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Platelet binding to lymphocytes and platelet activation in systemic lupus erythematosus patients

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Abstract
Background: A condition known as systemic lupus erythematosus (SLE) is caused by the creation of multiple autoantibodies targeting various biological components, which may impact many cells, tissues, and organs. The purpose of this study was to evaluate the role of platelet-lymphocyte binding and platelet activation in pathogenesis of SLE, clarifying their relationship to the clinical and laboratory characteristics of individuals with SLE.
Methods: This case-control work was performed on 30 individuals, their age was more than 18 years old, with clinical criteria of SLE, divided into SLE patient group and control health group. Each participant was exposed to flow cytometric analysis of the peripheral blood samples to detect lymphocytes bound to platelets and Enzyme-linked immune-sorbent assay (ELISA) analysis of serum, to evaluate the concentrations of soluble cluster of differentiation 40 ligand (sCD40L) and the concentrations of interleukin 10 (IL-10).
Results: A substantial elevation was existed in the percentage of lymphocyte bound platelets (CD19+CD41a+ lymphocytes and CD3+CD41a+ lymphocytes), sCD40L level and IL10 level in individuals with SLE contrasted to controls. The percentage of lymphocyte bound platelets, sCD40L and IL10 expressed a significant increase in SLE patients who had hematuria and positive anti-dsDNA compared to SLE patients without hematuria and negative anti-dsDNA. Both sCD40L and IL10 had a substantial positive association with each other and with CD19+CD41a+ lymphocytes, CD3+CD41a+ lymphocytes, and albumin to creatinine ratio, SLEDAI, creatinine and urea, while they had a significant negative correlation with C3, C4, hemoglobin, platelets and leucocytic count. CD19+CD41a+ lymphocytes and CD3+CD41a+ lymphocytes had a substantial positive association with each other and with sCD40L, IL10, albumin to creatinine ratio, SLEDAI, creatinine and urea, while they had a substantial negative association with C3, C4 and platelets. Moreover, CD3+CD41a+ lymphocytes had a substantial negative association with leucocytic count.
Conclusions: SLE patients had a substantial elevation in lymphocytes bound platelets contrasted to the healthy control group.

Keywords: Platelet binding to lymphocytes, lymphocytes, platelet activation, systemic lupus erythematosus

Introduction
Connective tissue is affected by the inflammatory, autoimmune, and multi-systemic illness known as systemic lupus erythematosus (SLE). It is marked by the accumulation of circulatory antigen-antibody complexes in different tissues, which harms organs [1]. The etiology of SLE, an autoimmune illness with a complicated immunopathogenesis that results in the loss of immunological balance regulation, is directly influenced by genetic, environmental, and hormonal variables. Loss of self-tolerance and autoimmune immunological responses are its causes [1, 2].
By serving as effector cells that react to antigens in humoral immunity and then deliver autoantigens to T cells as antigen-presenting cells, B-lymphocyte cells link innate immunity with adaptive immunity. They possess a significant role in SLE pathophysiology because polyclonal stimulation of B lymphocytes, which results in the production of excessive levels of pathologic cytokines, autoantibodies, and chemokines that lead to immune complex-related inflammation [2].

A key factor in avoiding inflammation and autoimmune diseases is the release of the immunoregulatory cytokine IL-10 by a various immune cells [3]. It serves a dual purpose by downregulating the T lymphocyte cells' response while simultaneously positively affecting B cell survival, proliferation, differentiation, and generation of autoantibodies [4]. Platelets are thought to serve as an immunoregulatory cellular components. When they are activated, chemokines, cytokines, growth factors, and platelets-derived microparticles (PMP) are released, and P-selectin and CD40L, two activation molecules produced on their membrane, enable platelets to attach to leukocytes. So, it is believed that soluble cluster of differentiation 40 ligand (sCD40L) is a marker of activation of platelets *in vivo* [5].

