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RESEARCH ARTICLE

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The predictive value of fibrinogen-to-albumin ratio in the active, severe active, and poor prognosis of systemic lupus erythematosus: A single-center retrospective study

Lu-lu Dai[1] | Cheng Chen[1] | Jie Wu[1] | Jin-feng Cheng[2] | Feng He[2]

[1]Department of Laboratory, Funan County People's Hospital, Fuyang, China

[2]Department of Laboratory and Blood Transfusion, Zhuzhou Hospital Affiliated to Xiangya Medical College of Central South University, Zhuzhou, China

Correspondence
Feng He, Department of Laboratory and Blood Transfusion, Zhuzhou Hospital Affiliated to Xiangya Medical College of Central South University, Zhuzhou 410007, China.
Email: hefeng207@126.com

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Abstract

Objective: To evaluate the prediction and effect of fibrinogen-to-albumin ratio (FAR) on active, severe active, and poor prognosis of systemic lupus erythematosus (SLE).

Methods: One hundred and sixty-eight patients with SLE who were treated in our hospital were enrolled, the clinical data, laboratory indexes, and disease prognosis of all patients were collected and analyzed.

Results: Triglyceride (TG), FAR, ESR, and anti-dsDNA (+) were the influencing factors, while complement 3 (C3) was the protective factor of active SLE, the odds ratio (OR) values were 2.968, 3.698, 2.114, 2.727, and 0.652, respectively ($p < 0.05$). FAR, ESR, and anti-dsDNA (+) were the influencing factors, while C3 was the protective factor of severe active SLE, the OR values were 3.791, 1.953, 2.187, and 0.742, respectively ($p < 0.05$). SLE disease activity index (SLEDAI), TG, FAR, and anti-dsDNA (+) were the influencing factors, while C3 was the protective factor of poor prognosis SLE, the OR values were 3.024, 2.293, 3.012, 2.323, and 0.801, respectively ($p < 0.05$). FAR and FIB were positively correlated with SLEDAI, while ALB was negatively correlated with SLEDAI, the related coefficient (r) were 0.398, 0.267, −0.270, respectively. The receiver operating curve (ROC) analysis showed that the predictive values of FAR for active, severe active and poor prognosis SLE were 0.769, 0.769, and 0.734, respectively, were significant higher than FIB and ALB ($p < 0.05$).

Conclusion: Fibrinogen-to-albumin ratio was an influencing factor of active, severe active, and poor prognosis SLE had higher predictive value than FIB and ALB for the activity and prognosis of SLE.

KEYWORDS
active SLE, fibrinogen-to-albumin ratio, poor prognosis SLE, severe active SLE, systemic lupus erythematosus

1 | INTRODUCTION

Systemic lupus erythematosus (SLE) is a chronic autoimmune disease,[1] often coexists with other diseases, which has a broad range of clinical presentations with variable disease courses, and damages multiple organs, such as kidney, liver, nervous system, and so on.[2,3] SLE differs between genders, with women affected nine times more frequently than men.[4] Although there is no consensus on the etiology and pathogenesis of SLE, contributing factors of SLE development are closely related to genetics, autoimmune system abnormalities, endocrine hormone disorders, external environment, and other factors.[5,6] Many studies have proved that the type and dose of hormones used in the treatment of SLE are closely related to disease activity,[7] hence, timely and effective evaluation of activity indexes is very important.

Hypercoagulable state, inflammatory response, and autoimmunity are important clinical features of SLE patients.[8] The inflammatory response process is closely related to the deposition of immune complexes in vascular endothelium, and the subsequent activation of complement leads to endothelial cell injury.[9] Previous studies have shown that hypercoagulable state is the result of interruption of hemostasis and fibrinolysis caused by endothelial cell injury and is closely related to SLEDAI.[10] Fibrinogen (FIB) is an acute time response protein, rises rapidly in inflammation, infection, myocardial infarction and tumor and is closely related to SLEDAI and poor prognosis. Dhillon et al.[11] have proved that the activation of endothelial cells also change the properties of endothelial cells and become a coagulant rather than an anticoagulant, resulting in the decreasing degradation and increasing concentration of FIB.

The formation and deposition of immune complexes are important mechanism of lupus nephritis (LN),[12] the infiltrate of inflammatory cells and the release of inflammatory factors cause renal injury, resulting in the decreasing concentration of ALB. Liu [13] found that low ALB in patients with active SLE was closely related to LN and poor prognosis, albumin-to-globulin may be a strong predictor for developing LN. The fibrinogen-to-albumin ratio (FAR) as a new inflammatory marker has been proved to have good predictive value in the diagnosis and prognosis of diabetes nephropathy,[14] acute renal injury,[15] rheumatoid disease,[16] and so on. However, there is few relevant research on whether FAR can predict the activity and prognosis of SLE and whether the predictive value is higher than FIB and ALB. Our study compared the predictive value of FIB, ALB, FAR, and analyzed the influencing factors of active, severe active, and poor prognosis of SLE, in order to provide a new predictive biomarker for the disease activity and prognosis.

