ± standard deviation, and comparisons between groups were conducted using the independent sample *t*-test; non-normal distribution quantitative data were expressed as median (interquartile range), and comparisons between groups were performed using the Kruskal–Wallis test; categorical variables were presented as frequency and percentage, and comparisons between groups were conducted using the chi-square test, with Bonferroni correction for multiple comparisons. Restricted cubic spline analysis was used to examine the correlation between fibrinogen and albumin ratio and prognosis, and the maximum selection rank statistic was used to determine the optimal cutoff value. Survival analysis was performed using the Kaplan-Meier method, and comparisons between groups were conducted using the Log rank test; univariate and multivariate Cox proportional hazards regression models were used to analyze the prognostic factors, and the consistency index was calculated. Time-dependent ROC curves were drawn to evaluate the model's predictive performance, and calibration curves were used to test the consistency between predicted survival rates and actual survival rates, and decision curve analysis was used to assess the clinical utility of the nomogram model. A difference was considered statistically significant if $P < 0.05$.

Results

The Baseline Characteristics of the Patient

The median follow-up time for all patients was 53 months. In terms of baseline characteristics, the vast majority (92.05%) were male, and 43.93% of the patients were older than 55 years. Hepatitis B history was the main cause (90.38%). TNM stage III patients accounted for 21.34%, the incidence of microvascular invasion was 54.81%, and the proportion of portal vein cancer thrombus was relatively low (10.04%). All patients were randomly divided into a training set (n=168) and a validation set (n=71) in a 7:3 ratio. There were no significant differences in baseline characteristics between the two groups, and they were highly comparable (Table 1).

Table 1 Patient Demographics and Baseline Characteristics

Variables	Overall (n = 239)	Training Cohort (n = 168)	Valid Cohort (n=71)	p-value
Gender (Male/Female)	220/19	157/11	63/8	0.332
TNM stages (III/I–II)	51/188	36/132	15/56	0.999
Age, years (>55/≤55)	105/134	70/98	35/36	0.346
Positive HBsAg (+/−)	216/23	153/15	63/8	0.749
MVI (Yes/No)	131/108	96/72	35/36	0.331
Tumor number (Multiple/Single)	129/110	86/82	43/28	0.235
Maximum tumor size, cm (>5/≤5)	62/177	43/125	19/52	0.979
Total tumor size, cm (>8/≤8)	48/191	35/133	13/58	0.788
Differentiation (Poor, undifferentiated/ Well, moderate)	184/55	133/35	51/20	0.288
AFP, ng/mL (>400/≤400)	80/159	54/114	26/45	0.603
PVTT (+/−)	24/215	18/150	6/65	0.767
Milan criteria (Yes/No)	111/128	73/95	38/33	0.199
Hangzhou criteria (Yes/No)	193/46	133/35	60/11	0.437
Re-treatment				
Resection		1 (0.60%)	4 (5.63%)	
Resection+RFA		1 (0.60%)	0 (0.00%)	
Resection+TACE		3 (1.79%)	0 (0.00%)	
RFA		6 (3.57%)	9 (12.7%)	
TACE		38 (22.6%)	14 (19.7%)	
TACE+RFA		18 (10.7%)	4 (5.63%)	
TACE+RFA+sorafenib		1 (0.60%)	0 (0.00%)	
FAR		0.06 (0.03)	0.06 (0.03)	0.728

Determination of the Optimal Cut-off Value for FAR

To further explore the relationship between the fibrinogen-albumin ratio (FAR) and the prognosis of patients, this study employed restricted cubic spline (RCS) for analysis. The results showed that there was a non-linear association between FAR and overall survival (Figure 1A) and disease-free survival (Figure 1B). Maximally Selected Rank Statistics was applied with the R package "maxstat", and the optimal cutoff value was determined by maximizing the Log rank test statistic for overall survival and disease-free survival, with the significance level set at $P < 0.05$. A total of 1000 permutation tests were used to verify the robustness of the cutoff value, and the final optimal FAR cutoff value was determined to be 0.0623. Accordingly, patients were divided into the high FAR group and the low FAR group (Figure 2A). In the training set and validation set, the prognosis of patients in the high FAR group was significantly worse than that in the low FAR group ($P < 0.05$, Figure 2B–E).