By promoting B cell growth, antibody synthesis, and increased IL-10 production via sCD40L, platelet formation and humoral activity are increased [6].

Through interactions with sCD40-CD40L, P-selectin/PSGL-1, GPIb-CD11b, and GPIIb/IIIa-CD11/CD18, platelets may attach to lymphocytes. Individuals with SLE and other autoimmune illnesses have been shown to have greater activation of platelets and a higher number of circulating lymphocyte-platelet complexes. [7].

The purpose of this study was to assess the potential function of platelets activation and platelet-lymphocyte binding in pathogenesis of SLE, clarifying their relationship to the clinical and laboratory characteristics of individuals with SLE.

Patients and Methods

This work was performed on 30 individuals, their age was more than 18 years old, with clinical criteria of SLE. The Internal Medicine Department and Physical Medicine, Rheumatology & Rehabilitation Department of Tanta University Hospitals received clearance from the Ethics Committee before beginning the research. Each participant provided written permission after being fully briefed.

Exclusion criteria were individuals receiving B cell-targeted treatments, or other biologic agents and patients with hematological disorders.

Two groups of participants were created: SLE patient group and control health group.

Each participant was exposed to

1. A thorough history
2. Clinical assessment [evaluate SLE]
3. Activity of the disease [measured via Systemic Lupus Erythematosus Disease Activity Index (SLEDAI) when the sample was collected]
4. Usual investigations [complete blood count (CBC), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), complement 4, complement 3, antinuclear antibody (ANA), anti-double strand DNA (Anti-dsDNA) and albumin/creatinine ratio]
5. Specific investigations tests [flow cytometric analysis of the peripheral blood samples to detect lymphocytes bound to platelets by using: (CD 19 and CD 41a monoclonal antibodies to detect B lymphocytes bound to platelets. CD 3 and CD 41a monoclonal antibodies to detect T lymphocyte bound to platelets) and using Enzyme-linked immune-sorbent assay (ELISA) kits, to assess: (the concentrations of sCD40L as platelet activation marker and the concentrations of IL-10 as a reflection of lymphocytes response)].

The sample was peripheral venous blood obtained from every subject under complete aseptic technique. Sterilized containers were used to collect spot urine samples, 20 minutes of centrifugation at a speed of 2000–3000 rpm then the supernatant was eliminated for the measurement of albumin/ creatinine ratio.

Flow cytometry (FCM) technique

The whole alignment operation was carried out using normal calibrator beads for correcting side scatter, forward scatter, and the photomultiplier tube (PMT) following that the argon laser (488) had warmed up for thirty min. When clicking the run button, modify the areas and display the cell population in a simple histogram wherever the laser scatter was detected on both forward scatter scale and detectors. The basic histogram had at least 10,000 events (cells), each of which was bordered by a line to distinguish it from the surrounding cells. Within the gated population of lymphocytes, the percentage of cells covered by monoclonal antibodies was calculated and evaluated in a single histogram. After 10000 events were counted, the total numbers of lymphocytes expressing the receptors and emitting fluorescence signals were divided by CD3 and CD19 monoclonal antibodies into T lymphocytes and B lymphocytes respectively, then to CD41a monoclonal antibodies were summated and multiplied in the PMT and the computer analysed the data as a single-colored frequency histogram.

Specific ELISA kits

Estimation of the concentrations of sCD40L

The kit used ELISA to calculate the amount of human sCD40L present in sample. The biotin-conjugated sCD40L antibodies were combined with streptavidin-HRP to produce an immunological complex after sCD40L was added to an enzyme well that was pre-coated with the sCD40L monoclonal antibody. The amounts of human sCD40L in this specimen and the color that results from the addition of chromogen solutions A and B were positively associated.