2 | MATERIALS AND METHODS

2.1 | Study population

A total of 168 patients (14 males and 154 females, age ranges from 19 to 62 years old) with SLE who were treated in Funan County People's Hospital from January 2016 to March 2021 were enrolled in this study. The diagnostic of SLE should meet the criteria of the American college of Rheumatology for SLE (ACR) in 1997 and comply with four or more clauses in the standard.[17] Patients were excluded from the study for any of the following reasons: age < 18 years, diabetes, severe liver disease, other autoimmune diseases, malignant tumors, infectious diseases, pregnancy, postpartum, steatosis, cirrhosis, hypertension, standardized treatment before admission, incomplete clinical data, and loss of follow-up. All patients were regularly evaluated (monthly) in 12 months after discharge, so as to adjust the treatment schemes in time. All procedures were approved by Ethics Committee of Funan County People's Hospital, and written informed consent was obtained from each subject.

2.2 | Data collection

A total of 23 clinical data including basic clinical data, blood lipids, bleeding and coagulation index, inflammatory indicators, autoantibody spectrum, and so on, were collected in this study. The detection of blood lipids [e.g., total cholesterol (TC) and triglyceride (TG)], lactate dehydrogenase (LDH), albumin (ALB), and inflammatory indicators [e.g., complement 3 (C3) and complement 4 (C4)] were measured by Roche Automatic Biochemical Analyzer (Cobas8000701). FIB and ESR were measured by STAGO Automatic Coagulation Analyzer (Compact Max) and Kate Automatic ESR Dynamic Analyzer (XC-A10), respectively. The detection of auto-antibody spectrum [e.g., anti-SjÖgren syndrome B antigen (anti-SSB), anti-nuclear antibody (ANA), anti-double stranded DNA (anti-dsDNA), anti-Sm, anti-histone, anti-SjÖgren syndrome A antigen (anti-SSA), anti-nucleosome, anti-cardiolipin antibody (ACA), and U1 small nuclear ribonucleoprotein (anti-U1RNP)] and anti-dsDNA by ELISA were measured by HUMAN-IMTEC. The laboratory indicators were done according to the supplier's instructions and all the quality control measures were applied.

2.3 | Definition

According to SLEDAI score, patients with 0–4 points were defined as stable SLE (56 cases), 5–9 points were defined as mild active SLE (12 cases), 10–14 points were defined as moderate active SLE (38 cases), and > 15 points were defined as severe active SLE (62 cases).[18] Active SLE including mild, moderate, and severe active SLE was defined as SLEDAI > 5 points, and non-severe active SLE including stable, mild active, moderate active SLE was defined as SLEDAI < 15 points. According to Zhao's report,[19] the clinical remission SLE includes complete remission, clinical hormone-free remission, and clinical hormonal remission, the poor prognosis SLE includes disease recurrence and death.

2.4 | Statistical analysis

Statistical analyses were carried out using SPSS 19.0 software for Windows. The categorical variables were presented as counts

(%) and compared by chi-squared test. Continuous variables were tested for normality using the Kolmogorov–Smirnov test. The normal distribution data were presented as mean ± SD and compared with Student's *t* test, while the non-normal distribution data were presented as the median (25–75 percentile) and compared with Mann–Whitney *U* test. The Pearson correlation analysis was used to analyze the correlation between two continuous variables, and then made the scatter diagram between FIB, ALB, FAR and SLEDAI. The univariate and multivariate analysis were used to find and identify the independent influencing factors for active, severe active, and poor prognosis of SLE, respectively. The predictive value of different indicators was analyzed by receiver operating curve (ROC), and compared by MedCalc software through *Z* test. For all statistical analyses, $p < 0.05$ was considered statistically significant.

3 | RESULTS

3.1 | Influencing factors of active SLE

The SLEDAI, LDH, TG, FIB, FAR, ESR, anti-dsDNA, and anti-dsDNA positive rate in active SLE were significantly higher than that in stable SLE, but C3, ALB were significantly lower than that in stable SLE (all $p < 0.05$). In order to stabilize the model, FIB, ALB, LDH, and SLEDAI were excluded from the multivariate analysis due to the obvious correlation with FAR (Figure 1). The multivariate regression analysis showed that TG, FAR, ESR, and anti-dsDNA (+) were the influencing factors, while C3 was the protective factor of active SLE, the odds ratio (OR) values were 2.968, 3.698, 2.114, 2.727, and 0.652, respectively (all $p < 0.05$), as shown in Table 1.