Univariate and Multivariate Cox Regression Analysis

To further evaluate the predictive value of the fibrinogen-albumin ratio (FAR) for prognosis, this study included binary FAR and other clinical pathological features in the COX regression analysis (Tables 2 and 3). The univariate analysis showed that TNM stage, microvascular invasion, maximum tumor diameter in the liver, number of tumors in the liver, tumor differentiation degree, portal vein tumor thrombus, total tumor diameter, and FAR were significantly associated with the overall survival of patients (all $P < 0.05$); while TNM stage, microvascular invasion, maximum tumor diameter in the liver, number of tumors in the liver, history of hepatitis B, portal vein tumor thrombus, total tumor diameter, and FAR were also significantly associated with disease-free survival (all $P < 0.05$). Multivariate COX regression analysis further indicated that microvascular invasion and FAR ≥ 0.0623 were independent risk factors for both overall survival (OS: MVI HR=2.809, 95% CI:1.333–5.922, P=0.006; FAR $\geq$0.0623 HR=1.972, 95% CI:1.065–3.652, P=0.031) and disease-free survival (DFS: MVI HR=2.892, 95% CI:1.421–5.885, P=0.003; FAR $\geq$0.0623 HR=2.176, 95% CI:1.196–3.960, P=0.011).

Construction and Evaluation of Nomogram Charts

Based on the two independent risk factors (FAR and microvascular invasion) identified by the multivariate Cox analysis, this study constructed a nomogram model for predicting the 1-year, 3-year and 5-year overall survival (OS) and disease-free survival (DFS) of patients with HCC after liver transplantation (Figure 3). In the training cohort, the 1 to 5-year time-dependent AUC values of this model for predicting OS were 0.78, 0.755, 0.741, 0.766 and 0.791, respectively; the corresponding AUC values for predicting DFS were 0.735, 0.729, 0.769, 0.798 and 0.792. In the validation cohort, the AUC values for predicting OS were 0.696, 0.709, 0.702, 0.755 and 0.746, respectively; the AUC values for predicting DFS

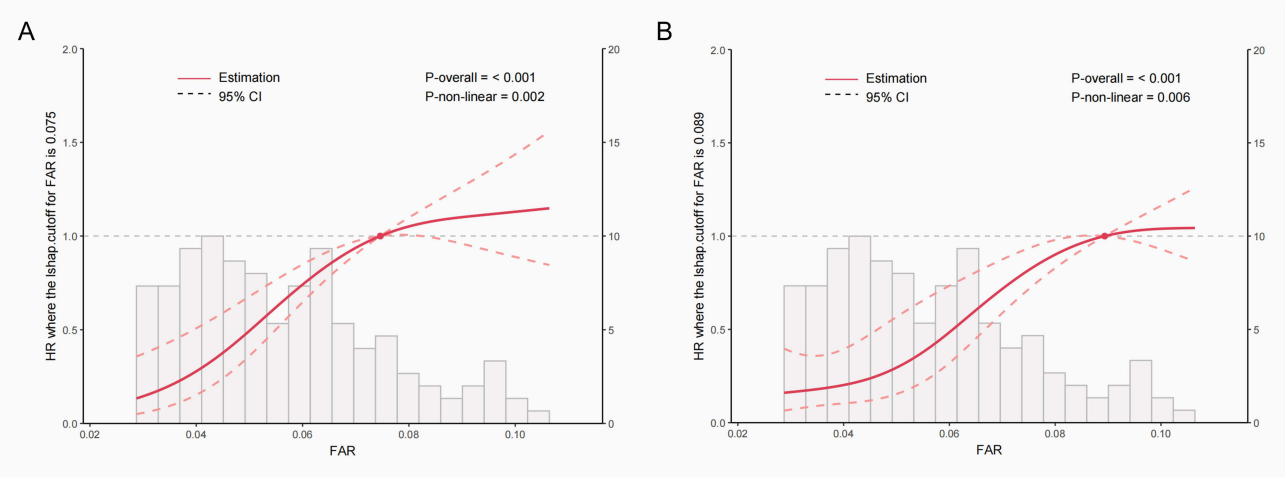

Figure 1 RCS of FAR for OS and DFS. (**A**): RCS for OS; (**B**): RCS for DFS.

