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ORIGINAL RESEARCH

Inflammatory Markers as Predictors of Diabetes Mellitus in Patients with Pulmonary Tuberculosis: A Retrospective Analysis of Hematological Parameters and Clinical Features

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Objective: This study aimed to investigate whether pretreatment hematological parameters and clinical features are associated with diabetes mellitus (DM) in patients with pulmonary tuberculosis (PTB).

Methods: A retrospective study was conducted at Meizhou People's Hospital from April 2016 to December 2020, including 1106 PTB patients—326 PTB-DM patients as the case group and 780 non-DM PTB patients as the control group. The clinical manifestations were collected, and the level of the inflammation index was measured. Receiver operating characteristic (ROC) curves were used to assess the diagnosis and analysis of the selected indices.

Results: There were no significant differences in the clinical manifestations including gender and age distribution, fever, shortness of breath/difficulty in breathing, expectoration, and extrapulmonary tuberculosis (all $p>0.05$). The level of ESR was higher, while the levels of neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and monocyte-to-lymphocyte ratio (MLR), system immune inflammation index (SII), and system inflammation response index (SIRI) were lower in PTB-DM patients than those in non-DM PTB patients (all $p<0.05$). Regression analysis showed that erythrocyte sedimentation rate (ESR) ($p<0.001$), MLR ($p=0.021$), and PLR ($p=0.003$) were found as the independent risk factors for DM in PTB patients. The area under ROC curve (AUC) value of ESR was 0.619 (95% CI: 0.590–0.648, cut-off value: 45.5), MLR was 0.600 (95% CI 0.570–0.629, cut-off value: 0.765), PLR was 0.584 (95% CI: 0.554–0.613, cut-off value: 239.615), ESR+MLR was 0.689 (95% CI: 0.661–0.716), ESR+PLR was 0.694 (95% CI: 0.666–0.721), MLR+PLR was 0.610 (95% CI: 0.574–0.645), and ESR+MLR+PLR was 0.712 (95% CI 0.685–0.739), respectively.

Conclusion: ESR, MLR, and PLR are associated with the risk of DM in patients with PTB. In particular, the combined detection of ESR, MLR, and PLR showed higher sensitivity and specificity for the diagnosis of DM among patients with PTB.

Keywords: pulmonary tuberculosis, diabetes mellitus, inflammatory markers, ESR, MLR, PLR

Introduction

As an ancient disease, tuberculosis (TB) has existed for thousands of years since the origin and evolution of mankind.[1] Pulmonary tuberculosis (PTB) is caused by the infection with Mycobacterium tuberculosis (Mtb), which primarily spreads among people through the air and affects the lung.[2] PTB was classified as a Global Health Emergency by the World Health Organization (WHO) in 1993, and it was the world's second leading cause of death from a single infectious agent, after Coronavirus disease 2019 (COVID-19) in 2022. According to the statistics of the WHO, the number of people who developed TB was approximately 10.6 million and the number of people newly diagnosed with TB was 7.5 million in 2022, of which TB patients newly diagnosed in China were approximately 748,000 (accounted for 7.1%),[3] ranking third among the 30 countries with a high TB burden.[4] Although the global incidence of TB has been well controlled, it still poses a severe challenge to global public health because of the poor prognosis caused by such as rising resistance rates and the severe complications. Currently, the epidemic situation of TB epidemics in China remains very serious. The risk factors for

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tuberculosis include overcrowding, poverty, malnutrition, and immunosuppression including human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS).[5] Diabetes mellitus (DM) is increasingly being recognized as an independent risk factor for tuberculosis.[6,7] DM is a chronic metabolic disease resulting from a combination of genetic and environmental factors.[8,9] The main pathogenesis of DM is an absolute or relative reduction in insulin secretion, which affects the metabolism of carbohydrates, proteins, fats, electrolytes, and water, resulting in chronic organ injury and dysfunction.[10,11] DM epidemic has grown worldwide and is associated with high morbidity and mortality.[12] During recent decades, the prevalence of DM has been sharply increased owing to an aging population, urbanization, physical inactivity and obesity caused by lifestyle changes.[13] According to International Diabetes Federation (IDF) reports in 2019, the number of patients with DM worldwide was as high as 463 million, with the most rapid increase occurring in low- and middle-income countries (LMICs).[14] Simultaneously, these countries face serious TB situations. The rising prevalence of diabetes may be contributed to the persistently high incidence of TB in countries with a high TB burden.