3.2 | Correlation between FAR and clinical data

FAR was positively correlated with SLEDAI, FIB and LDH, the *r*-values were 0.398 ($p = 0.000$, Figure 1C), 0.602 ($p = 0.000$), and 0.208 ($p = 0.012$), respectively, while negatively correlated with ALB, the *r*-value was −0.592 ($p = 0.000$). FIB was positively correlated with SLEDAI, the *r*-value was 0.267 ($p = 0.001$, Figure 1A), while ALB was negatively correlated with SLEDAI, the *r*-value was −0.270 ($p = 0.001$, Figure 1B), all $p < 0.05$.

3.3 | Predictive value of FIB, ALB, and FAR for active SLE

The AUCs of FIB, ALB, and FAR for predicting active SLE were 0.707 (0.608–0.807), 0.699 (0.594–0.803), and 0.769 (0.679–0.860), respectively (Figure 2). According to the analysis of MedCalc, FAR had the highest prediction value compared with FIB and ALB, the differences were statistically significant ($Z = 3.16$, 3.28, all $p < 0.05$), but there was no significant difference between FIB and ALB ($Z = 0.24$, $p = 0.780$). The optima cutoff value, predictive sensitivity, and specificity of FAR for predicting active SLE were 81.50 mg/g, 71.43%, and 73.21%, respectively (Table 2).

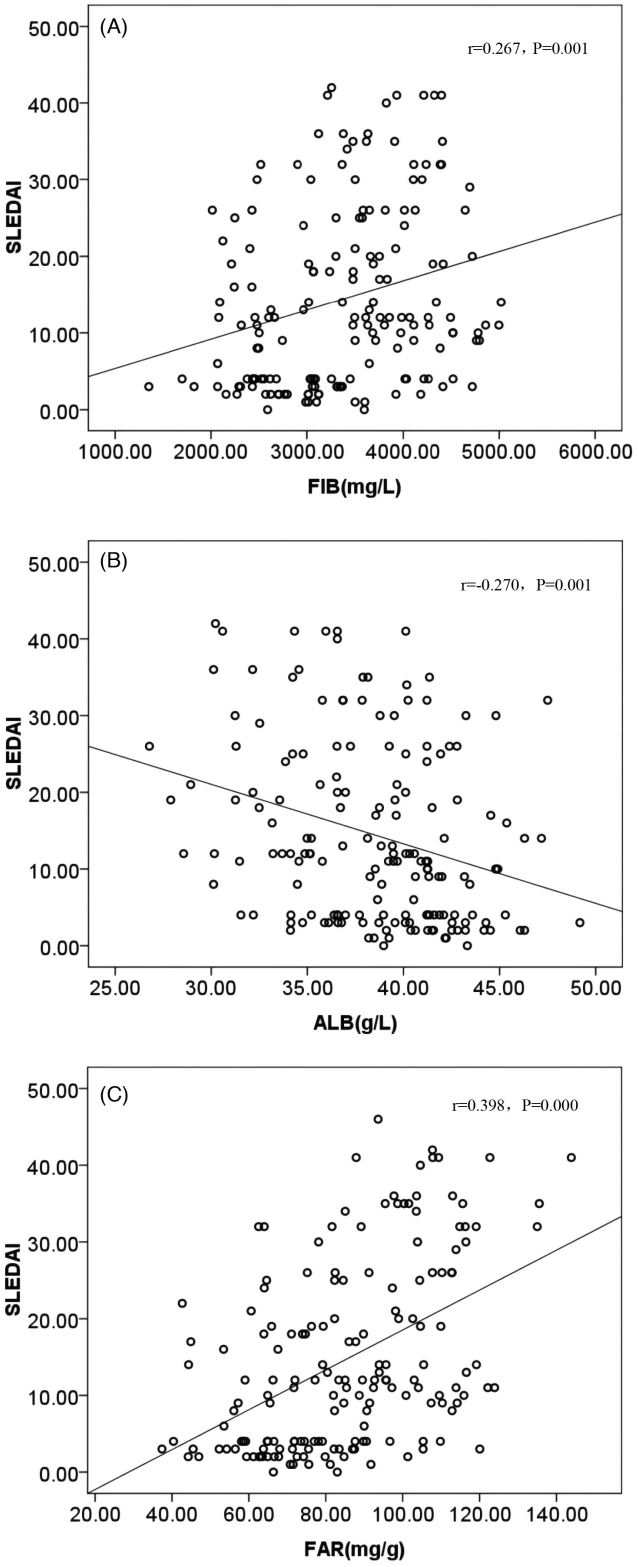

FIGURE 1 Correlation analysis between FIB (A), ALB (B), FAR (C), and SLEDAI. ALB, serum albumin; FAR, fibrinogen-to-albumin ratio; FIB, fibrinogen A; SLEDAI, SLE disease activity index.