Estimation of the concentrations of IL-10

The kit used ELISA to measure the level of human interleukin 10 (IL-10) in samples. IL-10 was added to monoclonal antibody Enzyme well which is pre-coated with (IL-10) monoclonal antibody and the biotin conjugated (IL-10) antibodies were combined with streptavidin-HRP to form immune complex. The color develops after adding chromogen solution A, B and the concentration of (IL-10) of sample were positively correlated.

Statistical analysis

SPSS v26 (IBM Inc., Chicago, IL, USA) was used for the statistical analysis. Histograms and the Shapiro-Wilks test were utilized to assess the normality of the data distribution. Using an unpaired Student's t-test, quantitative parametric variables were provided as mean and standard deviation (SD) and compared between the two groups. Interquartile range (IQR) and median were used to show and analyse quantitative non-parametric data. When applicable, qualitative parameters were examined using the Chi-square test or Fisher's exact test and provided as frequency and percentage (%). A two-tailed P value < 0.05 was considered statistically significant.

Results

Demographic data and disease duration showed no significant difference between both studied groups. Table 1

Table 1: Demographic data in the two studied groups

		SLE Patients (N=30)	Control group (N=30)	p-value
Age		39.27±7.46	41.80±7.27	0.188
Sex	Male	2 (6.7%)	1 (3.3%)	0.554
	Female	28 (93.3%)	29 (96.7%)	
	FET	0.351		

Data are presented as mean ± SD or number (%). FET= Fischer's exact test. p: probability.

In the included SLE patients, disease duration had mean value of 7.87± 2.78 years. The majority of our SLE patients had a joint disease (93.3%), while renal disease and constitutional manifestations were present in 40% and 63.3% of SLE patients respectively. Moreover, cutaneous manifestations and photosensitivity were reported by 60% and 76.6% of SLE patients respectively. Only two SLE patients (6.7%) had neurological manifestations. The SLEDAI score had mean value of 7.60 ± 5.22 in the studied SLE patients. Most SLE patients had moderate disease activity (46.7%), while mild disease was present in 33.3%of SLE patients and high activity was present in 20% of SLE patients, Table 2.

Table 2: Analysis of disease duration, manifestations and activity in SLE patients.

SLE Patients (N=30)		
Disease duration (years)		2.78 ± 7.87
Clinical manifestations		
Constitutional symptoms		19 (63.3)
Renal affection		12 (40)
Joint affection		28 (93.3)
Neurological manifestations		2 (6.7)
Cutaneous manifestations		18 (60)
Photosensitivity		23 (76.6)
Disease activity		
Sledai	No activity	0 (0)
	Mild activity	10 (33.3)
	Moderate activity	14 (46.7)
	High activity	6 (20)
	Very high activity	0 (0)
	Total	30 (100)
	7.60±5.22	

Data are presented as Mean ± SD or number (%). SLEDAI: Systemic Lupus Erythematosus Disease Activity Index.

a substantial elevation was existed in ESR level in individuals with SLE contrasted to control group (p = 0.001). CRP showed no substantial variation among individuals with SLE and control group. There was a substantial elevation in the ANA and anti-dsDNA levels in individuals with SLE contrasted to control group (p<0.001). a substantial reduce in C3 and C4 concentrations was existed in individuals with SLE contrasted to control group (p<0.001). Table 3

Table 3: Analysis of inflammatory and immunological markers in the SLE patients and control group

	SLE Patients (N=30)	Control group (N=30)	p-value
ESR (mm/h)	23.17±10.04	12.00±4.47	0.001*
CRP (mg/dl)	3.80±2.16	3.03±1.50	0.115
ANA (IU/ml)	9.50±4.81	0.56±0.28	0.001*
Anti-dsDNA (IU/ml)	181.5 (2.75-460)	11.25 (5.9-17.65)	0.001*
C3 (mg/dl)	56.43±36.37	114.67±29.07	0.001*
C4 (mg/dl)	12.40±4.56	30.27±10.49	0.001*

Data are presented as mean ± SD or median (IQR). ESR: erythrocyte sedimentation rate. CRP: C- reactive protein. ANA: antinuclear antibody. Anti-dsDNA: anti-double strand DNA. p: probability. *: statistically significant (p<0.05).

