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Original Research

Platelet-to-lymphocyte percentage ratio index: a simple non-invasive index to monitor the endoscopic activity in Crohn's disease

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Abstract

Background: Recent evidence has shown that the complete blood count (CBC) is abnormal in patients with Crohn's disease (CD). We aimed to investigate an effective CBC parameter and explore its impact on disease activity in a large CD cohort.

Methods: We performed a retrospective analysis of patients with established CD who underwent clinically indicated endoscopy at four tertiary centres in China between 2016 and 2020. Individual variables of the Simple Endoscopic Score for CD, CBC parameters, C-reactive protein (CRP) levels, erythrocyte sedimentation rate, and faecal calprotectin (FC) were independently reviewed by different investigators. The hold-out method was used to verify the predictive power of the established model.

Results: Data from a total of 1388 endoscopic procedures performed for 882 eligible CD patients were available with routine blood parameters and related indicators. The model using platelet-to-lymphocyte percentage ratio (PLpR) had high accuracy for identifying patients in endoscopic remission (ER), with an area under the curve (AUC) of 0.785 [95% confidence interval (CI): 0.784–0.787], which was comparable with that for CRP (AUC: 0.775, 95% CI: 0.774–0.777). Notably, the AUC of PLpR was significantly higher than that of CRP in patients with colonic disease and with a history of surgery. Moreover, after combining the FC with PLpR, the AUC value of FC + PLpR increased up to 0.892 (95% CI: 0.890–0.894) for identifying ER.

Conclusions: We explored an index (PLpR) to identify CD patients in ER based on platelet and lymphocyte percentage from the CBC. PLpR helped evaluate the degree of disease activity and monitor the therapeutic response.

Keywords: Crohn's disease, complete blood count, endoscopic disease activity, endoscopic remission, platelet-to-lymphocyte percentage ratio

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Introduction

Crohn's disease (CD) is a chronic gastrointestinal inflammatory disorder characterised by a relapsing course.[1] Approximately half of the patients with CD experience an intestinal complication, such as stricture or fistula, within 20 years of diagnosis.[2] The key management strategy is to achieve sustained control of intestinal inflammation. Therefore, close monitoring of disease activity is essential throughout the course of CD.[3] At present, endoscopic healing is recognised as the primary treatment target in CD as it is associated with reductions in disease-related complications, subsequent hospitalisation, and surgery.[4,5] However, endoscopy is invasive, uncomfortable, time-consuming, and expensive, and is ranked as the least acceptable examination for disease monitoring by CD patients.[6,7] Therefore, accurate and reliable non-invasive surrogate markers are needed to assess the severity of CD endoscopic disease activity.

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The ideal non-invasive diagnostic marker should be simple, easily accessible, inexpensive, and accurate. The most frequent used markers are faecal calprotectin (FC), C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and other doubtful indices, such as β2 microglobulin and vitamin D levels. FC has been considered a well-accepted monitoring tool.[8,9] The level of FC is proportional to neutrophil migration through the inflamed bowel wall to the mucosa and has been demonstrated to be correlated to the endoscopic activity in patients with CD.[10] However, the application of FC in clinical practice is somewhat impractical, and it is currently only being utilised for a small proportion of CD patients.[11] CRP level and ESR are important acute phase markers of inflammation and have been shown to perform well in the evaluation of disease activity in patients with CD.[12] However, recent studies have shown that baseline CRP production varies in different people based on the polymorphism of CRP genes in humans,[12] and the optimal thresholds for CRP and ESR that indicate disease activity are heterogeneous in different detection systems.[13,14] β2 microglobulin is also an acute-phase marker released by activated T and B lymphocytes, and has been shown to increase in inflammatory bowel disease.[15,16] Nevertheless, β2 microglobulin is filtered through glomeruli, and the age and kidney function of patients could affect its level.[12] Vitamin D is believed to have immunomodulatory properties in patients with CD, and an inverse correlation was observed between circulating 25-hydroxy vitamin D concentrations and severity of CD.[17,18] However, vitamin D is unable to reflect disease activity accurately in patients with more severe disease activity, who are likely to receive less sunlight and absorb inadequate vitamin D from their diet.[17]

