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ORIGINAL ARTICLE

Platelet-to-lymphocyte ratio as a potential inflammatory marker for assessing the severity of vertebral destruction in patients with tuberculous spondylitis

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ABSTRACT

Objective: To determine the association between platelet-to-lymphocyte ratio (PLR) and the severity of vertebral destruction in patients with tuberculous spondylitis.

Methods: This retrospective study was conducted at Wahidin Sudirohusodo Hospital, Makassar, Indonesia. Medical records of patients diagnosed with tuberculous spondylitis between January 2017 and December 2022 were reviewed. Patients aged ≥15 years with confirmed spinal tuberculosis and complete clinical, laboratory, and radiological data were included. PLR was calculated by dividing the absolute platelet count by the absolute lymphocyte count. Vertebral destruction was assessed by measuring the kyphotic angle using the Cobb method on lateral radiographs or sagittal computed tomography images. Pearson correlation and simple linear regression analyses were performed to evaluate the relationship between PLR and kyphotic angle.

Results: Out of 232 patients, 128 (55.2%) were male and 104 (44.8%) were female. The mean PLR was 209.3±139.2, while the mean kyphotic angle was 19.2±7.6°. No significant differences in haematological parameters or kyphotic angle were observed across age or gender groups (all $p>0.05$). PLR showed a weak but significant inverse correlation with kyphotic angle ($r=-0.156$, 95% CI: -0.28 to -0.03; $p=0.020$). Linear regression demonstrated that each one-unit increase in PLR was associated with a 0.087° decrease in kyphotic angle ($\beta=-0.087$, $p=0.020$), although the explanatory power was low ($R^2=0.024$).

Conclusion: PLR demonstrated a statistically significant but weak inverse association with vertebral destruction severity in tuberculous spondylitis. Although PLR may serve as a readily available inflammatory marker, its ability to predict disease severity appears limited and requires validation in prospective multicentre studies.

Keywords: Tuberculosis (MeSH); Tuberculosis, Spinal (MeSH); Spondylitis (MeSH); Inflammation (MeSH); Biomarkers (MeSH); Lymphocyte Count (MeSH); Platelet Count (MeSH); Kyphosis (MeSH); Spinal Curvatures (MeSH); Diagnostic Imaging (MeSH).

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INTRODUCTION

Tuberculous spondylitis (Pott disease) is the most common form of musculoskeletal tuberculosis, accounting for approximately 1-5% of all tuberculosis (TB) cases and nearly 50% of skeletal TB. Despite global progress in TB control, the burden of extrapulmonary TB remains substantial, partly due to the human immunod-eficiency virus (HIV) epidemic and increasing population mobility.[1] The disease predominantly affects adults and is more common in males. Spinal involvement usually occurs through hematogenous dissemination of Mycobacterium tuberculosis, most frequently affects the thoracolumbar junction, followed by the lumbar and cervical spine.[2] The clinical course is often insidious, with persistent back pain as the predominant presenting symptom. Delayed diagnosis may result in vertebral destruction, paravertebral abscess formation, kyphotic deformity, spinal instability, and irreversible neurological deficits.[3]

Spinal tuberculosis primarily involves the anterior vertebral body because of its rich vascular supply, resulting in progressive vertebral destruction while initially sparing the posterior elements. Progressive collapse of the anterior column leads to kyphotic deformity, the severity of which is directly related to the extent of vertebral destruction.[4] Kyphosis is commonly quantified using the Cobb angle on lateral radiographs by measuring the angle between the superior endplate of the nearest normal vertebra above the lesion and the inferior endplate of the nearest normal vertebra below it.[5,6] Early identification of patients at risk of severe vertebral destruction and progressive kyphotic deformity is crucial for timely intervention and prevention of long-term disability.

Systemic inflammatory markers derived from routine complete blood counts, particularly the platelet-to-lymphocyte ratio (PLR), have emerged

as inexpensive and readily available indicators of disease activity in various inflammatory and infectious disorders. However, evidence regarding the association between PLR and the structural severity of tuberculous spondylitis, particularly vertebral destruction and kyphotic deformity, remains scarce. Therefore, this study was planned to evaluate the association between PLR and the severity of vertebral destruction, assessed by the kyphotic angle, in patients with tuberculous spondylitis.

METHODS

This retrospective single-center study was conducted at Wahidin Sudirohusodo Hospital, Makassar, Indonesia, a tertiary referral center for spinal tuberculosis. Medical records of patients diagnosed with tuberculous spondylitis between January 2017 and December 2022 were reviewed.