Haemoglobin level, platelet count, leucocytic, total lymphocytes percentage, $CD3^+$ lymphocytes percentage and $CD19^+$ lymphocytes percentage showed substantial decrease in SLE patients contrasted to control group. But creatinine, urea levels, albumin to creatinine ratio, lymphocyte bound platelets, sCD40L level and IL10 level showed a significant increase in SLE patients compared to control group (p<0.001). Table 4

Table 4: Analysis of laboratory parameters in the SLE patients and control group

	SLE Patients (N=30)	Control group (N=30)	p-value
Hb (g/L)	9.75±1.20	11.89±0.57	< 0.001*
PLT (10^3/ul)	216.90 ±66.76	276.77±84.74	0.004*
WBC (10^3/ul)	6.26±1.89	7.97±1.79	< 0.001*
Lymphocytes (%)	19.50±4.58	26.40±7.91	< 0.001*
CD3+ lymphocytes (%)	56.70±9.87	66.17±6.67	< 0.001*
CD19+ lymphocytes (%)	6.44±3.23	13.50±2.76	< 0.001*
Creatinine (mg/dl)	1.35±0.44	0.74±0.16	< 0.001*
Urea (mg/dl)	53.90±26.26	24.60±7.31	< 0.001*
Alb/ Cr ratio (mg/g Cr)	170.5 (27.25-460)	17.5 (14-24)	< 0.001*
CD 19+CD41a + Lymphocytes*%*	21.01±7.07	2.19±1.18	< 0.001*
CD3 + CD41a + Lymphocytes*%*	22.62±7.65	2.45±1.12	< 0.001*
sCD40L (ng/ml)	9.69±3.16	1.06±0.90	< 0.001*
IL 10 (pg/ml)	176.43±32.97	46.10±17.33	< 0.001*

Data are presented as mean ± SD or median (IQR). Hb: hemoglobin. PLT: platelet. WBC: white blood cells. Alb/ Cr ratio: albumin to creatinine ratio. IL 10: interleukin 10. P. probability**.** *: statistically significant (p<0.05).

The percentage of lymphocyte bound platelets (CD19+CD41a+ lymphocytes and CD3+CD41a+ lymphocytes), sCD40L level and IL10 level expressed a significant increase in SLE patients who had haematuria and with positive anti-dsDNA compared to SLE patients without haematuria and with negative anti-dsDNA. Table 5

Table 5: Analysis of lymphocyte-bound platelets sCD40L and IL10 in the SLE patients according to hematuria and anti-dsDNA

	CD 19^+CD$41a^+$ Lymphocytes %	$CD3^+$ $CD41a^+$ Lymphocytes %	sCD40L (ng/ml)	IL 10 (pg/ml)
SLE patients with hematuria (N=12)	24.31±4.86	26.82±5.23	12.09±1.12	202.73±19.07
SLE patients without hematuria (N=18)	17.72±7.52	18.41±7.47	7.29±2.65	150.13±20.16
p-value	0.008*	< 0.001*	< 0.001*	< 0.001*
SLE patients with positive Anti-dsDNA (N=20)	24.88±4.97	26.86±5.17	11.78±1.14	194.50±22.48
SLE patients with negative Anti-dsDNA (N=10)	13.28±3.00	14.13±3.44	5.52±0.60	140.30±16.13
p-value	< 0.001*	< 0.001*	< 0.001*	< 0.001*

Data are presented as mean ± SD. Anti-dsDNA: anti-double strand DNA. SLE: systemic lupus erythematosus. sCD40L: soluble cluster of differentiation 40 ligand p: probability**.** *: statistically significant (p<0.05).