Recent evidence attests that the complete blood count (CBC) is abnormal in CD patients. Many studies have found that some routine blood indicators of CBC, such as red blood cell distribution width, platelet count, mean platelet volume, and thrombocytocrit (PCT), can serve as biomarkers for monitoring disease activity in patients with CD.[19–21] Some indirect parameters, such as neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio, have also been used to determine the disease activity.[22,23] However, the clinical implications of these biomarkers in patients with CD are inconsistent and their sensitivities were generally poor. Furthermore, most studies did not validate their results in a separate group of patients.[24]

The development of simple and stable predictive models with conventional indicators will make monitoring of CD easier and more efficient. Parameters from the CBC are available for almost all patients at different medical centres. The aim of our study was to develop a simple model consisting of automatically reported blood parameters from traditional haematological tests that could reliably reflect the severity of endoscopic disease activity in CD. Through a multicentre collaboration of four independent tertiary centres in China, we derived a novel index, the platelet-to-lymphocyte percentage ratio (PLpR), which was assessed for accuracy in identifying endoscopic remission (ER).

Patients and methods

Patients

This study was a retrospective, multicentre cohort study, approved by the Research Ethics Committee of the First Affiliated Hospital of Sun Yat-sen University [No. (2020) 260]. Each patient provided written informed consent before participation. Patients who were diagnosed with CD and underwent endoscopy were eligible to be enrolled in the study, which was conducted between January 2016 and June 2020 at the Endoscopy Centre of the First Affiliated Hospital of Sun Yat-sen University, the Sixth Affiliated Hospital of Sun Yat-sen University, Sir Run Run Shaw Hospital of Zhejiang University, and General Hospital of Tianjin Medical University, which are tertiary referral centres in China. The patients from the First Affiliated Hospital of Sun Yat-sen University were consecutive recruited, while the patients from other three centres were randomly selected from their inflammatory bowel disease (IBD) database in a 1:5 ratio through a computer randomisation system. The inclusion criteria were as follows: (1) a confirmed diagnosis of CD based on clinical symptoms, laboratory examinations, endoscopic manifestations, and histological and radiological data; (2) the results of CBC, CRP level, and ESR were available within 7 days before colonoscopy procedures. The exclusion criteria were as follow: (1) upper gastrointestinal CD; (2) coexistence of other active autoimmune diseases, such as ankylosing

spondylitis, rheumatoid arthritis, and systemic lupus erythematosus; (3) coexistence of allergic diseases, myeloproliferative disorder, and haematological malignancy; (4) history of acute infections in the last month before blood sampling; (5) history of blood transfusion in the last 6 months before blood sampling; (6) coexistence of chronic diseases which may cause complete blood count abnormalities, such as chronic kidney disease, type 2 diabetes, hypothyroidism or hyperthyroidism, hypertension and coronary atherosclerotic heart disease; and (7) pregnancy and lactation.

Endoscopic disease activity and parameters examination

After screening based on the inclusion and exclusion criteria above, 1388 endoscopic procedures performed in 882 CD patients were included in this study, in which 1038, 185, 139, and 26 endoscopic procedures were performed in the First Affiliated Hospital of Sun Yat-sen University, the Sixth Affiliated Hospital of Sun Yat-sen University, Sir Run Run Shaw Hospital of Zhejiang University, and General Hospital of Tianjin Medical University, respectively. All patients were assessed according to the Montreal classification.[13] The endoscopic image collection and descriptions were used as a uniform template. Endoscopic disease activity was assessed according to Simple Endoscopic Score for CD (SES-CD).[25] ER was defined as an SES-CD of 0–2, mild endoscopic activity as an SES-CD of 3–6, moderate endoscopic activity as an SES-CD of 7–15, and severe endoscopic activity as SES-CD >15. Two investigators, who were blinded to the other variables (including clinical characteristic of the patients and values of the parameters), were responsible for the endoscopic scoring individually. When they produced conflicting scores, a third investigator scored the images, and the average value was regarded as the final score. The investigators were blinded to each other's score during the scoring process.