TABLE 1 Influencing factors of active SLE

	Univariate analysis			Multivariate analysis		
Variable	**Active SLE ($n = 112$)**	**Stable SLE ($n = 56$)**	***p***	**OR**	**95% CI**	***p***
Age (years)	38.56 ± 7.78	36.92 ± 6.33	0.174			
Female (%)	103 (91.96)	51 (91.07)	0.844			
Disease duration (months)	14.00 (2.00–20.00)	12.00 (3.00–19.00)	0.210			
SLEDAI	19.21 ± 10.42	2.59 ± 1.96	0.000	*		
LDH (U/L)	268.42 ± 81.21	167.47 ± 79.33	0.000	*		
TG (mmol/L)	2.72 ± 0.72	2.45 ± 0.69	0.021	2.968	1.141–8.698	0.026
TC (mmol/L)	5.12 ± 1.10	5.02 ± 0.98	0.566			
FIB (mg/L)	3824.00 (2014.19–4877.00)	2965.00 (1676.15–4272.35)	0.000	*		
ALB (g/L)	36.92 ± 8.59	41.33 ± 9.74	0.000	*		
FAR (mg/g)	92.71 ± 22.12	72.42 ± 14.65	0.000	3.698	2.546–11.712	0.016
C3 (g/L)	0.64 (0.32–0.95)	0.82 (0.46–1.12)	0.000	0.652	0.471–0.852	0.003
C4 (g/L)	0.15 (0.06–0.29)	0.17 (0.08–0.35)	0.195			
ESR (mm/h)	25.82 ± 8.93	22.67 ± 6.59	0.021	2.114	1.256–6.332	0.031
Anti-dsDNA (IU/ml)	60.33 (20.15–94.36)	33.65 (13.73–56.24)	0.000	*		
Anti-dsDNA (+)	70 (62.50)	21 (37.50)	0.002	2.727	1.364–5.454	0.006
Anti-SSA (+)	67 (59.82)	31 (55.36)	0.580			
Anti-SSB (+)	18 (16.07)	10 (17.86)	0.770			
Anti-Sm (+)	40 (35.71)	14 (25.00)	0.161			
Anti-ANA (+)	112 (100.00)	56 (100.00)	1.000			
ACA(+)	72 (64.29)	38 (67.86)	0.646			
Anti-nucleosome (+)	26 (23.21)	13 (23.21)	1.000			
Anti-histone (+)	19 (16.96)	8 (14.29)	0.656			
Anti-U1RNP (+)	45 (40.18)	20 (35.71)	0.575			

Abbreviations: ACA, anti-cardiolipin antibody; ALB, serum albumin; ANA, anti-nuclear antibody; anti-SSA, anti-SjÖgren syndrome A antigen; Anti-SSB, anti-SjÖgren syndrome B antigen; Anti-U1RNP, U1 small nuclear ribonucleoprotein; C3, complement 3; C4, complement 4; ESR, erythrocyte sedimentation rate; FAR, fibrinogen-to-albumin ratio; FIB, fibrinogen A; LDH, lactate dehydrogenase; SLEDAI, SLE disease activity index; TC, total cholesterol; TG, triglyceride.

*Variables were not included in the equation.

3.4 | Influencing factors of severe active SLE

The SLEDAI, LDH, TG, FIB, FAR, ESR, anti- dsDNA, and anti-dsDNA positive rate in severe active SLE were significantly higher than that in non-severe active SLE, but C3, ALB were significantly lower than that in non-severe active SLE (all $p < 0.05$). The multivariate analysis showed that FAR, ESR, and anti-dsDNA (+) were the influencing factors, while C3 was the protective factor of severe active SLE, the OR values were 3.791, 1.953, 2.187, and 0.742, respectively (all $p < 0.05$), TG was not the influencing factor of severe active SLE, as shown in Table 3.

3.5 | Predictive value of FIB, ALB, and FAR for severe active SLE

The AUCs of FIB, ALB, and FAR for predicting severe active SLE were 0.713 (0.605–0.822), 0.716 (0.614–0.818), 0.769 (0.673–0.865), respectively (Figure 3). According to the analysis of MedCalc, FAR had the highest prediction value compared with FIB and ALB, the differences were statistically significant ($Z = 3.012$, 2.986, all $p < 0.05$), but there was no significant difference between FIB and ALB ($Z = 0.20$, $p = 0.821$). The optima cutoff value, predictive sensitivity, and specificity of FAR for predicting severe active SLE were 102.00 mg/g, 79.03%, and 73.58%, respectively (Table 4).

3.6 | Influencing factors of poor prognosis SLE

During the 12 months follow-up, 51 of 112 patients with active SLE had poor prognosis, accounting for 45.54% of all patients. High levels of SLEDAI, TG, FIB, FAR, anti- dsDNA, anti-dsDNA positive rate, and low levels of C3, ALB were observed in poor prognosis of SLE compared with clinical remission of SLE (all $p < 0.05$). The multivariate analysis showed that SLEDAI, TG, FAR, and anti-dsDNA (+) were the influencing factors, while C3 was the protective factor of poor

prognosis SLE, the OR values were 3.024, 2.293, 3.012, 2.323, and 0.801, respectively (all $p < 0.05$), as shown in Table 5.