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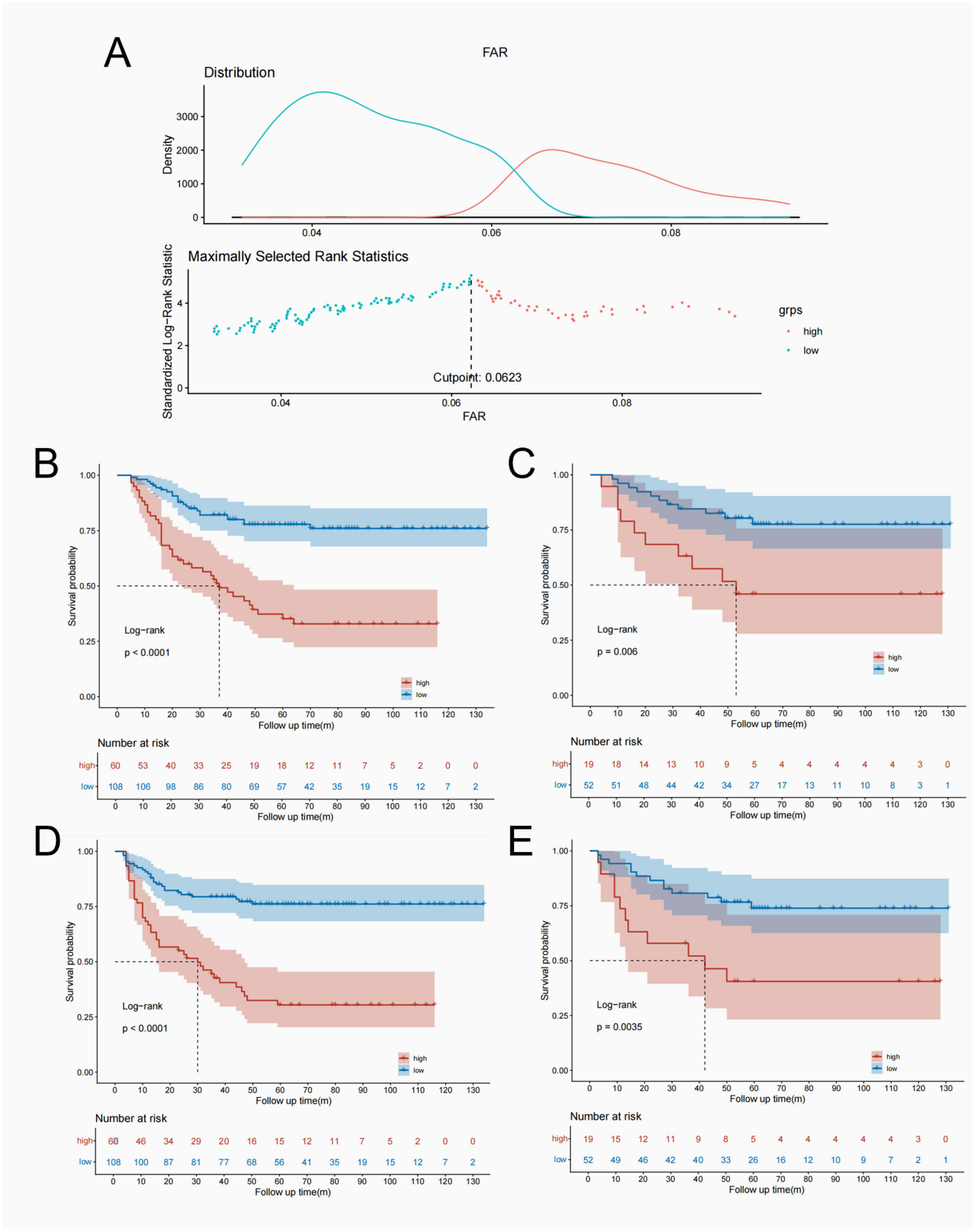