Blood samples were obtained within 7 days before endoscopy and laboratory physicians conducted the tests of CBC (UniCel DxH Slidemaker Stainer Coulter Cellular Analysis System, Beckman Coulter, US; UniCel DxH 800 Coulter Cellular Analysis System, Beckman Coulter, US; Sysmex XN-9000 Fully Automated Blood Cell Analyzer, Kobe, Japan and Mindray BC-6800Plus Blood Cell Analyzer, Mindray, Shenzhen, China), CRP (CRP-M100 All-in-One Machine, Mindray, Shenzhen, China; Mindray BC-5310 CRP, Mindray, Shenzhen, China), and ESR (ALIFAX-TEST1 fully automated haematocrit, Alifax, Italy). As FC has currently only been tested for a small proportion of CD patients in our centres, FC values were only available from 220 eligible patients. The FC levels were measured using immunofluorescence chromatography (FR-101 Immunofluorescence analyzer, Guangzhou Forreal Biotechnology Co., Guangzhou, China) and a high-range kit (measuring 15–2100 mg/kg). All samples with FC levels below the assay range (<15 mg/kg) were set as 14.9 mg/kg in the analyses.

Selection of indicators for identifying ER

The median (interquartile range; IQR) of CRP, ESR, and the routine blood indicators in the different endoscopic activity subgroups are shown in Table S1 (supplemental material). In order to determine the most effective indicator for identifying ER, we performed a series of univariate analysis and multivariate analysis involving these indicators (see Supplemental File and Table S2). The model consisting of platelet count and lymphocyte percentage had the largest area under the curve (AUC) [0.776; 95% confidence interval (CI), 0.743–0.809] for identifying ER (Table S3, supplemental material). In addition, the severity of endoscopic activity was positively correlated with platelet count ($r=0.458$, $p<0.001$) and negatively correlated with lymphocyte percentage ($r=-0.444$, $p<0.001$) (Figure S1A and B, supplemental material). To amplify the differences between platelet count and lymphocyte percentage in patients with different endoscopic activity levels, we developed a simple index called the PLpR.

$$\textbf{PLpR} = \textbf{Platelet count}\left(10^9/\textbf{L}\right)/\textbf{Lymphocyte percentage}\,(\%)$$

Statistical analysis

R version 4.0.0 (R Foundation for Statistical Computing, Vienna, Austria) and SPSS version 22.0 (IBM, Armonk, NY) were used for the statistical analyses. Median and numerical ranges (minimum, maximum) or IQR was used to describe continuous variables. Frequency and absolute frequency were used to describe categorical

variables. The non-parametric Wilcoxon test was used to compare the differences in routine blood examination values between the different severities of endoscopic activity, and Spearman's regression was used for correlation analysis. A p-value < 0.05 was considered significant. Univariate logistic regression and multivariate logistic regression were used to evaluate the association between blood indicators and ER. The receiver operating characteristic (ROC) curve was used to determine optimum the cut-off value (in terms of the maximised Youden index) for the relevant metrics to distinguish patients in ER from patients with active disease. The predictive power of the model or indicator was verified using the hold-out method with 1000 replications: all samples were randomly divided into a validation set and a testing set in a 7:3 ratio, and the cut-off value, obtained from the validation set, acted as a threshold for the calculation of sensitivity, specificity, positive and negative predictive values, and accuracy for identifying ER in the testing set.

Results

Patient characteristics

A total of 1388 endoscopic procedures, which were performed for 882 eligible CD patients (Table 1), were analysed in our study. Regarding the endoscopic procedures, 992 (71.5%) were conducted in men. The median age at diagnosis was 24.5 years, and 206 (14.8%) patients were diagnosed at ⩽16 years. According to disease location, 148 cases (10.7%) were ileal, 157 cases (11.3%) were colonic, and 1083 cases (78.0%) were ileocolonic. Previous enterectomy had been conducted in 118 (8.5%) patients. According to endoscopic activity, 316 (22.8%) patients were in remission, 322 (23.2%) had mild activity, 426 (30.7%) had moderate activity, and 323 (23.3%) had severe activity.

PLpR, CRP, and FC in groups by endoscopic activity

PLpR, CRP, and FC were all significantly different between the two different levels of endoscopic activity, and were all positively correlated to the severity of endoscopic activity (Figure 1). Notably, the correlation coefficient between endoscopic activity and PLpR was 0.557 ($p < 0.001$) (Figure 2C). In addition, the PLpR level exhibited significant correlations with CRP ($r = 0.623$, $p < 0.001$) and FC ($r = 0.491$, $p < 0.001$) levels (Figure 2A and B). See Table S4 for clinical characteristic of the patients with FC detecting.

