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ORIGINAL ARTICLE

The Assessment of Red Blood Cell Distribution Width, Platelet Parameters and Inflammatory Markers in Patients on Antıpsoriasis Therapy

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ABSTRACT

Objective: Psoriasis is an inflammatory skin disease with several comorbidities. We aimed to evaluate red blood cell distribution width (RDW), platelet parameters and inflammatory markers in patients on antipsoriasis therapies.
Materials and Methods: 94 psoriasis patients and 74 healthy controls were prospectively analyzed. Before and after 8 weeks of different therapies (calcipotriol+clobetasol propionate; narrow-band UVB; combined narrow-band UVB and acitretin; infliximab and adalimumab), red blood cell distribution width, platelet parameters, high sensitivity C reactive protein, and erythrocyte sedimentation rate levels were measured. Lipid profile and fasting blood glucose tests were also performed prior the treatment. Psoriasis severity and area index and body mass index were calculated for each patient.
Results: red blood cell distribution width, high sensitivity C reactive protein, triglyceride, total cholesterol levels and body mass index were higher in patients than in controls ($p<0.05$, for all four). No significant differences were observed in red blood cell distribution width, platelet parameters, high sensitivity C reactive protein and erythrocyte sedimentation rate levels after all therapies ($p>0.05$, for all). Red blood cell distribution width was not correlated with psoriasis severity and area index ($p>0.05$). The limitations of our study are the relatively small samples of therapy groups and short duration of follow-up.
Conclusion: The role of antipsoriasis therapies on inflammatory markers should be elucidated via additional larger-scale studies. Red blood cell distribution width and high sensitivity C reactive protein might be useful to detect systemic inflammation in psoriasis.
Keywords: Psoriasis, therapy, inflammation, comorbidity

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INTRODUCTION

Psoriasis which is a chronic, recurrent skin disease is characterized by systemic inflammation leading to certain autoinflammatory diseases including cardiovascular disease, obesity, insulin resistance, and thromboembolic events [1]. There are many parameters which are elevated in inflammatory diseases and they are accepted as predictors of risk for development of them [2,3]. The hemogram parameters in routine blood panels have been proposed as one of these markers in systemic inflammation [4]. Red blood cell distribution width (RDW) which is used to differentiate causes of anemia, has been reported to be related with chronic inflammation and has been defined as a prognostic tool in different clinical settings such as pulmonary arterial hypertension, congestive heart failure and coronary heart disease

[5-12]. It has also been detected as a powerful predictor of mortality and morbidity in general population and older adults [13]. And also, platelet parameters including mean platelet volume (MPV), platelet volume distribution width (PDW) and plateletcrit (PCT) have been found to be associated with some inflammatory conditions [14-16].

The aim of this study was to evaluate the hemogram parameters, erythrocyte sedimentation rate (ESR), high sensitivity C reactive protein (hs-CRP), fasting lipid profile and fasting blood glucose (FBG) levels in patients with psoriasis, and to search for a relationship between hemogram parameters, ESR, hs-CRP and different therapies. We also aimed to determine if RDW might be a new inflammatory marker which shows the severity of psoriasis.

MATERIALS and METHODS

Patients and Procedure

After the study protocol was approved by the Hacettepe University School of Medicine ethics committee and the participants provided written informed consent, data were collected from 94 psosiasis patients and 74 healthy controls. The study was conducted at Hacettepe University, School of Medicine, Dermatology Out-Patient Clinic, Ankara, Turkey, between December 2010 and November 2011. Inclusion criteria for psoriasis patients were age ≥18 years, plaque type psoriasis and absence of anemia. Patients who had psoriatic arthritis, had signs of acute or chronic infection or any systemic inflammatory disease and an increase in lesions under treatment were excluded from the study. Patients with a history of any systemic therapy and/or phototherapy for psoriasis within the previous month, any topical treatment within the preceeding two weeks and any systemic anti-inflammatory treatment due to other comorbidities were also excluded. The patient group was divided into five different therapy groups: (1) topical therapy [calcipotriol+clobetasol propionate (n=15)], (2) narrow-band UVB (n=29), (3) combined narrow-band UVB and acitretin (n=11), (4) infliximab (n=24) and (5) adalimumab (n=15), and they had been followed up for 8 weeks under the therapy. The treatment groups were determined according to the comorbidities in the patients, the severity of the disease and their compliance with the treatment. For each patient and control, body mass index (BMI) was calculated before and after treatment. RDW, MPV, PDW, PCT, ESR and hs-CRP levels were measured before and after treatment. Fasting lipid profile including low density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C), triglyceride (TG), total cholesterol and FBG tests were also performed prior the treatment. The severity of psoriasis was evaluated by psoriasis severity and area index (PASI). Psoriasis patients were divided into mild (PASI<10) and moderate/severe (PASI ≥10) psoriasis groups. For each group, RDW levels were analyzed. Complete blood count and ESR data, fasting lipid profile and FBG levels were analyzed with flow cytometric, Westergren and spectrophotometric methods, respectively. Hs-CRP was evaluated using nephelometric method.