Figure 2 Selection of the optimal FAR cutoff value: (**A**) The optimal FAR cutoff value was determined as 0.0623 using Maximally Selected Rank Statistics. (**B**) The difference in OS between the high-FAR group and the low-FAR group in the training set. (**C**) The difference in OS between the high-FAR group and the low-FAR group in the validation set. (**D**) The difference in DFS between the high-FAR group and the low-FAR group in the training set. (**E**) The difference in DFS between the high-FAR group and the low-FAR group in the validation set.

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Table 2 Univariate and Multivariate Cox Analyses of Baseline Characteristics and FAR on Overall Survival in Patients with Hepatocellular Carcinoma Undergoing Liver Transplantation

Variables	Univariate Analysis			Multivariate Analysis		
	HR	95% CI	p-value	HR	95% CI	p-value
Age, years (≤55 vs >55)	1.344	0.798–2.261	0.266			
TNM stage (III vs I+II)	3.395	2.04–5.649	<0.001*	1.271	0.644–2.508	0.489
MVI (Yes vs No)	5.035	2.557–9.918	<0.001*	2.809	1.333–5.922	0.006*
AFP, ng/mL (≤400 vs >400)	1.241	0.717–2.148	0.44			
Maximum tumor size, cm (≤5 vs >5)	0.316	0.191–0.524	<0.001*	0.692	0.272–1.762	0.441
Tumor number (Single vs Multiple)	0.505	0.3–0.85	0.01*	0.703	0.341–1.588	0.339
Gender (Male vs Female)	2.772	0.677–11.35	0.156			
Differentiation (Well, moderate vs Poor, undifferentiated)	0.463	0.22–0.973	0.042*	0.721	0.327–1.588	0.417
Positive HBsAg (+ vs −)	6.877	0.953–49.621	0.056			
PVTT (+ vs −)	2.315	1.205–4.448	0.012*	1.268	0.615–2.614	0.520
Total tumor size, cm (≤8 vs >8)	0.274	0.164–0.459	<0.001*	0.725	0.312–1.688	0.456
FAR grade (≥0.0623 vs <0.0623)	3.915	2.344–6.541	<0.001*	1.972	1.065–3.652	0.031*

Note: *P < 0.05 was considered statistically significant.

Table 3 Univariate and Multivariate Cox Analyses of Baseline Characteristics and FAR on Disease Free Survival in Patients with Hepatocellular Carcinoma Undergoing Liver Transplantation

Variables	Univariate Analysis			Multivariate Analysis		
	HR	95% CI	p-value	HR	95% CI	p-value
Age, years (≤55 vs >55)	1.344	0.756–2.072	0.383			
TNM stage (III vs I+II)	3.395	2.011–5.453	<0.001*	1.244	0.651–2.377	0.508
MVI (Yes vs No)	5.035	2.554–9.366	<0.001*	2.892	1.421–5.885	0.003*
AFP, ng/mL (≤400 vs >400)	1.241	0.660–1.893	0.679			
Maximum tumor size, cm (≤5 vs >5)	0.316	0.207–0.560	<0.001*	0.933	0.377–2.312	0.881
Tumor number (Single vs Multiple)	0.505	0.305–0.845	0.009*	0.818	0.406–1.650	0.575
Gender (Male vs Female)	2.772	0.679–11.352	0.155			
Differentiation (Well, moderate vs Poor, undifferentiated)	0.463	0.254–1.038	0.063			
Positive HBsAg (+ vs −)	6.877	1.033–53.699	0.046*	4.504	0.614–33.051	0.139
PVTT (+ vs −)	2.315	1.296–4.558	0.006*	1.328	0.662–2.665	0.424
Total tumor size, cm (≤8 vs >8)	0.274	0.165–0.452	<0.001*	0.603	0.262–1.391	0.236
FAR grade (≥0.0623 vs <0.0623)	3.933	2.378–6.504	<0.001*	2.176	1.196–3.960	0.011*