The bidirectional association between PTB and DM is well established, and the relationship between them is bidirectional. Studies have shown that the overall risk of PTB in patients with DM is three times higher than in the general population,[15,16] and the prevalence of DM among PTB patients ranges from 1.9% to as high as 35%.[17] Nearly 80% of adult DM cases are expected to occur in developing countries, and the convergence of these two epidemics may lead to an increased incidence of PTB.[18] The patients with PTB and DM lead to treatment failure, longer sputum conversion time to normal, relapse, increased risk of developing multidrug-resistant tuberculosis (MDR-TB), and high mortality.[19] According to the WHO PTB screening guidelines, uncontrolled diabetes doubles the risk of TB treatment failure, relapse, and death.[20] There are significant challenges in the treatment and care of patients with DM and TB. Systematic evaluation of Asian countries showed that the prevalence of diabetes among PTB patients is between 5% and 50%, while the prevalence among DM patients in developing Asian countries is 1.8–9.5 times the general population.[21] China has experienced the largest dual DM and TB epidemic globally, and DM combined with PTB poses a major public health problem. The incidence rates of DM and PTB comorbidity (PTB-DM) among Chinese individuals increased from 19.3% to 24.1%.[22] Therefore, clarifying the diagnostic value of clinical laboratory indices for PTB-DM is of great clinical significance.

Inflammation has long been identified as an essential component of both DM and TB.[23,24] DM increases the risk of TB infection by inducing chronic inflammation and immune deficiency. TB infection aggravates abnormal blood glucose through inflammatory responses, forming a bidirectional worsening cycle of "DM-tuberculosis". Inflammation is the core mechanism connecting diabetes and tuberculosis, running through the entire process of disease occurrence and development. The neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and monocyte-to-lymphocyte ratio (MLR) have been found to be useful markers for the diagnosis and differential diagnosis of TB,[25,26] and DM related disease and prognosis.[27–29] In addition, system immune inflammation index (SII) and system inflammation response index (SIRI) are two markers of system immune inflammation, and their links to DM are being revealed.[30,31] However, the association between immunoinflammatory markers and PTB-DM remains unclear. In the present study, we aimed to investigate whether these immunoinflammatory markers and clinical features are associated with the risk of DM in patients with PTB. It would provide a scientific basis for the prevention and control of PTB in patients with DM.

Materials and Methods

Study Population

A total of 1106 patients with PTB were selected as the case group at Meizhou People's Hospital between April 2016 and December 2020 were retrospectively. During the study period, 326 cases with PTB (observation group) of DM patients with PTB were randomly selected, and compared with 780 PTB patients without DM during the same period (control group). PTB patients were diagnosed according to the criteria of "WS 288–2017 Pulmonary Tuberculosis Diagnosis"[32] by microbiological diagnosis. The diagnostic criteria for T2DM were as follows: (1) There were typical clinical symptoms of DM (polydipsia, polydipsia, polyuria, polydipsia, and unexplained weight loss), and random intravenous plasma glucose ≥11.1mmol/L; or fasting blood glucose (FBG) ≥7mmol/L; or blood glucose level at the 2-hour oral glucose tolerance test ≥11.1mmol/L.[33] Patients with leukemia, HIV infection, septic shock, organ failure, malignancy, or mental disorders; those with diseases that can affect immune function, such as AIDS, malignant tumor, chronic hepatitis,

cirrhosis, primary kidney disease, renal failure, blood disease, renal transplantation, gastrectomy, or use of hormones and immunosuppressants within four months were also excluded. Clinical data, including age, sex, cough, fever, respiratory symptoms, expectoration, and extrapulmonary tuberculosis, were collected from all study subjects. This study was approved by the Human Ethics Committee of Meizhou People's Hospital.