PLpR in identifying ER

To assess the capacity and generalisability of PLpR, CRP, FC, neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio for the identification of ER, the hold-out method was performed. The AUC values of PLpR, CRP, FC, neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio for identifying ER were 0.785 (95% CI: 0.784–0.787), 0.775 (95% CI: 0.774–0.777), 0.856 (95% CI: 0.854–0.859), 0.735 (95% CI: 0.734–0.737), and 0.731 (95% CI: 0.729–0.732), respectively (Table 2). The PLpR cut-off value of 11.51 showed a sensitivity of 0.755 (95% CI: 0.751–0.756), a specificity of 0.689 (95% CI: 0.687–0.691), a positive predictive value (PPV) of 0.418 (95% CI: 0.416–0.420), and a negative predictive value (NPV) of 0.905 (95% CI: 0.904–0.906) for identifying ER (Table 2). After combining the CRP with PLpR, the AUC value of CRP + PLpR for identifying ER reached 0.813 (95% CI: 0.812–0.815) (Table 2). Moreover, after combining the FC with PLpR, the AUC value of FC + PLpR for identifying ER increased up to 0.892 (95% CI: 0.890–0.894) (Table 2).

We further developed a series of subgroup analyses. Regarding CD location, PLpR had a higher AUC than CRP in patients with colonic disease [Figure 3, Table 3; PLpR: 0.864 (95% CI: 0.861–0.867), CRP: 0.752 (0.748–0.757), $p < 0.001$]. Furthermore, PLpR had a higher AUC than CRP in patients with history of surgery (Figure 4). However, PLpR showed no significant difference to CRP for identifying ER in patients with different CD behaviour (Figure 5) or in patients aged ⩽16 years at diagnosis (Figure 6).

Discussion

The aim of our study was to develop a simple model based on routine CBC for monitoring the endoscopic activity in patients with CD. In the present study, we found that the model consisting of platelet count and lymphocyte percentage platelet count had the best accuracy for identifying ER. To amplify the relationship of the different endoscopic activity levels with platelet count and lymphocyte percentage, we devised a novel

index, the PLpR, which was simple to use and had comparable accuracy with CRP in monitoring endoscopic disease activity. Moreover, the AUC of PLpR was higher than that of CRP in patients with colonic disease and with a history of surgery. Therefore, we believe that the role of PLpR in disease surveillance might be underestimated until now, and suggest that PLpR could be a potential standard laboratory surrogate for CRP to identify acute inflammation.

Previous studies have reported that the platelet count was significantly elevated in patients with active-phase CD.[26,27] It is believed that platelets act as an inflammatory amplifier under chronic inflammatory conditions, releasing various bioactive inflammatory particles and expressing a variety of inflammatory receptors. Therefore, an elevated platelet count indicates an inflammatory activation state.[26,27] Meanwhile, it has also been found that an increase in whole-blood lymphocyte apoptosis, attributed to an imbalance in lymphocyte apoptosis factors, causes lymphocyte levels to decrease during the active period in paediatric IBD patients.[28] In addition, a recent study of inflammatory bowel disease in children found reduced T-cell abundance and platelet aggregation in the intestinal epithelium of children with colitis.[29] All of the above indicate that platelet count and lymphocyte percentage play an important role in the acute inflammatory course of CD.

As shown in previous studies, the neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio have emerged as well-known biomarkers of disease severity in IBD[30] and other inflammatory diseases[31] and were recently proposed as prospective biomarkers of therapeutic effectiveness in ulcerative colitis.[23] Both high neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio levels can predict active endoscopic disease in ulcerative colitis,[22] and lower levels of both baseline neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio levels can predict positive therapeutic response to anti-tumour necrosis factor treatment in patients with ulcerative colitis.[23] In this study, we found that PLpR better predicts ER in patients with CD than either the neutrophil-to-lymphocyte ratio or the platelet-to-lymphocyte ratio. Basically, the lymphocyte ratio parameter partly represents both neutrophils and lymphocytes, as these cells make up most white blood cells. To some extent, PLpR can be considered as the combination of the neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio. In summary, among the parameters derived from the CBC, PLpR performed better as an emerging inflammatory marker that can assess the activity of CD in patients.

In recent years, some new biomarkers have been used to monitor endoscopic activity in patients with CD. Among them, FC is considered to be

Table 1. Clinical characteristic of the patients.