$CD19^+CD41a^+$ lymphocytes had a substantial positive association with $CD3^+CD41a^+$ lymphocytes, sCD40L, IL10, anti-dsDNA, albumin to creatinine ratio, SLEDAI, creatinine and urea, while they had a substantial negative association with C3, C4 and platelets. CD3+ CD41a+ lymphocytes had a substantial positive association with CD19+ CD41a+ lymphocytes, sCD40L, IL10, anti-dsDNA, albumin to creatinine ratio, SLEDAI, creatinine and urea, whereas they had a substantial negative association with C3, C4, platelets and leucocytic count. sCD40L had a substantial positive association with $CD19^+CD41a^+$ lymphocytes, $CD3^+CD41a^+$ lymphocytes, IL10, anti-dsDNA, albumin to creatinine ratio, SLEDAI, creatinine and urea, while it had a substantial negative association with C3, C4, haemoglobin, platelets and leucocytic count. IL-10 had a substantial positive association with $CD19^+CD41a^+$ lymphocytes, $CD3^+CD41a^+$ lymphocytes, sCD40L, anti-dsDNA, albumin to creatinine ratio, SLEDAI, creatinine and urea (r = 0.696 and p<0.001), while it had a substantial negative association with C3, C4, haemoglobin, platelets and leucocytic count. Table 6.

Table 6: Correlation between the percentage of CD19+CD41a+ lymphocytes, CD3+CD41a+ lymphocytes, sCD40L level, and IL-10 level with other clinical and laboratory data in the SLE patients, (N=30)

		CD 19+ CD41a+ Lymphocytes	CD3+ CD41a+ Lymphocytes %	sCD40L (ng/ml)	IL 10 (pg/ml)
CD3+ CD41a+ Lymphocytes %	R	0.894	---	0.728	0.608
	P	< 0.001*		< 0.001*	< 0.001*
CD 19+ CD41a+ Lymphocytes %	R	---	0.894	0.724	0.532
	P		< 0.001*	< 0.001*	0.002*
sCD40L	R	0.724	0.728	---	0.833
	P	< 0.001*	< 0.001*		< 0.001*
IL 10	R	0.532	0.608	0.833	---
	P	0.002*	< 0.001*	< 0.001*	
ANA	R	0.167	0.326	0.285	0.297
	P	0.485	0.326	0.208	0.197
Anti dsDNA	R	0.482	0.541	0.843	0.800
	P	0.007*	0.002*	< 0.001*	< 0.001*
C3	R	-0.660	-0.734	-0.897	-0.783
	P	< 0.001*	< 0.001*	< 0.001*	< 0.001*
C4	R	-0.658	-0.700	-0.853	-0.715
	P	< 0.001*	< 0.001*	< 0.001*	< 0.001*

Alb/Cr ratio	R	0.398	0.449	0.814	0.799
	P	0.029*	0.013*	< 0.001*	< 0.001*
SLEDAI	R	0.464	0.485	0.810	0.823
	P	0.010*	0.007*	< 0.001*	< 0.001*
Creatinine	R	0.659	0.677	0.783	0.756
	P	< 0.001*	< 0.001*	< 0.001*	< 0.001*
Urea	R	0.654	0.669	0.806	0.696
	P	< 0.001*	< 0.001*	< 0.001*	< 0.001*
Age	R	-0.119	-0.040	-0.239	-0.267
	P	0.532	0.835	0.203	0.146
Duration	R	0.182	0.231	-0.018	-0.127
	P	0.335	0.218	0.925	0.505
ESR	R	0.141	0.046	0.206	0.259
	P	0.456	0.811	0.276	0.167
CRP	R	0.172	0.196	0.332	0.334
	P	0.364	0.300	0.073	0.071
Hb	R	-0.175	-0.236	-0.514	-0.570
	P	0.355	0.210	0.004*	< 0.001*
Platelet count	R	-0.427	-0.403	-0.610	-0.662
	P	0.019*	0.027*	< 0.001*	< 0.001*
Leucocytic count	R	-0.294	-0.373	-0.544	-0.439
	P	0.115	0.042*	0.002*	0.015*
Total Lymphocytes %	R	-0.109	-0.321	-0.268	-0.265
	P	0.567	0.084	0.152	0.157
CD3+ Lymphocytes %	R	-0.025	-0.117	-0.044	-0.105
	P	0.895	0.537	0.817	0.581
CD19+ Lymphocytes %	R	-0.341	-0.301	-0.395	-0.161
	P	0.065	0.106	0.131	0.395