Note: *P < 0.05 was considered statistically significant.

were 0.734, 0.724, 0.723, 0.724 and 0.713 (Figure 4). The calibration curve showed that the model's predicted survival rates were highly consistent with the actual observed values, reflecting a good calibration ability (Figures S1 and S2). Additionally, the decision curve analysis (DCA) indicated that the model had significant clinical net benefits in predicting the 1-year, 3-year and 5-year survival probabilities, demonstrating superior clinical practicability (Figures S3 and S4).

Subgroup Analysis

To deeply explore the interaction between the fibrinogen-albumin ratio (FAR) and other clinical factors, this study conducted subgroup analyses on key clinical variables. Figure S5 presents the subgroup analysis results of FAR and overall survival (OS): In most subgroups such as age, microvascular infiltration, alpha-fetoprotein level, number of tumors, Milan criteria, and Hangzhou criteria, FAR still demonstrated stable prognostic predictive value. However, no significant association was observed between FAR and OS in TNM stage III, well-differentiated tumors, or female patients. Figure S6 further presents the subgroup analysis results of FAR and disease-free survival (DFS): In most subgroups, FAR also exhibited good predictive

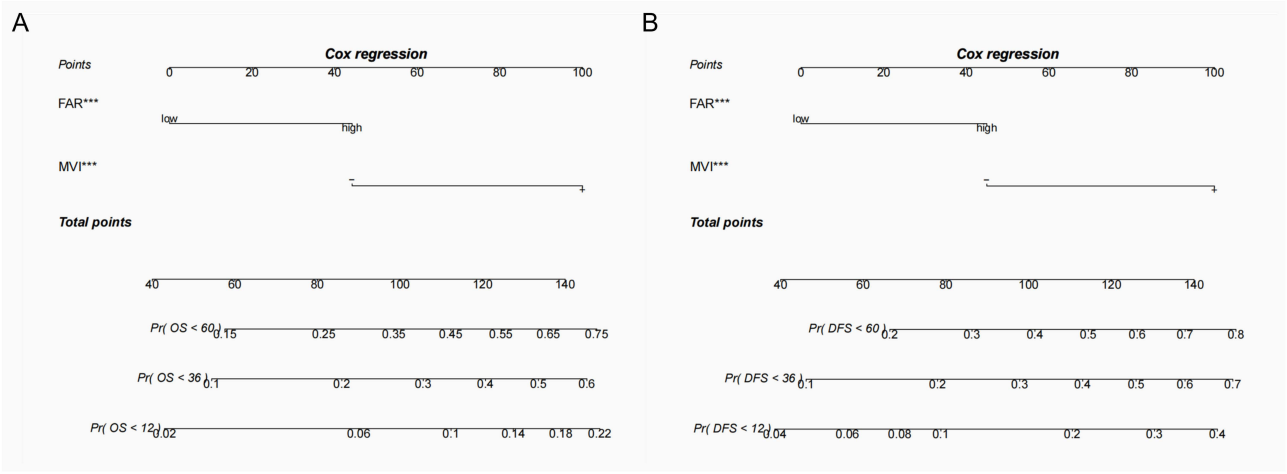

Figure 3 Nomogram for OS (Overall Survival) of liver cancer patients after liver transplantation (**A**) and nomogram for DFS (Disease-Free Survival) (**B**). Statistical significance was defined as ***p < 0.001.