Statistical Analysis

All statistical evaluations were performed using Statistical Package for Social Sciences (SPSS) v16.0 for Windows package program. Descriptive analysis was used to summarise the data (mean ±SD or frequencies) as appropriate. In order to compare independent groups with nonparametric data Mann-Whitney U-test and for parametric data independent samples t-test were used. Wilcoxon test and paired sample t test were used to compare the measurements before and after treatment within the same group for data with parametric and non-parametric distributions respectively. Significant p values were accepted when they are ≤0.05

RESULTS

This prospective study included 94 psoriasis patients (40 males and 54 females) with a mean age of 44.22 ± 14.66 years and 74 healthy controls (32 males and 42 females) with a mean age of 42.02 ± 14.15 years. There were not any significant differences in age or gender between the groups (p=0.385, p=0.929). Mean PASI score at baseline was 9.49 ± 7.04. Patients presented with a significantly higher BMI compared with controls. (Mean of 24.81 ± 3.15 vs 23.79 ± 2,97 kg/m2 ; p=0.035). Baseline laboratory parameters of patients and controls were summarized in Table 1. Mean RDW, MPV, PDW, PCT, Hb, ESR, hs-CRP, total cholesterol, LDL, TG, FBG levels were higher in the patients than in the controls but the differences were statistically significant only for RDW, hs-CRP, TG and total cholesterol (p=0.020, p=0.049, p=0.005, p=0.049). No any statistically significant difference was found between RDW and severity of psoriasis (p=0.718). Correlation between RDW and baseline PASI scores was depicted in Figure 1.

Table 1. Baseline laboratory parameters in patient and control groups.

Parameter	Psoriasis Patients (n=94)	Controls (n=74)	p
RDW (%)	13.92 ± 1.16	13.52 ± 0.99	0.020
MPV (fL)	8.72 ± 1.17	8.60 ± 1.01	0.279
PDW (%)	16.60 ± 0.45	16.57 ± 0.46	0.586
PCT (%)	0.216 ± 0.46	0.210 ± 0.40	0.392
hs-CRP (mg/dL)	0.71 ± 1.29	0.54 ± 1.22	0.049
ESR (mm/h)	13.74 ± 1.03	11.51 ± 1.04	0.169
BMI (kg/m^2)	24.81 ± 3.15	23.79 ± 2.97	0.035
FBG (mg/dL)	93.19 ± 14.75	92.86 ± 2.34	0.912
LDL-C (mg/dL)	116.32 ± 32.03	112.23 ± 37.73	0.449
HDL-C (mg/dL)	48.84 ± 12.00	49.87 ± 1.34	0.600
TG (mg/dL)	153.32 ± 78.35	119.39 ± 73.93	0.005
Total cholesterol (mg/dL)	196.91 ± 38.56	184.29 ± 43.98	0.049

RDW: Red blood cell distribution width, MPV: Mean platelet volume, PDW: Platelet volume distribution width, PCT: Plateletcrit, hs-CRP: High sensitivity C reactive protein, ESR: Erythrocyte sedimentation rate, BMI: Body mass index, FBG: fasting blood glucose, LDL-C: Low density lipoprotein cholesterol, HDL-C: High density lipoprotein cholesterol, TG: Triglyceride