Data Collection

Data on clinical characteristics, laboratory outcomes, and inflammation indices were systematically collected from the medical record system of Meizhou People's Hospital. Clinical symptoms recorded included fever (defined as a body temperature ≥38°C, measured using a standard clinical thermometer), sputum production (assessed based on the presence and quantity of sputum, categorized as mild, moderate, or severe), shortness of breath/difficulty breathing (evaluated using clinical assessment tools such as the Respiratory Distress Observation Scale or the Modified Borg Dyspnea Scale), and extrapulmonary tuberculosis (diagnosed based on clinical presentation, imaging studies, and laboratory confirmation). Laboratory outcomes included erythrocyte sedimentation rate (ESR), measured using the Westergren method and reported in millimeters per hour (mm/hr); C-reactive protein (CRP), quantified using high-sensitivity CRP assays and reported in milligrams per liter (mg/L); and complete blood count (CBC), analyzed using automated hematology analyzers to record absolute neutrophil count (ANC), absolute lymphocyte count (ALC), absolute monocyte count (AMC), and platelet count (reported as cells per microliter). Inflammation indices were calculated as follows: neutrophil-to-lymphocyte ratio (NLR=ANC/ALC), platelet-to-lymphocyte ratio (PLR=Platelet count/ALC), monocyte-to-lymphocyte ratio (MLR=AMC/ALC), systemic immune-inflammation index (SII=Platelet count × ANC/ALC), and systemic inflammation response index (SIRI = AMC × ANC/ALC). These indices were used to assess systemic inflammation and immune response.

Data Processing and Statistical Analysis

SPSS 26.0 and GraphPad Prism software were used for the statistical analysis of the experimental data. Data with non-normal distributions were described as median and interquartile range (IQR) values, and evaluated using the Mann–Whitney *U*-test. Categorical variables were represented numerically and as percentages, and were compared using the chi-squared test. Univariate regression analysis (Pearson) and Spearman correlation analysis were used to analyze the relationship between the correlation test indicators. Receiver operating characteristic (ROC) curve analysis was used to determine the optimal cutoff values of ESR, NLR, MLR, PLR, SII, and SIRI for differentiating whether pulmonary tuberculosis patients developed DM or not, and the area under the ROC curve (AUC) was calculated. In addition to the logistic regression model, a 95% confidence interval (95% CI) was used to determine the diagnostic probability of PTB combined with DM. The significance level was set at $P < 0.05$.

Results

General Characteristics in PTB Patients with or without DM

A total of 1106 patients diagnosed with PTB were enrolled, including 326 (29.5%) PTB patients with DM and 780 (70.5%) without DM. The clinical characteristics of the two patient groups of patients are shown in Table 1. The majority of PTB patients were male (84.6%), and most had no fever (83.7%) or shortness of breath/difficulty breathing (76.9%). There were 39 (3.5%) had concurrent extrapulmonary tuberculosis. The differences in gender distribution, age distribution, and clinical manifestations including fever, shortness of breath/difficulty breathing, and expectoration, and extrapulmonary tuberculosis between the two groups were not statistically significant. The level of ESR (44.00 (22.00, 80.00) vs 30.00 (12.00, 54.00), $p<0.001$) was higher while the levels of NLR (4.61 (2.90, 7.64) vs 6.43 (3.62, 11.20), $p<0.001$), MLR (0.50 (0.31, 0.75) vs 0.64 (0.38, 1.00), $p<0.001$), PLR (197.38 (135.53, 299.16) vs 248.44 (149.74, 396.43), $p<0.001$), SII (1333.06 (712.37, 2289.35) vs 1603.72 (844.73, 3224.20), $p<0.001$), and SIRI (3.13 (1.73, 6.42) vs 3.93 (2.00, 8.79), $p<0.001$) were lower in PTB-DM patients than those in non-DM PTB patients.

Logistic Regression Analysis of Related Factors for DM in Patients with PTB

Logistic regression analyses of the association between PTB-DM and related factors were performed (Table 2). Univariate logistic regression analysis showed that PTB patients with DM were more likely to have a higher ESR (odds ratio (OR): 1.024,

Table 1 Comparison of Clinical Features and Peripheral Blood Inflammatory Markers Between Non-DM PTB Group and PTB-DM Group