3.7 | Predictive value of FIB, ALB, and FAR for poor prognosis SLE

The AUCs of FIB, ALB, and FAR for predicting poor prognosis SLE were 0.670 (0.537–0.808), 0.673 (0.536–0.804), 0.734 (0.614–0.853), respectively (Figure 4). According to the analysis of MedCalc, FAR had the highest prediction value compared with FIB and ALB, and the differences were statistically significant ($Z = 3.412$, 3.423, all $p < 0.05$), but there was no significant difference between FIB and ALB ($Z = 0.311$, $p = 0.757$). The optima cutoff value, predictive sensitivity, and specificity of FAR for predicting poor prognosis SLE were 104.14 mg/g, 78.43%, and 65.57%, respectively (Table 6).

4 | DISCUSSION

The aim of this study was to investigate the predictive value of FAR for active, severe active, and poor prognosis of SLE in Chinese patients.

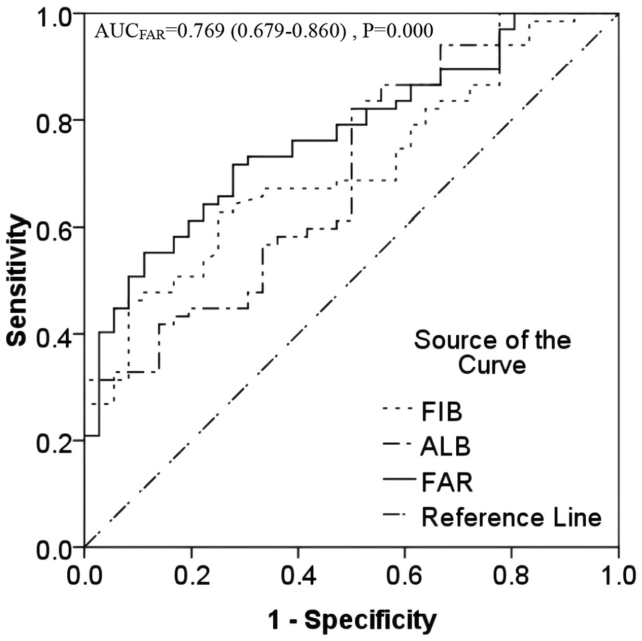

FIGURE 2 ROC analysis of different variables predicting active SLE

Our findings demonstrated that FAR had higher predictive value than FIB and ALB, and showed great associated with an increasing probability of active, severe active, and poor prognosis of SLE, in other words, FAR would be a better potential biomarker for predicting the severity and prognosis of SLE than the single indicators of FIB and ALB.

At present, there are many methods to assess SLE disease activity, including SLEDAI, systemic lupus activity measure (SLAM), and UK Lupus Assessment,[20] but the above scoring methods have several limitations. Firstly, the scoring methods including both laboratory indicators and clinical performance are very complex for clinical application. Secondly, the evaluation of clinical manifestations is related to personal subjective cognition.[21] Thirdly, the results of platelet count, leukocyte count, hematuria, and proteinuria are susceptible to infection, blood system diseases and kidney diseases, which may be inaccurate.[22] Therefore, the rapid, sensitive, and specific evaluation of disease activity for patients with SLE is important for both short-term and long-term diagnosis and treatment planning.[23]

Autoimmune and inflammatory reaction in SLE patients can damage vascular endothelium, break the balance between procoagulant and anticoagulant, cause coagulation and fibrinolysis disorders, and lead to high risk of thrombosis and atherosclerosis.[24] FIB is an important biomarker in the coagulation system, which has been proved to be closely related to disease activity and organ damage.[10] He et al.[25] found that FIB in active SLE was significantly higher than stable SLE and was positively correlated with a variety of inflammatory factors. These studies support that coagulation system imbalance plays an important role in the pathogenesis and disease progression of SLE. Immune complex deposition can damage multiple organs in the whole body, among them, liver and kidney injury can often be observed.[26] Liver injury can lead to reduce albumin synthesis, and kidney injury can lead to increase protein loss through kidney. In fact, hypoproteinemia can often be observed in SLE patients, especially in active SLE. Yip et al.[27] found that ALB in LN patients was lower than that in non-LN patients, which was negatively correlated with SLEDAI both in LN and non-LN patients. Anti-dsDNA as an important parameter in SLEDAI score, is often observed in SLE patients, especially in active SLE and LN. In fact, anti-dsDNA has renal toxicity, and the level of circulating antibody is closely related to the degree of renal damage.[28] Christopher et al.[29] reported that anti-dsDNA and anti-C1q antibodies were useful tools to identify disease activity and/or renal involvement in SLE patients, and the combination of multiple indicators had higher diagnostic efficiency than the single indicator. Antigen and antibody complex can activate complement, lead to the release of inflammatory factors,