Characteristics	Statistics: frequency (%), mean (SD/IQR)
Patients (*n*)	882
Total number of endoscopic procedures (*n*)	1388
Gender, male, *n* (%)	992 (71.5)
Median age at diagnosis, yr (IQR)	24.5 (18.0–31.0)
Endoscopic remission, *n* (%)	316 (22.8)
Age at diagnosis, *n* (%)	
⩽16 yr	206 (14.8)
>16 yr	1182 (85.2)
CD location	
Terminal ileum	148 (10.7)
Colon	157 (11.3)
Ileocolon	1083 (78.0)
CD behaviour	
Non-stricturing, non-penetrating	767 (55.2)
Stricturing	372 (26.8)
Penetrating	249 (17.9)
Perianal disease	522 (37.6)
SES-CD	
Remission (0–2)	316 (22.8)
Mild (3–6)	322 (23.2)
Moderate (7–15)	426 (30.7)
Severe (⩾16)	323 (23.3)
Surgery history, *n* (%)	118 (8.5)

CD, Crohn's disease; IQR, interquartile range; SD, standard deviation; SES-CD, Simple Endoscopic Score for CD; Yr, year.

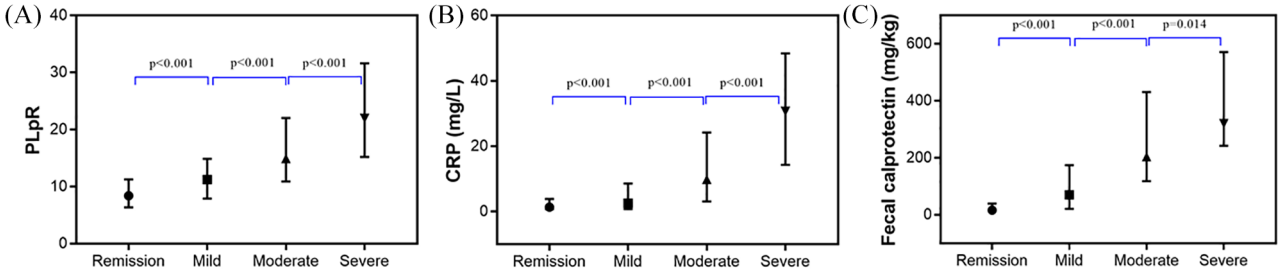

Figure 1. Median and interquartile range of (A) PLpR, (B) C-reactive protein (CRP), and (C) faecal calprotectin in patients with different endoscopic activity.

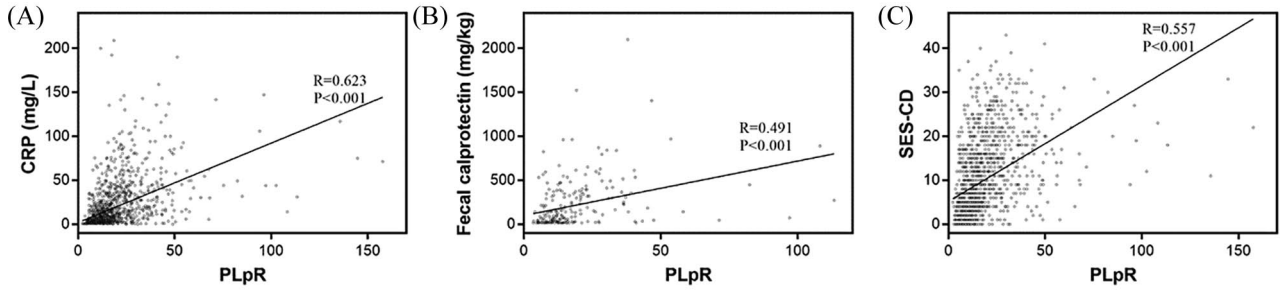

Figure 2. Correlations between PLpR and (A) serum C-reactive protein (CRP), (B) faecal calprotectin, and (C) SES-CD.