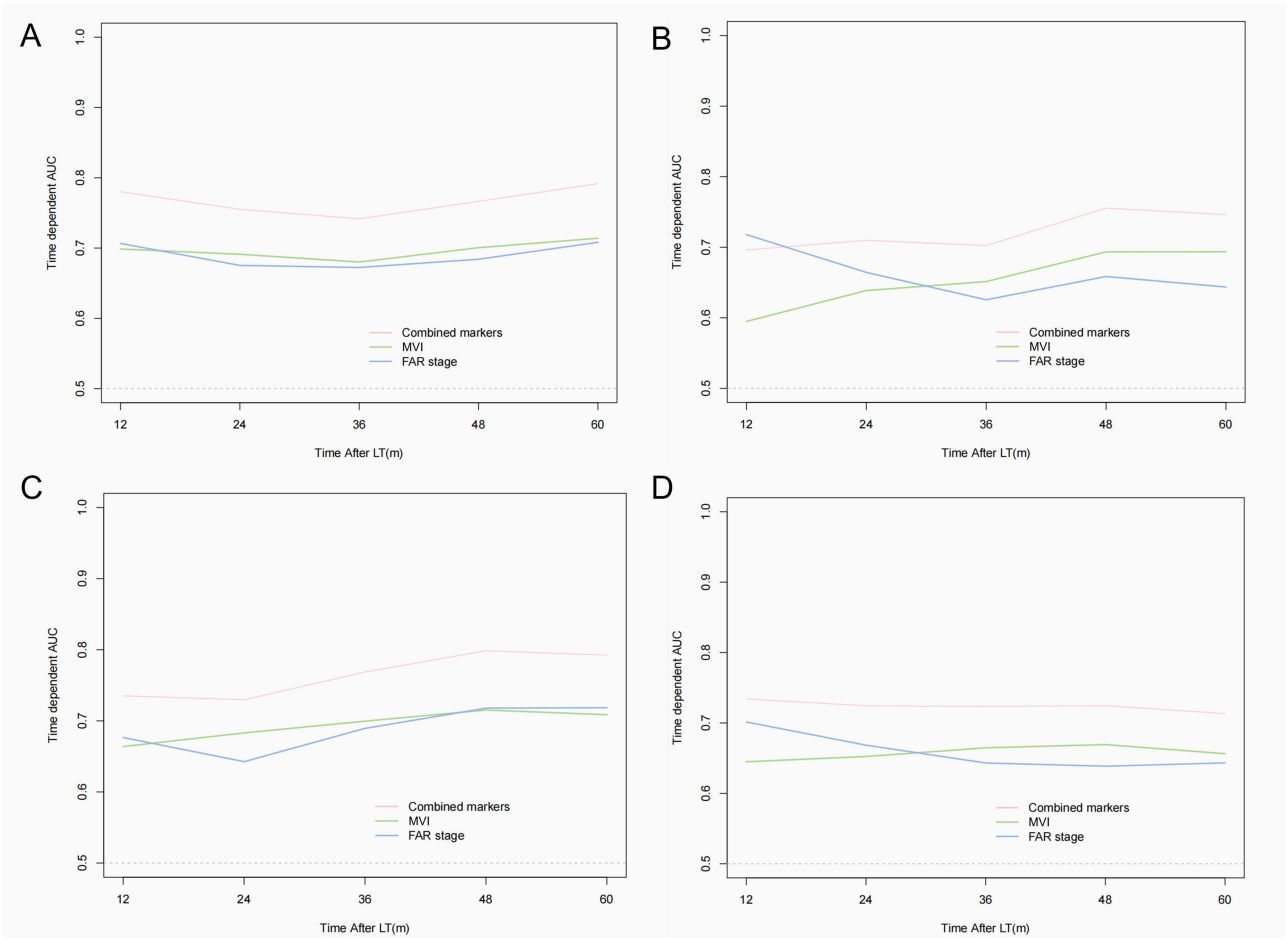

Figure 4 The time-dependent ROC curves of the prediction models for OS and DFS, (**A**) OS of the training set; (**B**) OS of the validation set; (**C**) DFS of the training set; (**D**) DFS of the validation set.

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performance; however, in specific subgroups such as TNM stage III, well-differentiated tumors, exceeding the Hangzhou criteria, or female patients, there was no significant correlation between FAR and DFS.