TABLE 2 Predicted values of different variables

Variable	AUC (95%CI)	Optimal cut off value	Sensitivity (%)	Specificity (%)	Youden index
ALB	0.699 (0.594–0.803)	38.60 g/L	66.07	71.43	0.377
FIB	0.707 (0.608–0.807)	3520.00 mg/L	80.36	58.93	0.393
FAR	0.769 (0.679–0.860)	81.50 mg/g	71.43	73.21	0.446

Abbreviations: ALB, serum albumin; FAR, fibrinogen-to-albumin ratio; FIB, fibrinogen A.

TABLE 3 Influencing factors of severe active SLE

	Univariate analysis			Multivariate analysis		
variable	Severe active SLE ($n = 62$)	Non-severe activity SLE ($n = 106$)	p	OR	95% CI	p
Age (years)	38.11 ± 8.34	37.91 ± 9.21	0.888			
Female (%)	57 (91.94)	97 (91.51)	0.923			
Disease duration (months)	15.00 (3.00–21.00)	12.00 (2.00–18.00)	0.052			
SLEDAI	21.29 ± 8.58	9.21 ± 6.22	0.000	*		
LDH (U/L)	274.14 ± 86.33	211.56 ± 79.72	0.000	*		
TG (mmol/L)	2.81 ± 0.89	2.52 ± 0.79	0.030	2.104	0.986–7.698	0.066
TC (mmol/L)	5.11 ± 0.87	5.07 ± 0.95	0.786			
FIB (mg/L)	4012.11 (2214.29–4932.14)	3260.97 (1921.74–4344.94)	0.000	*		
ALB (g/L)	33.62 ± 10.23	41.20 ± 9.97	0.000	*		
FAR (mg/g)	106.67 ± 24.14	73.81 ± 21.20	0.000	3.791	2.120–10.557	0.031
C3 (g/L)	0.52 (0.26–0.81)	0.81 (0.40–0.95)	0.000	0.742	0.421–0.937	0.041
C4 (g/L)	0.14 (0.05–0.26)	0.17 (0.09–0.35)	0.100			
ESR (mm/h)	26.16 ± 6.76	23.95 ± 7.02	0.048	1.953	1.179–7.017	0.033
Anti-dsDNA (IU/ml)	65.52 (24.98–101.22)	43.19 (26.56–74.17)	0.000	*		
Anti-dsDNA (+)	41 (66.13)	50 (47.17)	0.017	2.187	1.142–4.187	0.024
Anti-SSA (+)	38 (61.29)	60 (56.60)	0.552			
Anti-SSB (+)	9 (14.52)	19 (17.92)	0.567			
Anti-Sm (+)	24 (38.71)	30 (28.30)	0.163			
Anti-ANA (+)	62 (100.00)	106 (100.00)	1.000			
ACA (+)	38 (61.29)	72 (67.92)	0.383			
Anti-nucleosome (+)	13 (20.97)	26 (24.53)	0.598			
Anti-histone (+)	11 (17.74)	16 (15.09)	0.652			
Anti-U1RNP (+)	25 (40.32)	40 (37.74)	0.740			

Abbreviations: ACA, anti-cardiolipin antibody; ALB, serum albumin; ANA, anti-nuclear antibody; anti-SSA, anti-SjÖgren syndrome A antigen; Anti-SSB, anti-SjÖgren syndrome B antigen; Anti-U1RNP, U1 small nuclear ribonucleoprotein; C3, complement 3; C4, complement 4; ESR, erythrocyte sedimentation rate; FAR, fibrinogen-to-albumin ratio; FIB, fibrinogen A; LDH, lactate dehydrogenase; SLEDAI, SLE disease activity index; TC, total cholesterol; TG, triglyceride.

*Variables were not included in the equation.