Hematological data, including platelet and absolute lymphocyte counts, were retrieved from routine complete blood count (CBC) results performed at the hospital laboratory using automated hematology analyzers according to standard laboratory protocols. The PLR was calculated by dividing the absolute platelet count by the absolute lymphocyte count. Owing to the retrospective nature of the study, details of the haematology analyser model and manufacturer were unavailable.

The study included patients with tuberculous spondylitis treated at Wahidin Sudirohusodo Hospital, Makassar, Indonesia, between January 2017 and December 2022. Patients aged ≥15 years with a confirmed diagnosis of spinal tuberculosis and complete clinical, laboratory, and radiological records were eligible for inclusion. For subgroup analyses, participants were categorized into two age groups: <50 years and ≥50 years.

Patients with incomplete medical records, including missing hematological or radiological data required for analysis, were excluded. Additional exclusion criteria included known hematologic disorders, active systemic infections other than tuberculosis, malignancy, chronic inflammatory diseases, and immunosuppressive therapy (including long-term corticosteroid use), where such information was available in the medical records. Information on HIV status and prior anti-tuberculosis treatment was recorded when available but was not used as an exclusion criterion unless it resulted in incomplete data for the primary study variables. Missing data were handled using a complete-case analysis, whereby only patients with complete data for the variables of interest were included in the final analysis.

The kyphotic angle was measured using the Cobb method on lateral radiographs or sagittal computed tomography (CT) images by measuring the angle between the superior endplate of the nearest normal vertebra above the lesion and the inferior endplate of the nearest normal vertebra below the lesion. All imaging was performed with patients in the supine position.

The diagnosis of tuberculous spondylitis was confirmed using GeneXpert laboratory testing. Demographic characteristics, clinical presentation, comorbidities, nutritional status, anti-tuberculosis treatment, and laboratory findings were extracted from medical records using a standardized data collection form. CBC parameters used to calculate PLR were obtained within 48 hours of radiological imaging and, whenever possible, before initiation of anti-tuberculosis therapy. When laboratory and imaging investigations were performed at different times, the closest available results obtained during the same hospital admission were used for analysis.

The study was approved by the Research Ethics Committee, Faculty of Medicine, Hasanuddin University (Reference No. 541/UN4.6.4.5.31/Pp36/2022; dated: September 27, 2022). Patient confidentiality was maintained by anonymizing all extracted data. As this was a retrospective record review, the requirement for informed consent was waived by the Ethics Committee.

Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 28.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as frequencies and percentages. Continuous variables were assessed for normality using the Kolmogorov–Smirnov test. Normally distributed data were expressed as mean±standard deviation (SD) and compared using the independent-samples t-test, whereas non-normally distributed variables were expressed as median (inter-quartile range [IQR]) and compared using the Mann–Whitney U test. Pearson correlation analysis was performed to assess the association between PLR and kyphotic angle. Simple linear regression analysis was used to evaluate the predictive relationship between PLR and kyphotic angle. A two-tailed p-value <0.05 was considered statistically significant.

RESULTS

The study included 232 patients with tuberculous spondylitis, of whom more than half (55.2%) were male, and approximately three-quarters (76.7%) were younger than 50 years. Back pain was the most common presenting symptom (48.3%), followed by paresthesia (29.3%). Most patients had a normal body mass index (59.9%), whereas nearly one-quarter (24.1%) were underweight. More than half of the participants (59.5%) received anti-tuberculosis therapy. Overall, 62.5% had no documented comorbidity, while pulmonary tuberculosis was the most frequent comorbid condition (19.4%), followed by diabetes mellitus (4.3%) and anemia (3.9%) [Table I].

The main haematological parameters of 232 included subjects based on gender and age were summarized in Table II. No significant differences were observed in platelet count, lymphocyte count, WBC count, or PLR across gender and age groups (all $p>0.05$), indicating comparable baseline characteristics.

Table I: Baseline demographic and clinical characteristics of patients with tuberculous spondylitis (n=232)

Characteristics	Category	Frequency (%)
Age (years)	< 50	178 (76.7)
	≥ 50	54 (23.3)
Gender	Male	128 (55.2)
	Female	104 (44.8)
Symptoms	Back pain	112 (48.3)
	Paresthesia	68 (29.3)
	Paraplegia	52 (22.4)
Body Mass Index	Underweight	56 (24.1)
	Normal	139 (59.9)
	Overweight	34 (14.7)
	Obesity	3 (1.3)
Anti-Tuberculous Therapy	Yes	138 (59.5)
	No	94 (40.5)
Comorbidity	Pulmonary tuberculous	45 (19.4)
	Psoas abscess	15 (6.5)
	Tuberculous Meningitis	1 (0.4)
	Diabetes mellitus	10 (4.3)
	Hypertension	5 (2.2)
	Human Immunodeficiency Virus infection	2 (0.9)
	Anemia	9 (3.9)
	No comorbidity	145 (62.5)