Variables	Total (n=1106)	Non-DM PTB Group (n=780)	PTB-DM Group (n=326)	Statistic	*p* values
Gender					
Male, n (%)	936 (84.6%)	657 (84.2%)	279 (85.6%)	χ^2=0.323	0.585
Female, n (%)	170 (15.4%)	123 (15.8%)	47 (14.4%)		
Age (Years)					
<60, n (%)	621 (56.1%)	425 (54.5%)	196 (60.1%)	χ^2=2.966	0.097
≥60, n (%)	485 (43.9%)	355 (45.5%)	130 (39.9%)		
Fever					
No, n (%)	926 (83.7%)	654 (83.8%)	272 (83.4%)	χ^2=0.028	0.929
Yes, n (%)	180 (16.3%)	126 (16.2%)	54 (16.6%)		
Shortness of breath/Difficulty breathing					
No, n (%)	851 (76.9%)	590 (75.6%)	261 (80.1%)	χ^2=2.532	0.118
Yes, n (%)	255 (23.1%)	190 (24.4%)	65 (19.9%)		
Expectoration					
No, n (%)	477 (43.1%)	332 (42.6%)	145 (44.5%)	χ^2=0.344	0.594
Yes, n (%)	629 (56.9%)	448 (57.4%)	181 (55.5%)		
Extrapulmonary tuberculosis					
No, n (%)	1067 (96.5%)	747 (95.8%)	320 (98.2%)	χ^2=3.861	0.072
Yes, n (%)	39 (3.5%)	33 (4.2%)	6 (1.8%)		
Peripheral blood inflammatory markers					
ESR	33.00 (14.00, 62.00)	30.00 (12.00, 54.00)	44.00 (22.00, 80.00)	Z=−6.25	<0.05
CRP, M(Q1, Q3)	29.23 (7.37, 76.40)	29.38 (7.15, 73.76)	27.85 (7.91, 82.24)	Z=−0.93	0.354
NLR, M(Q1, Q3)	5.80 (3.36, 10.00)	6.43 (3.62, 11.20)	4.61 (2.90, 7.64)	Z=−5.45	<0.05
MLR, M(Q1, Q3)	0.59 (0.37, 0.90)	0.64 (0.38, 1.00)	0.50 (0.31, 0.75)	Z=−5.24	<0.05
PLR, M(Q1, Q3)	225.83 (142.92, 368.12)	248.44 (149.74, 396.43)	197.38 (135.53, 299.16)	Z=−4.41	<0.05
SII, M(Q1, Q3)	1536.96 (796.13, 2920.07)	1603.72 (844.73, 3224.20)	1333.06 (712.37, 2289.35)	Z=−3.51	<0.05
SIRI, M(Q1, Q3)	3.68 (1.88, 7.80)	3.93 (2.00, 8.79)	3.13 (1.73, 6.42)	Z=−3.76	<0.05

Abbreviations: PTB, pulmonary TB; DM, diabetes mellitus; IQR, interquartile range; ESR, erythrocyte sedimentation rate; CRP, C-reactive protein; NLR, Neutrophil to lymphocyte ratio; MLR, Monocyte to lymphocyte ratio; PLR, Platelet to lymphocyte ratio; SII, system immune-inflammatory index; SIRI, system inflammatory response index.

Table 2 Logistic Regression Analysis of Related Factors for DM in Patients with PTB

Variables	Univariate		Multivariate	
	OR (95% CI)	*p* values	OR (95% CI)	*p* values
Gender (Male/female)	1.111 (0.772–1.599)	0.570	1.458 (0.979–2.171)	0.063
Age (≥60/<60, years old)	0.794 (0.611–1.033)	0.085	0.781 (0.585–1.041)	0.092
Fever (Yes/no)	1.030 (0.727–1.460)	0.866	0.981 (0.653–1.473)	0.927
Shortness of breath/Difficulty breathing (Yes/no)	0.773 (0.563–1.062)	0.112	0.756 (0.524–1.093)	0.137
Expectoration (Yes/no)	0.925 (0.713–1.200)	0.558	1.081 (0.803–1.456)	0.608
Extrapulmonary tuberculosis (Yes/no)	0.424 (0.176–1.023)	0.056	0.456 (0.178–1.170)	0.103
ESR	1.012 (1.008–1.016)	<0.001	1.024 (1.018–1.030)	<0.05
CRP	1.001 (0.998–1.004)	0.454	0.999 (0.995–1.003)	0.603
NLR	0.964 (0.945–0.983)	<0.001	1.001 (0.960–1.044)	0.953
MLR	0.440 (0.319–0.607)	<0.001	0.352 (0.145–0.856)	0.021
PLR	0.998 (0.998–0.999)	<0.001	0.997 (0.995–0.999)	0.003
SII	1.000 (1.000–1.000)	0.005	1.000 (1.000–1.000)	0.486
SIRI	0.965 (0.944–0.987)	0.002	1.013 (0.943–1.089)	0.720

Abbreviations: OR, odds ratio; CI, confidence interval.