Discussion

This single-center retrospective study evaluated the prognostic value of the preoperative fibrinogen-to-albumin ratio (FAR) in patients with HCC undergoing liver transplantation and developed a combined nomogram incorporating microvascular invasion (MVI). A non-linear relationship was identified between FAR and both overall survival (OS) and disease-free survival (DFS), with an optimal statistical cutoff of 0.0623. Postoperative prognosis was significantly worse for patients in the high FAR group (≥0.0623), and multivariate Cox regression confirmed FAR ≥0.0623 and MVI as independent risk factors for OS and DFS. The nomogram constructed from these two variables demonstrated good predictive performance in the training and validation cohorts, offering a practical tool for prognostic assessment after liver transplantation.

Previous studies have confirmed the prognostic value of the FAR in HCC patients undergoing curative hepatectomy, consistently linking higher FAR levels with poor postoperative outcomes and increased recurrence risk.[12] Our study extends this finding to the HCC population undergoing liver transplantation, further supporting the FAR's broader utility as a combined inflammatory and nutritional biomarker for prognostic assessment. In clinical practice, conventional selection criteria such as the Milan[13] and Hangzhou[14] standards primarily focus on tumor morphology including size and number while offering limited evaluation of a patient's systemic condition. Our subgroup analysis demonstrated that the FAR retained stable prognostic predictive value across most subgroups stratified by these conventional criteria and key pathological features, such as portal vein tumor thrombus,[15] MVI status,[16] tumor number[17] and AFP level. Even among HCC patients meeting the Milan or Hangzhou criteria, a high FAR level signaled a significantly elevated risk of poor prognosis, indicating that the FAR could usefully supplement the existing liver transplantation selection framework. However, the FAR did not show a significant prognostic correlation in certain subgroups, including those with TNM stage III disease, well-differentiated tumors, or female patients, which may be due to the limited sample sizes within these categories in our cohort. Additionally, estrogen levels in female patients can regulate hepatic fibrinogen synthesis and expression,[18] potentially altering the relationship between the FAR and tumor prognosis—a hypothesis that requires validation in larger future studies.

Fibrinogen, a key acute-phase protein, and albumin, a core indicator of nutritional and inflammatory status, are both closely linked to the occurrence, progression, and metastasis of HCC; their ratio comprehensively reflects the imbalance between systemic inflammation, nutritional status, and coagulation function in these patients. In the chronic inflammatory state associated with HCC, fibrinogen levels rise significantly and can promote tumor stromal angiogenesis through interactions with platelets, vascular endothelial growth factor (VEGF), and transforming growth factor-β (TGF-β), thereby enhancing the invasive and metastatic potential of HCC cells.[19] Numerous clinical studies have established that elevated serum fibrinogen is an independent poor prognostic factor for various malignancies, including HCC,[20] gastric cancer,[21] and colorectal cancer,[22] a finding consistent with our results. Conversely, albumin synthesis is suppressed in chronic liver disease and HCC, so low albumin levels reflect both poor nutritional status and the overactivation of systemic inflammatory responses within the tumor microenvironment. Albumin itself can inhibit HCC progression by modulating alpha-fetoprotein expression and suppressing the release of inflammatory cytokines such as TNF-α and IL-6.[23] Consequently, an elevated FAR in HCC patients arises from the mutual reinforcement of chronic liver inflammation and tumor development: chronic inflammation drives increased fibrinogen and decreased albumin,[24] and this FAR imbalance further exacerbates the tumor microenvironment to promote progression and metastasis. This pathological mechanism explains why the FAR serves as an effective prognostic biomarker for HCC transplant recipients.

From a clinical perspective, FAR integrates readily into the preoperative evaluation workflow for liver transplantation in HCC patients as a low-cost, rapid, and easily accessible blood test, complementing existing risk scores and pathological indicators to form a comprehensive prognostic system. For HCC patients meeting conventional transplantation criteria but with a high FAR (≥0.0623), clinicians may classify them as high-risk for postoperative recurrence and devise individualized intensive follow-up and adjuvant treatment plans, such as regular dynamic monitoring of tumor