Table II: Comparison of hepatological parameters and kyphotic angle according to gender

Variables	Male (n=128)	Female (n=104)	p-value
	Mean±SD	Mean±SD	
White blood cell	9.834 (±3.552)	12.566 (±1.413)	0.515
Platelet	389.396 (±112.530)	388.308 (±113.828)	0.683
Lymphocyte Count	23.540 (±10.647)	24.241 (±7.769)	0.671
Platelet-lymphocyte ratio	209.652 (±140.148)	208.792 (±138.563)	0.177
Kyphotic Angle	19.491 (±7.828)	18.740 (±7.382)	0.456

Table III: Sample characteristics based on age

Variables	Mean±SD		
	<50 years	≥50 years	p-value
White blood cell	10.614 (±3.332)	12.526 (±1.504)	0.3
Platelet	392.465 (±115.889)	377.185 (±102.423)	0.42
Lymphocyte Count	23.515 (±9.984)	24.974 (±7.413)	0.467
Platelet-lymphocyte ratio	214.208 (±135.461)	192.976 (±150.817)	0.768
Kyphotic Angle	19.455 (±7.741)	18.164 (±7.207)	0.277

Similarly, the mean kyphotic angle did not differ significantly between groups (p=0.277) (Table III). All variables were normally distributed based on the Kolmogorov–Smirnov test (p>0.05).

Pearson correlation analysis demonstrated a significant but weak inverse correlation between PLR and kyphotic angle (r=-0.156, 95% CI: -0.28 to -0.03; p=0.020), indicating that higher PLR values were associated with a lower degree of kyphotic deformity.

Linear regression analysis showed that each 1-unit increase in PLR was associated with a 0.087° decrease in kyphotic angle (β=-0.087; 95% CI: -0.16 to -0.01; p=0.020), with low explanatory power (R^2=0.024), suggesting limited predictive value (Figure 1).

DISCUSSION

This study evaluated the relationship between PLR and the severity of vertebral destruction, as assessed by the kyphotic angle, in patients with tuberculous spondylitis. A statistically significant but weak inverse association was observed between PLR and kyphotic angle, indicating that higher PLR values were associated with a lower degree of kyphotic deformity. However, the low coefficient of determination suggests that PLR alone has limited ability to explain or predict the severity of vertebral destruction. Furthermore, hematological parameters, including platelet count, lymphocyte count, and PLR, did not differ significantly according to age or gender, indicating that these factors were unlikely to have influenced the observed association.

Previous studies have shown that thrombocytosis is commonly associated with tuberculosis, particularly in active disease. Daniel K, et al., reported that thrombocytosis was more frequent in patients with TB spondylitis compared to controls, suggesting a link between infection and increased platelet production.[7] Similarly, Kahase D, et al,. found that thrombocytosis occurred in 65% of pulmonary tuberculosis (PTB) patients,[8] while Tozkoparan E, et al,. demonstrated that platelet counts were higher in active TB compared to inactive disease and decreased following treatment.[9] These findings support the role of platelets as part of the acute phase response in TB. The underlying mechanism is thought to involve increased thrombopoietin

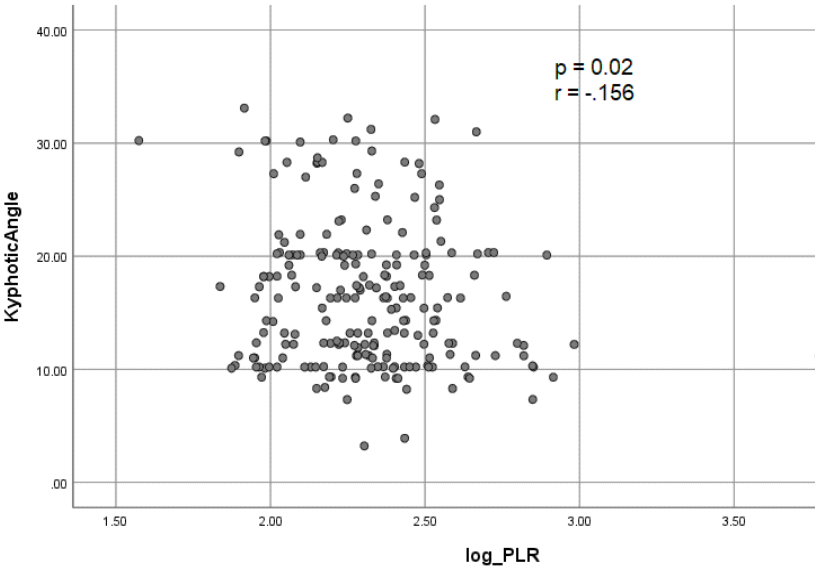

Figure 1: Correlation between Platelet-lymphocyte ratio value and kyphotic angle

levels during infection, which stimulate platelet production, although the exact pathways remain unclear.[10]