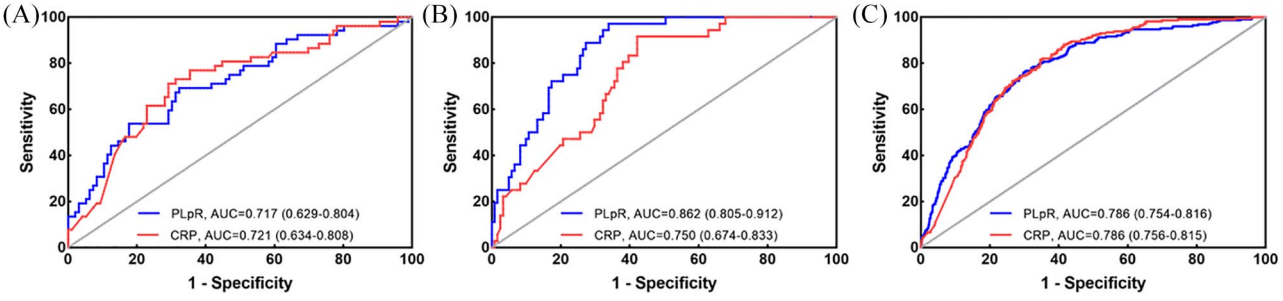

Figure 3. ROC Curve of PLpR and CRP for identifying endoscopic remission in patients with different disease location. (A) patients with terminal ileum disease, (B) patients with colon disease, and (C) patients with ileocolon disease.

highly correlated to the degree of endoscopic activity and regarded as the most promising candidate for disease activity monitoring.[32] In our study, FC also showed acceptable performance in identifying ER. However, FC has some drawbacks. At present, it is believed that several factors affect FC levels during detection. For example, faecal form as well as various components in the faeces, such as water, mucus, and blood, can affect FC test results.[33] As FC is released by inflammatory cells in the intestine, the duration of faecal retention in the intestine also affects FC levels, and different defecation times may produce some bias.[34,35] In addition, the detection kits and normal cut-off points of FC are reported to be heterogeneous among different laboratories, and the normal value of FC cannot be consolidated universally.[32,36] Moreover, previous studies found that CD patients usually prefer blood-based testing over faecal testing, and FC in clinical practice is somewhat impractical and is currently only being employed for less than 2% of

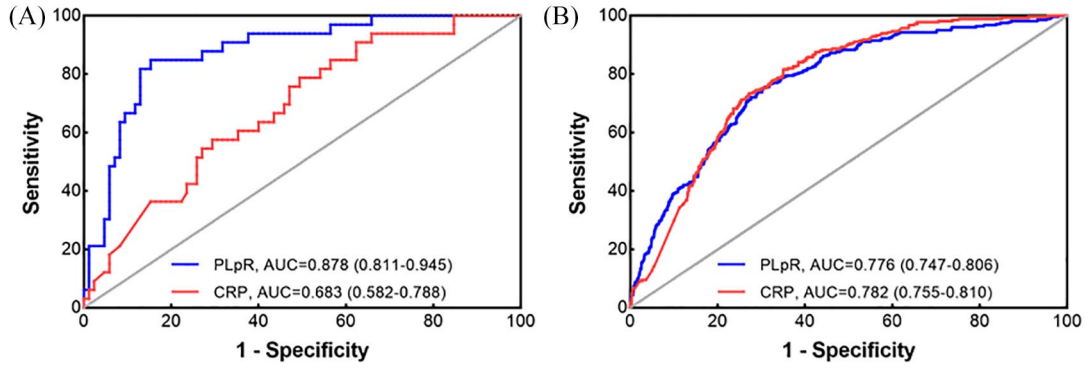

Figure 4. ROC Curve of PLpR and CRP for identifying endoscopic remission in patients with different surgery situation. (A) patients with surgery history, (B) patients without surgery history.

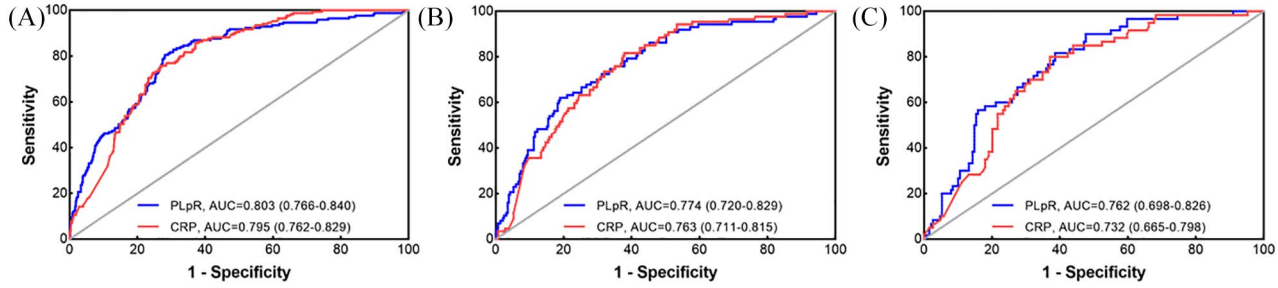

Figure 5. ROC Curve of PLpR and CRP for identifying endoscopic remission in patients with different CD behaviour. (A) patients with inflammatory behaviour, (B) patients with stricturing behaviour, and (C) patients with penetrating behaviour.