RS: Spearman's correlation, P: probability, *: Statistically significant (p<0.05)

Discussion

Regarding the inflammatory markers, SLE patients showed a substantial elevation in the levels of ESR while CRP levels showed no significant difference. These agreed with the study of Aringer M. [10] who stated that CRP levels in SLE remained below 6 mg/dL in active SLE, but in several situations CRP showed higher levels in SLE patients, while ESR levels were raised in SLE patients. In addition, Littlejohn *et al.* [11] reported that CRP levels were low in SLE patients with flare, while ESR levels was elevated.

However, Farouk *et al.* [12] disagreed by reporting that there was rise in the levels of CRP and ESR in SLE patients.

Regarding CBC, Hb, leucocytic count and total lymphocytic count showed significant decrease in SLE patients compared to controls. This was in line with Kunireddy *et al.* [13] who found that there was substantial variation among the levels of hemoglobin and erythrocytes in SLE patients and controls. In addition, Han *et al.* [14] found that active disease was associated with low leucocytic count and low lymphocyte count. Leukopenia in SLE could be because of the activity of the disease as well as viral infections, drug toxicity or hematological disorders, while Lymphopenia could be due to antibodies against T lymphocytes, uncontrolled apoptosis and increased complement-mediated cytolysis of T cells [15, 16].

Furthermore, platelet count was statistically decreased in between the two groups which agreed with Abdel Galil *et al.* [17] who reported that SLE disease activity was associated with low platelet count. Thrombocytopenia could be immune-mediated through immune-complex coating of platelets leading to their early destruction or antiplatelet antibodies [18].

There was a significant decrease in the percentage of CD19+ lymphocytes in SLE patients that agreed with the study of Odendahl *et al.* [19] who found significant B lymphopenia associated with major disturbances in the homeostasis of all three major B cell types and suggesting that CD27+ memory B cells were the predominant peripheral blood population in SLE. In addition, Korganow *et al.* [20] described a decrease in the membrane expression of CD19 protein on all B cells in SLE patients compared to controls with the persistence of plasmacyte-differentiated and plasmacyte-activated B cells even in quiescent patients.

In the present study, there was an increase in the albumin/ creatinine ratio in SLE patients. This was in agreement with Birmingham *et al.* [21] who reported that SLE is associated with an increase in urinary albumin creatinine ratio.

ANA and anti-dsDNA showed higher levels in SLE patients, while low levels of C3 and C4 were demonstrated. This agreed with Font *et al.* [22] and Wichainun *et al.* [23] who showed that positive ANA and high anti-dsDNA levels were found in SLE patients while complement C3 and complement C4 levels were low.

The results of the present study revealed that there was a significant increase in serum levels of IL10 level in SLE patients compared to a control group. In addition, there was a significant increase in the IL10 level in SLE patients with hematuria and positive anti-dsDNA, negative correlation with complement C3 and C4 and positive correlation with albumin/creatinine ratio and SLEDAI score. Also, IL10 level was found to be correlated with sCD40L levels and with the percentages of CD19+PLT+, CD3+PLT+ lymphocytes. This agreed with Zamora *et al.* [7] who reported that IL10 correlated with lymphocyte-bound platelets and sCD40L serum levels.