PLR has emerged as a readily available composite inflammatory marker that reflects both thrombocytosis and lymphopenia. Elevated PLR has been associated with disease activity and adverse outcomes in several inflammatory and infectious conditions, including ankylosing spondylitis, malignancies, and cardiovascular disease.[11,12]

In tuberculosis, elevated PLR has been reported in patients compared to healthy controls, although its ability to differentiate disease severity remains inconsistent.[13,14] In our study, PLR values were higher in males than females but did not reach statistical significance, which is consistent with findings from other population-based studies demonstrating variability of PLR across different cohorts.[15,16] Importantly, our results suggest that while PLR reflects systemic inflammation, it may not directly correspond to the degree of structural damage in spinal TB.

Kyphotic deformity in spinal TB results from progressive anterior vertebral body destruction, leading to collapse and sagittal imbalance. The degree of kyphosis is closely related to the extent of vertebral damage and biomechanical instability.[5,17] Previous studies have shown that vertebral body compression correlates strongly with kyphotic angle and clinical outcomes.[14] However, studies evaluating the relationship between hematological inflammatory markers and spinal deformity are limited. Acarbas A, et al., found that neutrophil-to-lymphocyte ratio (NLR), but not PLR, was associated with sagittal imbalance,[18] which aligns with our finding that PLR has only a weak association with kyphotic angle. This suggests that structural deformity in spinal TB is likely influenced more by local pathological processes than systemic inflammatory response alone.

Although lymphocytosis is commonly described in tuberculosis, several studies have demonstrated that active or severe TB may be associated with relative lymphopenia due to immune dysregulation and consumption of lymphocytes at the site of infection.[17] This reduction in circulating lymphocyte count reflects impaired cellular immunity, which plays a central role in the host response to Mycobacterium tuberculosis. Consequently, the combination of reactive thrombocytosis and relative lymphopenia results in an elevated PLR,[17] which may better reflect systemic inflammatory burden than either parameter alone. PLR has also been proposed as a useful inflammatory marker in tuberculosis and related conditions.[13,15,18] Therefore, PLR can serve as a composite marker integrating both inflammatory response and immune status, potentially correlating with disease severity, including structural damage in spinal tuberculosis.

From a clinical perspective, PLR is an inexpensive and widely available parameter that can be easily obtained from routine blood tests. Although its predictive value for kyphotic deformity is limited, it may still serve as an adjunctive marker in resource-limited settings where access to advanced imaging is restricted. In such contexts, PLR could provide preliminary information regarding disease activity and assist in early risk stratification.

This study has several limitations. First, its retrospective design may have introduced selection bias and limited the completeness of clinical data. Second, important clinical variables, including the number of affected vertebral levels, presence of para-vertebral or epidural abscess, and neurological status, were not available and may have influenced the findings. Third, the weak correlation and limited predictive value of the PLR suggest that other factors contributing to vertebral destruction were not accounted for. Future prospective studies with larger sample sizes should incorporate comprehensive clinical, radiological, and laboratory parameters, including additional inflammatory biomarkers, to improve the prediction of disease severity and vertebral destruction.

CONCLUSION

The PLR demonstrated a statistically significant but weak association with kyphotic deformity in patients with tuberculous spondylitis, indicating limited utility as a standalone predictor of vertebral destruction. Nevertheless, owing to its simplicity, low cost, and wide availability, PLR may serve as an adjunctive inflammatory marker, particularly in resource-limited

settings. Future prospective studies should evaluate PLR in combination with clinical, radiological, and other inflammatory markers to improve prediction of disease severity and spinal deformity.

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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

JA: Conception and study design, acquisition, analysis and interpretation of data, critical review, approval of the final version to be published

YM: Acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

KSK & DK: Acquisition, analysis and interpretation of data, critical review, approval of the final version to be published

SDL: Conception and study design, acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

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DATA SHARING STATEMENT

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

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