CD patients.[11,37,38] Unlike FC, routine blood tests, especially the CBC, are convenient, well established, and most commonly used in clinical settings. Moreover, after combining the PLpR with FC, the prediction efficiency of ER significantly increased. Therefore, PLpR may be useful as an independent index or as a complementary biomarker in monitoring the disease activity in patients with CD, and it is suggested that PLpR is extensively utilised for this purpose.

However, we acknowledge that this study has some limitations. First, our study was retrospectively designed. Nevertheless, we adopted some necessary steps to minimise information bias. To ensure consistency in data extraction, a predetermined set of criteria was established for all subjective variables. Moreover, the investigators who were responsible for the colonoscopy scoring were blinded to other information of the patients. In addition, to decrease training and empirical errors, the hold-out method was used in this study. Second, we used SES-CD as the standard disease activity assessment criteria, which could not assess the disease activity of patients with small intestinal CD. This would be well founded when including radiological evaluations, such as magnetic resonance enterography and computed tomography enterography.

In conclusion, we demonstrated that a simple disease surveillance model, the PLpR, consisting of two easily available indicators (platelet count and lymphocyte percentage), could be used to identify ER in patients with CD with a high degree of accuracy and NPV. Current guidelines suggest that CRP is a standard laboratory surrogate for assessing the disease activity of CD.[13] Our results were validated in four different centres in China and showed that PLpR had comparable accuracy with CRP in identifying ER. Thus, our study suggests that PLpR could be a potential standard laboratory surrogate for CRP

Table 2. Median (95% CI) of AUC, cut-off value, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy for identifying endoscopic remission in all patients.

Indicator	AUC	Cut-off value	Sensitivity	Specificity	PPV	NPV	Accuracy
PLpR	0.785 (0.784–0.787)	11.51 (11.49–11.53)	0.754 (0.751–0.756)	0.689 (0.687–0.691)	0.418 (0.416–0.420)	0.905 (0.904–0.906)	0.704 (0.702–0.705)
CRP (mg/L)	0.775 (0.774–0.777)	4.94 (4.86–5.03)	0.778 (0.774–0.782)	0.643 (0.640–0.647)	0.394 (0.391–0.396)	0.909 (0.908–0.910)	0.674 (0.672–0.676)
FC (mg/kg)	0.856 (0.854–0.859)	52.47 (51.83–53.10)	0.795 (0.79–0.801)	0.78 (0.776–0.784)	0.589 (0.584–0.594)	0.907 (0.905–0.910)	0.784 (0.782–0.787)
Neutrophil-to-Lymphocyte Ratio	0.735 (0.734–0.737)	2.54 (2.52–2.55)	0.665 (0.660–0.669)	0.682 (0.679–0.686)	0.383 (0.380–0.385)	0.875 (0.874–0.877)	0.678 (0.676–0.680)
Platelet-to-Lymphocyte Ratio	0.731 (0.729–0.732)	198.05 (198.33–198.78)	0.752 (0.749–0.755)	0.626 (0.624–0.628)	0.374 (0.372–0.376)	0.895 (0.894–0.896)	0.655 (0.654–0.656)
PLpR + CRP	0.813 (0.812–0.815)		0.764 (0.761–0.767)	0.722 (0.72–0.724)	0.448 (0.446–0.45)	0.912 (0.911–0.913)	0.731 (0.730–0.733)
PLpR + FC	0.892 (0.890–0.894)		0.754 (0.748–0.760)	0.869 (0.866–0.872)	0.700 (0.694–0.706)	0.899 (0.897–0.902)	0.836 (0.833–0.839)

CRP, C-reactive protein; FC, faecal calprotectin; PLpR, platelet-to-lymphocyte percentage ratio.