95% CI: 1.018–1.30, $p<0.001$), lower levels of NLR (OR: 0.964, 95% CI 0.945–0.983, $p<0.001$), MLR (OR: 0.440, 95% CI 0.319–0.607, $p<0.001$), PLR (OR: 0.998, 95% CI: 0.998–0.999, $p<0.001$), and SIRI (OR: 0.965, 95% CI: 0.944–0.987, $p=0.002$). Clinical features such as gender, age, fever, expectoration, shortness of breath/difficulty breathing, extrapulmonary tuberculosis, and other blood indicators were not associated with DM in PTB patients. Multivariable logistic regression analyses indicated that a high ESR (OR: 1.024, 95% CI: 1.018–1.030, $p<0.001$), low levels of MLR (OR: 0.352, 95% CI 0.145–0.856, $p=0.021$), and PLR (OR: 0.997, 95% CI: 0.995–0.999, $p=0.003$) were independent risk factors for DM in patients with PTB.

The Value of Different Indexes and Their Combined Detection in the Differential Diagnosis of PTB-DM

To analyze the discriminating ability of these inflammatory parameters in the PTB-DM versus PTB groups, ROC curves for the related parameters were plotted (Figure 1). Results revealed the AUC value of ESR was 0.619 (95% CI: 0.590–0.648, cut-off value: 45.5), MLR was 0.600 (95% CI 0.570–0.629, cut-off value: 0.765), PLR was 0.584 (95% CI: 0.554–0.613, cut-off value: 239.615), ESR+MLR was 0.689 (95% CI: 0.661–0.716), ESR+PLR was 0.694 (95% CI: 0.666–0.721), MLR+PLR was 0.610 (95% CI: 0.574–0.645), and ESR+MLR+PLR was 0.712 (95% CI 0.685–0.739), respectively. The PTB-DM and PTB groups could be well discriminated by the combination of indicators ESR, MLR and PLR, with sensitivity and specificity of 63.8% and 70.6%, respectively. Table 3 presents the comprehensive features of ESR, MLR, and PLR for the diagnosis.

Discussion

This study compared the characteristics of the PTB patients with and without DM. Among the patients diagnosed with PTB, 29.5% had DM. The results showed that there were no significant differences in clinical manifestations including gender distribution, age distribution, fever, shortness of breath/difficulty breathing, expectoration, and extrapulmonary tuberculosis. ESR was higher, while NLR, MLR, PLR, SII, and SIRI were lower in PTB-DM patients than in non-DM PTB patients. In addition, high ESR and low MLR and PLR were independent risk factors for PTB-DM.

The high prevalence of DM creates more pressure on the PTB burden. DM increases the risk of PTB, posing a significant threat to the public health, particularly, in countries with a high burden of both diseases.[34] Thus, experts have raised concerns regarding the co-prevalence of PTB and DM. PTB patients with DM often have nutritional deficiency, leading to body injury and disease recurrence, which ultimately affects prognosis and increases the risk of mortality.[22,35] In many studies on the Chinese population, male sex and advanced age were identified as factors associated with PTB with DM;[36–38] however, in this study, age and gender were not statistically different. In addition, the presence of symptoms such as fever, cough, sputum, shortness of breath, difficulty breathing, or extrapulmonary tuberculosis was similar between patients with and without DM. Therefore, we cannot estimate whether TB patients are at risk for diabetes based on simple clinical manifestations.