The increased level of IL 10 in SLE patients could be assigned to autoreactive B lymphocytes and activated monocytes. This finding agreed with Melamud *et al.* [24] who reported that the level of IL10 was increased in SLE patients. Also, Chun *et al.* [25] reported that serum IL-10 titers in SLE patients were positively correlated with the SLADEI and anti-dsDNA antibody titers, and negatively

with C3 and C4 levels. Many studies reported that the serum IL-10 titers increased in SLE patients and correlated with clinical and serological markers of disease activity as C3, C4 and with anti-DNA antibody titers [26, 27]. However, Mariscal *et al*. [28] reported that there was no association between IL10 level with autoantibodies or disease activity.

On the other hand, there was a significant increase in serum levels of sCD40L level in SLE patients compared to control group. Also, there was a significant increase in the sCD40L level in SLE patients with hematuria and positive anti-dsDNA. The results showed negative correlation with complement C3 and C4 while they showed positive correlation with albumin/creatinine ratio and SLEDAI score. This was in agreement with Goules *et al*. [29] who reported that serum of SLE patients had significantly higher levels of sCD40L than the control serum and showed that SLE-sCD40L positive patients produce more frequently anti-dsDNA which correlated sCD40L with the disease severity. Also, Duffau *et al*. [30] reported that sCD40L was correlated with disease activity measured by SLEDAI proving that platelets activation is responsible for increase of level of sCD40L in SLE patients.

Moreover, the proportion of each subpopulation of lymphocyte-bound platelets and the serum concentrations of sCD40L, a putative indirect measurement of activation of platelets, were positively and significantly correlated in SLE patients. This study's findings were supported by Zamora *et al*. [7], who discovered a correlation between the proportion of lymphocyte-bound platelets and plasma concentrations of sCD40L. It is likely that platelet binding affects lymphocyte functions and provides a role in SLE pathogenesis and illness activity because the activation of platelets has been linked with platelets binding to lymphocytes in SLE and other authors, such as El Gendi *et al*. [31], discovered that platelets activation has a direct relationship with SLE disease progression.

When contrasted with the control group, the quantities of circulating B and T lymphocytes bound platelets were significantly higher in the individuals suffering from SLE. Additionally, it was shown that in those suffering from SLE, the proportions of B and T cells with bound platelets closely linked with one another. According to Zamora *et al*. [7], there was a link between B and T lymphocytes bound platelets in patients with SLE, and the amounts of lymphocytes with bound platelets were greater in SLE patients compared with healthy people. Additionally, Joseph *et al*. [32] discovered that SLE patients had considerably more platelet-lymphocyte complexes than the control group.

In individuals suffering from SLE with hematuria and positive anti-dsDNA, the amounts of lymphocytes bound platelets significantly increased. Additionally, albumin/ creatinine ratio and SLEDAI score revealed a positive link with lymphocytes attached to platelets, including B and T cells, whereas complements 3 and 4 exhibited a negative association. This was in agreement with Zamora *et al*.'s findings [7] that lymphocytes with bound platelets were more prevalent in individuals with SLE with a larger albumin/creatinine ratio, SLEDAI > 3, a lower complement C3, positive anti-dsDNA, and hematuria. All things considered; our research indicated that estimating the percentages of lymphocytes bound platelets in SLE would prove to be a valuable technique for predicting the severity of SLE. Moreover, controlling this binding might be used as a therapeutic regulation of autoimmunity.

Limitations

Further studies must evaluate the association of lymphocytes bound platelets with each subpopulation of B lymphocytes and its relation to production of different immunoglobulin in SLE patients are required. Future studies are needed to evaluate controlling the binding lymphocytes to platelets as a target therapy for regulation of autoimmunity in SLE patients.

Conclusions

SLE patients had a substantial elevation in lymphocytes bound platelets contrasted to healthy control group, this elevated percentage was in association with increase concentrations of sCD40L and IL10. Renal symptoms and active illness were more common in those suffering from SLE, as were lymphocytes bound platelets.

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