Table 3. Median (95% CI) of AUC, cut-off value, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of PLpR, CRP in identification of endoscopic remission by disease location.

Variable	AUC	Cut-off value	Sensitivity	Specificity	PPV	NPV	Accuracy
Terminal ileal disease location							
PLpR	0.718 (0.714–0.723)	10.06 (9.98–10.14)	0.575 (0.566–0.584)	0.718 (0.711–0.726)	0.534 (0.527–0.542)	0.762 (0.758–0.766)	0.668 (0.664–0.672)
CRP (mg/L)	0.717 (0.712–0.721)	2.46 (2.43–2.50)	0.677 (0.670–0.685)	0.675 (0.670–0.680)	0.530 (0.525–0.536)	0.797 (0.792–0.801)	0.675 (0.671–0.679)
Colonic disease location							
PLpR	0.864 (0.861–0.867)	11.67 (11.63–11.72)	0.893 (0.886–0.901)	0.680 (0.676–0.685)	0.453 (0.447–0.459)	0.958 (0.955–0.961)	0.729 (0.725–0.732)
CRP (mg/L)	0.752 (0.748–0.757)	6.35 (6.31–6.39)	0.871 (0.864–0.877)	0.585 (0.580–0.589)	0.382 (0.377–0.387)	0.940 (0.937–0.943)	0.650 (0.646–0.654)
Ileocolonic disease location							
PLpR	0.788 (0.786–0.789)	11.70 (11.65–11.74)	0.754 (0.750–0.757)	0.686 (0.683–0.689)	0.391 (0.389–0.394)	0.913 (0.912–0.915)	0.700 (0.698–0.702)
CRP (mg/L)	0.785 (0.784–0.787)	6.04 (5.92–6.15)	0.805 (0.800–0.810)	0.633 (0.629–0.637)	0.371 (0.369–0.374)	0.926 (0.924–0.927)	0.669 (0.667–0.671)

CRP, C-reactive protein; PLpR, platelet-to-lymphocyte percentage ratio.

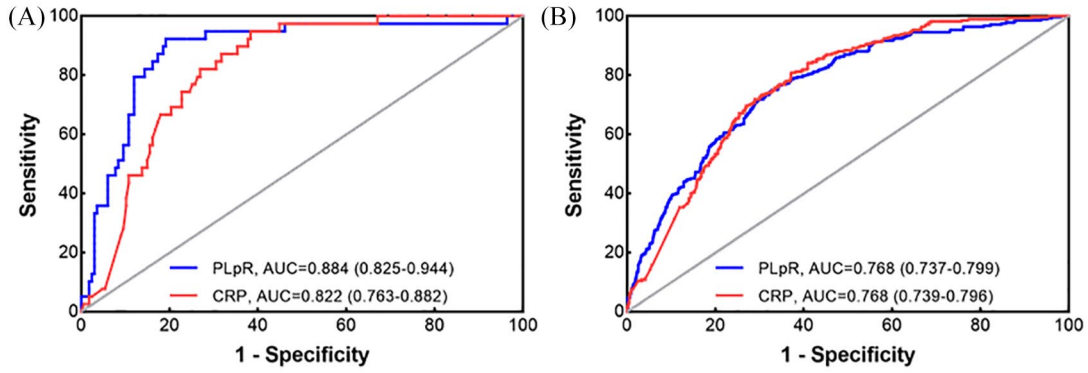

Figure 6. ROC Curve of PLpR and CRP for identifying endoscopic remission in patients with different diagnostic age. (A) patients diagnostic age ⩽16, (B) patients diagnostic age >16.

in identifying acute inflammation. The application of this simple formula could contribute to the monitoring of therapeutic response, while potentially precluding unnecessary endoscopy examinations.

Author contributions

All authors were responsible for the study concept and design. Li Li, Rirong Chen, Kang Chao: analysis and interpretation of data; Li Li, Rirong Chen: drafting of manuscript; Li Li, Rirong Chen, Gaoshi Zhou: evaluation of endoscopic scores; Zhirong Zeng, Minhu Chen and Shenghong Zhang: critical revision of the manuscript for important intellectual content; all authors, collection of data. All authors revised the report and approved the final version.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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Data availability statement

The datasets generated for this study are available on request from the corresponding author.

Supplemental material

Supplemental material for this article is available online.

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