Chronic infection with Mtb can induce hematopoietic stem cell proliferation and immune changes, which in turn cause changes in the proportion of lymphocyte and other cells.[39] There is a correlation between the immune status (including ESR, NLR, MLR, PLR, SII, and SIRI) and clinicopathological features of PTB patients,[40] which are some of the more novel inflammatory markers currently available.[41] ESR is a sensitive marker of the inflammatory response, and is often used to obtain information regarding disease progression and retrogression.[42] The ESR value was significantly higher in tuberculosis patients with tuberculosis, and was even elevated in 98% of the patients.[43,44] MLR has been proven to be associated with the diagnosis of PTB and the predictive value of MLR in patients with tuberculosis, and higher MLR levels are associated with more severe disease and poorer prognosis.[45,46] The importance of PLR has been emphasized as a marker in some disorders such as non-small-cell lung cancer, acute coronary syndrome, end-stage renal disease, and so on.[47,48] PLR could be developed as a valuable maker for identifying tuberculosis infection in chronic obstructive pulmonary disease (COPD) patients,[40] indicating that PLR is a convenient, and easily measured prognostic indicator. In this study, the inflammation index of ESR was significantly increased, MLR, PLR, SII, and SIRI were significantly decreased in the PTB patients with DM compared to those in PTB patients alone. Further regression

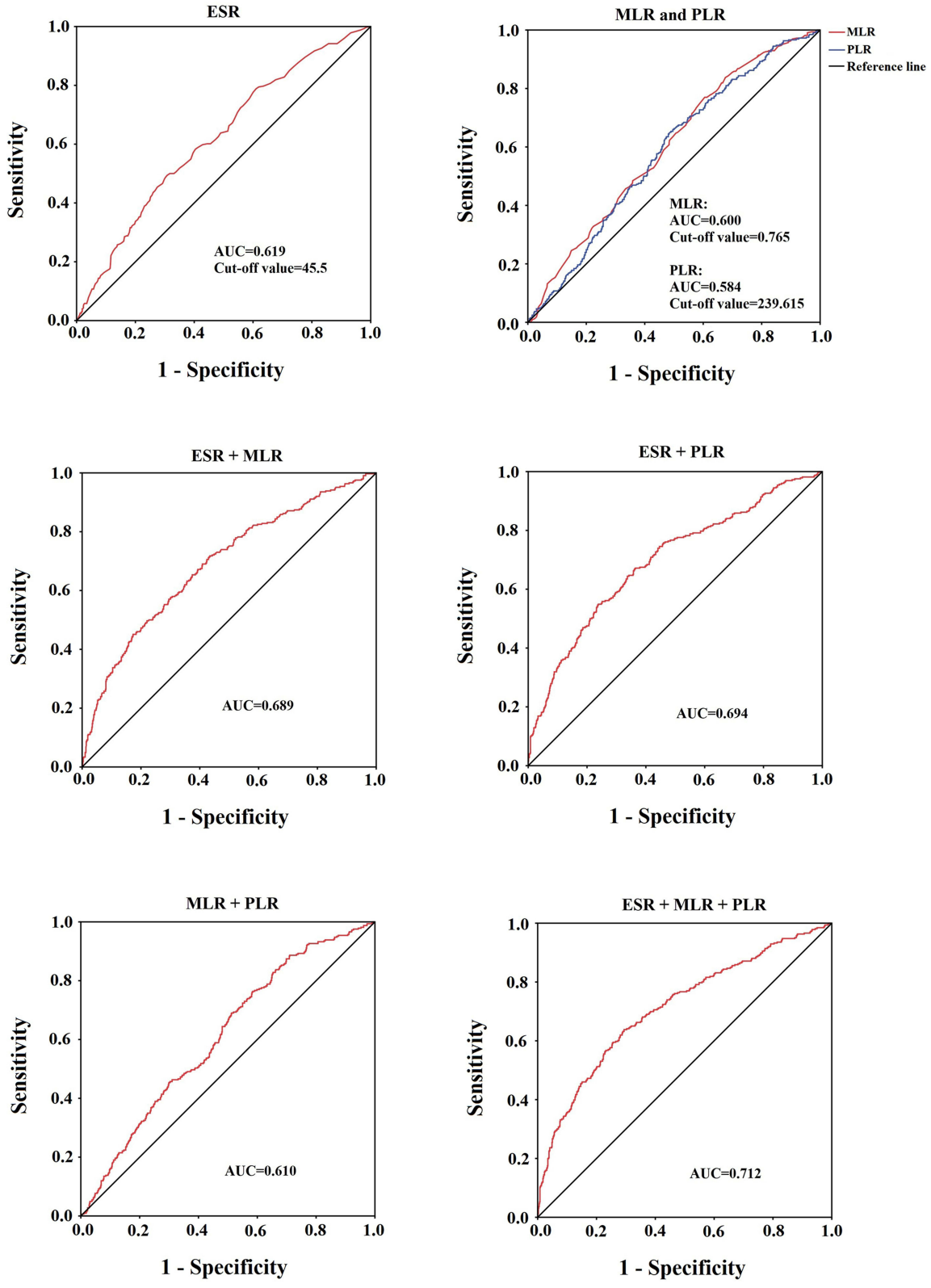

Figure 1 The ROC curve of ESR, MLR, PLR, and their combination on PTB-DM.