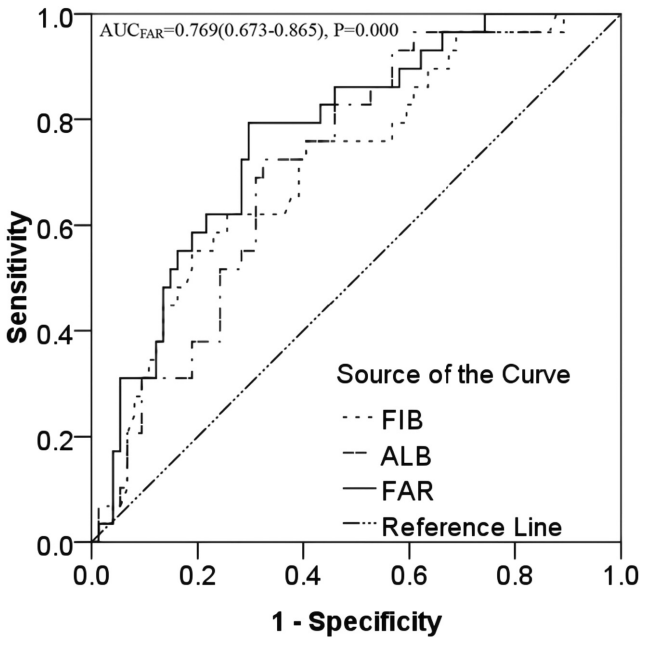

FIGURE 3 ROC analysis of different variables predicting severe active SLE

cause inflammatory injury, and reduce complement concentration. Many reports showed that C3 in patients with active SLE was lower than that in patients with stable SLE, while ESR was higher than that in stable SLE.[30] Our study found that TG, ESR, anti-dsDNA, FAR, and C3 were the independent influencing factors of active SLE, which had a few difference with Zhao's report,[19] and the reason may be related to the differences of subjects. The further study found that ESR, anti-dsDNA, FAR, and C3 were the influencing factors of severe active SLE. The predictive value of FAR was significantly higher than that of FIB and ALB, the reason may be as follows: FIB was positively correlated with SLEDAI, while ALB was negatively correlated with SLEDAI. FAR included positive and negative correlation factors, which enlarged the difference between active and stable SLE, severe active, and non-severe active SLE. The above results suggested that FAR might be more valuable than FIB and ALB in judging the activity and severity of SLE, hence, clinicians should pay more attention to it.

The clinical symptoms of SLE are complex and changeable, so it is difficult for clinicians to judge the severity and prognosis of the disease by clinical symptoms alone. Previous studies have found that many laboratory indicators not only have important reference value for the diagnosis of SLE but also can judge the activity, recurrence,

TABLE 4 Predicted values of different variables

Variable	AUC (95% CI)	Optimal cut off value	Sensitivity (%)	Specificity (%)	Youden index
ALB	0.716 (0.614–0.818)	34.50 g/L	69.35	71.70	0.411
FIB	0.713 (0.605–0.822)	3920.00 mg/L	66.13	73.58	0.397
FAR	0.769 (0.673–0.865)	102.00 mg/g	79.03	73.58	0.526

Abbreviations: ALB, serum albumin; FAR, fibrinogen-to-albumin ratio; FIB, fibrinogen A.

TABLE 5 Influencing factors of poor prognosis SLE

	Univariate analysis			Multivariate analysis		
variable	Poor prognosis SLE ($n = 51$)	Clinical remission SLE ($n = 61$)	p	OR	95% CI	p
Age (years)	39.55 ± 8.21	37.65 ± 7.98	0.218			
Female (%)	48 (94.12)	55 (90.16)	0.443			
Disease duration (months)	14.00 (3.00–22.00)	12.00 (2.00–21.00)	0.173			
SLEDAI	22.14 ± 10.36	16.75 ± 9.98	0.006	3.024	1.251–7.964	0.022
LDH (U/L)	274.14 ± 81.32	262.87 ± 95.62	0.471			
TG (mmol/L)	2.90 ± 0.86	2.57 ± 0.75	0.032	2.293	1.015–5.698	0.026
TC (mmol/L)	5.20 ± 0.89	5.05 ± 0.91	0.382			
FIB (mg/L)	4005.21 (2224.17–4974.66)	3681.99 (2014.74–4656.75)	0.044	*		
ALB (g/L)	35.04 ± 8.34	38.50 ± 7.95	0.027	*		
FAR (mg/g)	102.80 ± 26.17	84.26 ± 23.13	0.000	3.012	1.698–8.942	0.028
C3 (g/L)	0.58 (0.11–0.86)	0.69 (0.20–0.91)	0.030	0.801	0.472–0.975	0.042
C4 (g/L)	0.14 (0.05–0.26)	0.16 (0.06–0.28)	0.268			
ESR(mm/h)	27.14 ± 10.52	24.71 ± 9.69	0.206			
Anti-dsDNA (IU/ml)	64.92 (26.75–102.32)	57.64 (22.32–89.17)	0.023	*		
Anti-dsDNA (+)	37 (72.55)	33 (54.10)	0.045	2.323	1.052–5.127	0.019
Anti-SSA (+)	34 (66.67)	33 (54.10)	0.177			
Anti-SSB (+)	9 (17.65)	9 (14.75)	0.678			
Anti-Sm (+)	21 (41.18)	19 (31.15)	0.270			
Anti-ANA (+)	51 (100.00)	61 (100.00)	1.000			
ACA (+)	35 (68.63)	37 (60.66)	0.381			
Anti-nucleosome (+)	11 (21.57)	15 (24.59)	0.706			
Anti-histone (+)	9 (17.64)	10 (16.39)	0.860			
Anti-U1RNP (+)	22 (43.14)	23 (37.70)	0.559			