markers and imaging alongside appropriate anti-inflammatory or nutritional support. When FAR values are near the cutoff of 0.0623 (eg, 0.055–0.07), risk stratification should not rely on a single measurement but instead incorporate a comprehensive assessment of the patient's systemic status using nutritional indicators (eg, prealbumin, body mass index), inflammatory markers (eg, C-reactive protein, white blood cell count), and pathological features (eg, MVI, tumor differentiation). Perioperative factors—including surgical trauma, post-transplant liver function variability, and immunosuppressive therapy—also influence FAR dynamics: surgical trauma can temporarily elevate fibrinogen and depress albumin, causing a short-term FAR increase; the recovery of graft synthetic function lowers FAR by increasing albumin; and immunosuppressants (eg, tacrolimus, mycophenolate mofetil) may suppress systemic inflammation, thereby reducing fibrinogen and modulating FAR. These factors must be fully considered in the clinical interpretation of FAR results.

This study has several limitations. First, as a single-center retrospective investigation, the cohort consisted predominantly of male patients with HBV-related HCC, and this lack of demographic diversity may limit the generalizability of the findings. The applicability of the FAR to female patients or to populations with alcoholic or non-alcoholic fatty liver disease-related HCC requires validation through multi-center studies. Second, only a single preoperative FAR measurement was analyzed, without monitoring its dynamic changes throughout the perioperative period, including at one week, one month, and three months postoperatively. Tracking such dynamics could more accurately reflect shifts in a patient's inflammatory and nutritional status following transplantation and might possess greater prognostic value than a solitary preoperative value. Third, the study lacked data on several key clinical indicators, such as C-reactive protein and interleukin-6, whose integration with the FAR could potentially enhance prognostic accuracy. Fourth, the optimal FAR cutoff value of 0.0623 was derived from this study's internal data and has not been validated in external independent cohorts; therefore, threshold calibration may be necessary when applying it to different populations or clinical settings.

Despite these limitations, our study establishes the preoperative FAR as an independent prognostic factor for HCC patients following liver transplantation; the constructed nomogram demonstrates robust predictive performance and clinical utility. In practice, the FAR can serve as an auxiliary metric for preoperative risk assessment and postoperative prognosis evaluation in HCC transplant recipients, complementing conventional screening criteria and pathological indicators to enable more comprehensive, individualized risk stratification. Future research should prioritize multi-center, prospective cohort studies to validate the prognostic value and optimal cutoff of the FAR in larger, more diverse populations. Subsequent work should also explore the dynamic monitoring of perioperative FAR levels and their correlation with postoperative outcomes. Further analysis should investigate the combined prognostic value of the FAR with other inflammatory, nutritional, and molecular biomarkers to refine the prognostic evaluation system for HCC patients after liver transplantation and provide a more precise foundation for clinical decision-making.

Conclusions

In conclusion, this study has confirmed that the preoperative fibrinogen-albumin ratio (FAR) is an independent prognostic factor for the overall survival and disease-free survival of patients with HCC after liver transplantation. The nomogram model constructed based on FAR has good predictive efficacy and is expected to be used as an auxiliary tool in clinical practice for preoperative risk assessment and postoperative prognosis judgment of patients.

Institutional Review Board Statement

The study was approved by the Institutional Review Board of Beijing chaoyang hospital in accordance with the 1964 Helsinki Declaration and its later amendments (No. 2020-D-303). All donor livers used in this study were from voluntary deceased donors with written informed consent signed by their legal representatives, and the organ donation and transplantation procedures were strictly conducted in accordance with the Declaration of Istanbul. All patient medical record data involved in this study were strictly confidential in accordance with the relevant medical privacy regulations, and no personal identifying information was disclosed in the research process and manuscript writing.

Data Sharing Statement

The datasets used and analyzed during the current study are available from the corresponding authors (Jun Ma, majun8523@126.com; Zhili Ji, anzhenjzl@mail.ccmu.edu.cn) on reasonable request.

Informed Consent Statement

This study is a retrospective study. It has been approved by the Ethics Committee of Beijing Chaoyang Hospital, and the requirement for patients to sign an informed consent form has been waived.(No. 2020-D-303).

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflict of interest.

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