Table 3 The Diagnostic Efficacy of ESR, MLR, PLR, and Their Combination on PTB-DM

Peripheral Blood Inflammatory Markers	AUC	95% CI	Sensitivity (%)	Specificity (%)	Cut-Off Value
ESR	0.619	0.590–0.648	49.4	69.2	45.5
MLR	0.600	0.570–0.629	77.0	39.5	0.765
PLR	0.584	0.554–0.613	64.7	51.7	239.615
ESR+MLR	0.689	0.661–0.716	71.8	56.5	/
ESR+PLR	0.694	0.666–0.721	54.9	76.2	/
MLR+PLR	0.610	0.574–0.645	76.4	41.5	/
ESR+MLR+PLR	0.712	0.685–0.739	63.8	70.6	/

analysis indicated that the ESR, MLR, and PLR were relevant factors for PTB-DM. It indicates that a higher ESR and lower MLR and PLR may indicate PTB-DM.

However, these indicators fluctuate to a certain extent and do not have the significance of an independent diagnosis in patients with PTB-DM. Hence, these factors need to be combined to improve the diagnostic value of PTB complicated by DM. Thus, we analyzed the diagnostic efficacy of ESR, MLR, and PLR in PTB patients with DM, and found that ESR has low sensitivity and MLR has low specificity, while PLR has slightly higher sensitivity and specificity. In addition, we also analyzed the sensitivity and specificity of ESR, MLR, and PLR combined tests, and found that the combined tests of these indicators were superior to the single indicator in both sensitivity and specificity. Therefore, the combined detection of ESR, MLR, and PLR is helpful in the differential diagnosis of PTB with DM and non-DM PTB. The results of this study provide a convenient method for clinicians to assess the risk of developing DM in patients with PTB.

This study offers valuable insights into the relationship between hematological markers and DM in patients with PTB, though there are opportunities for further exploration. Firstly, the relationship between these indicators and the severity of DM has not been studied. Future research could investigate the association between inflammation markers (ESR, MLR, and PLR) and the severity of DM. Secondly, the research subjects included in this study were from a single medical structure. Due to the incomplete representativeness of the research subjects, the application of the results of this study in other populations was limited. So, expanding the study to multiple centers would provide a more diverse sample, enhancing the generalizability of the results. Thirdly, this study only analyzed the differences in ESR, NLR, MLR, PLR, SII, and SIRI levels, and did not investigate the role of other factors in the occurrence of DM in patients with PTB, especially some confounding factors. Lastly, collecting data at multiple time points, rather than a single pre-treatment measure, would allow for a more comprehensive analysis of the dynamic changes in these hematological indicators and their clinical significance throughout the treatment process. Addressing these factors would provide a more complete understanding of the role of these markers in DM and PTB, which depends on more research in the future.

Conclusion

ESR, MLR, and PLR were associated with the risk of DM in patients with PTB. In particular, combined tests of these indicators were superior to the single indicator in both sensitivity and specificity in the diagnosis of DM among patients with PTB. It provides a convenient method for clinicians to assess the risk of developing DM in patients with PTB. Specifically, during the treatment of tuberculosis, it is necessary to closely monitor the changes in the patient's blood sugar, adjust the diabetes treatment plan in a timely manner, and reduce the fluctuations in blood sugar caused by inflammation. Secondly, for pulmonary tuberculosis patients with abnormal inflammatory indicators, their association with diabetes should be emphasized. Through anti-inflammatory treatment or immunomodulatory measures, insulin resistance can be improved, immune balance can be regulated, and the risk of disease progression can be reduced.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of Medicine, Meizhou People's Hospital number. All participants signed informed consent in accordance with the Declaration of Helsinki.

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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 that they have no competing interests.

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