Abbreviations: ACA, anti-cardiolipin antibody; ALB, serum albumin; ANA, anti-nuclear antibody; anti-SSA, anti-SjÖgren syndrome A antigen; Anti-SSB, anti-SjÖgren syndrome B antigen; Anti-U1RNP, U1 small nuclear ribonucleoprotein; C3, complement 3; C4, complement 4; ESR, erythrocyte sedimentation rate; FAR, fibrinogen-to-albumin ratio; FIB, fibrinogen A; LDH, lactate dehydrogenase; SLEDAI, SLE disease activity index; TC, total cholesterol; TG, triglyceride.

*Variables were not included in the equation.

and therapeutic effect. They also report that a variety of factors unrelated to SLE can affect the prognosis, including age of onset, sex, race, socioeconomic level, and organ damage degree.[31,32] The alternation of active and stable phase is an important feature of SLE, delaying the progress of the disease, and making lupus stable in clinical remission for a long time is one of the treatment goal. Therefore, looking for rapid, sensitive, and simple laboratory indicators to predict the prognosis of the disease is important for the adjustment of hormone dosage and types. Feng et al.[33] reported that the CD4+ T lymphocyte count in the poor prognosis SLE was lower than that in the continuous remission SLE, and was positively correlated with the poor prognosis of SLE, which might be a potential marker for

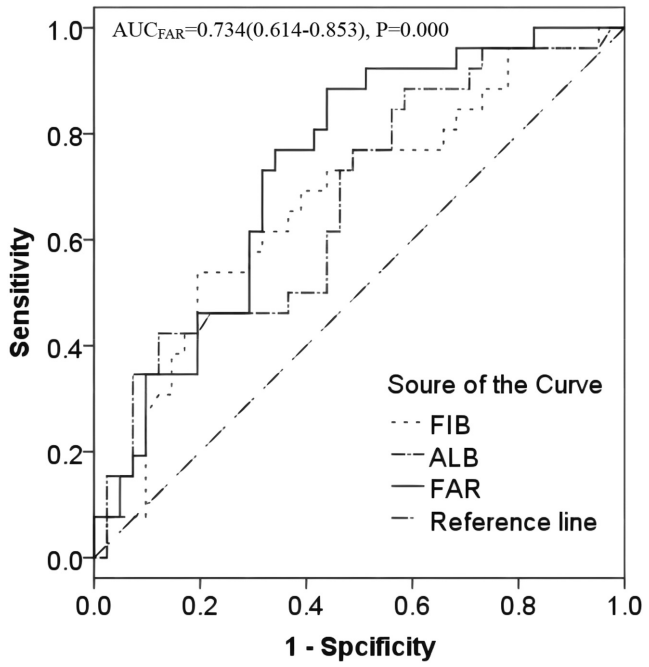

FIGURE 4 ROC analysis of different variables predicting poor prognosis SLE

predicting the poor prognosis of SLE. Pang et al.[34] reported that the level of C5a and ESR increased in SLE patients, and the combined detection of C5a and ESR had important predicting value in poor prognosis of SLE patients. Our data revealed that SLEDAI, TG, FAR, anti-dsDNA (+), and C3 were the independent influencing factors of poor prognosis SLE, and FAR had higher predictive value than single variable in predicting poor prognosis of SLE. To the best of our knowledge, the above results were reported for the first time.

The limitations of our study are as follows. Firstly, there was a small sample size included in this study, which may cause sample selection bias and affect the statistical results. Secondly, this study did not analyze the effect of inflammatory factors and other thrombus markers in poor prognosis of SLE. Thirdly, our study also did not analyze the relationship between organ damage, disease activity and prognosis in SLE patients. In the future, multicenter, big data, and multi-index prospective research may help us further explore the predictors of active SLE, severe active SLE, and poor prognosis SLE.

5 | CONCLUSION

The purpose of this study was to analyze the impact and predictive value of FAR on the disease activity and severity of SLE, and provide reliable predictive indicators for clinical practice, so as to adjust the treatment methods timely, prolong the continuous remission time, and reduce the adverse prognosis of SLE. Our data revealed that FAR was not only an independent influencing factor of the disease severity and poor prognosis of SLE but also had high predictive value for active SLE, severely active SLE and poor prognosis SLE. In other words, FAR might be a potential effective marker to judge the severity and prognosis of SLE and have a wide range of clinical application.

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CONFLICT OF INTEREST

None.

DATA AVAILABILITY STATEMENT

The data are available upon reasonable request.

ORCID

Lu-lu Dai https://orcid.org/0000-0001-9784-0564
Feng He https://orcid.org/0000-0002-6847-3467

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