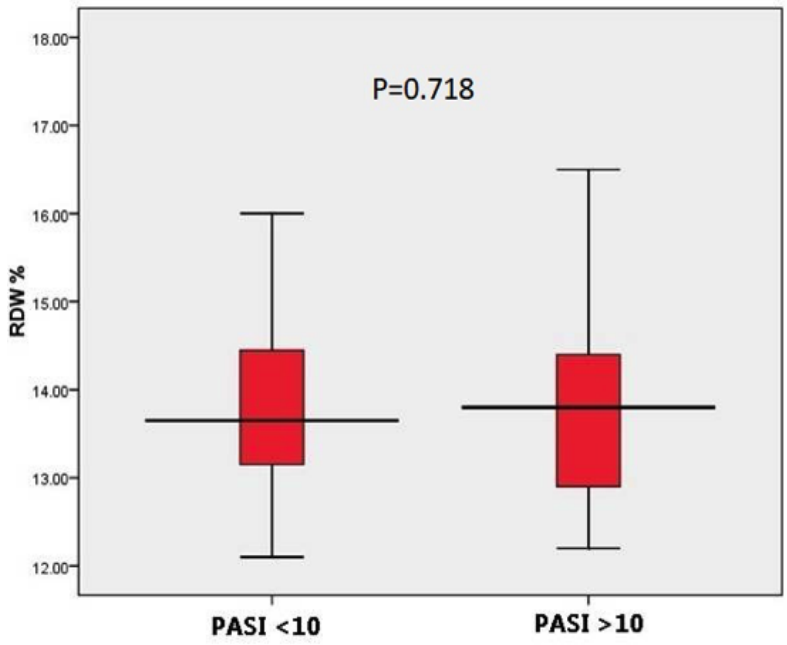

Figure 1. RDW values of the patients in mild and moderate/severe psoriasis groups.

Analyzing the results of hemogram parameters, hs-CRP and ESR according to therapy groups, no significant differences were observed in mean RDW, MPV, PDW, PCT, hs-CRP and ESR after all five different therapies ($p>0.05$, for all), as shown in Table 2. A significant decrease in PASI was detected in all therapy groups ($p<0.05$, for all).

Table 2. Laboratory parameters and PASI scores of the patients before and after therapy for 8 weeks.

Parameter	Topical Therapy (n=15)			Narrow-band UVB (n=29)			Narrow-band UVB + Acitretin (n=11)			Infliximab (n=24)			Adalimumab (n=15)		
	Baseline	**wk 8**	**p**	**Baseline**	**wk 8**	**p**	**Baseline**	**wk 8**	**p**	**Baseline**	**wk 8**	**p**	**Baseline**	**wk 8**	**p**
RDW (%)															
Mean ± SD	13,53 ± 1,11	13,50 ± 0,9	0,759	13,88 ±0,97	13,93 ± 1,29	0,780	13,60 ± 1,04	13,34 ± 0,80	0,148	14,20 ± 1,40	14,12 ± 1,92	0,763	14,16 ± 1,21	14,02 ± 1,38	0,345
Median	13,20	13,20		13,70	13,80		13,30	13,20		13,85	13,65		13,80	13,80	
Range	12,40-16,90	12,40-15,90		12,20-16,70	12,20-17,60		12,10-15,80	12,40-15,10		12,20-17,20	12,40-21,20		12,50-16,00	12,40-16,30	
MPV (fL)															
Mean ± SD	8,62 ± 1,55	8,613 ± 1,55	0,856	8,65 ±0,81	8,66 ± 0,91	0,928	8,06 ± 0,76	8,12 ± 0,76	0,693	8,49 ± 0,74	8,55 ± 0,68	0,532	9,06 ± 1,11	9,120 ± 1,30	0,701
Median	8,60	8,40		8,40	8,60		8,20	8,10		8,45	8,50		8,80	8,90	
Range	6,40-12,20	6,30-12,00		7,20-10,00	7,20-11,00		7,10-9,30	7,10-9,30		7,00-10,20	7,50-9,80		6,80-10,80	6,50-12,00	
PDW (%)															
Mean ± SD	16,36 ± 0,31	16,43 ± 0,30	0,313	16,64 ± 0,47	16,68 ± 0,54	0,651	16,74 ± 0,44	16,58 ± 0,37	0,178	16,48 ± 0,44	16,47 ± 0,54	0,954	16,86 ± 0,40	16,68 ± 0,56	0,122
Median	16,40	16,50		16,70	16,70		16,90	16,70		16,40	16,50		16,90	16,70	
Range	15,70-16,90	15,90-17,00		15,80-17,70	15,90-18,70		16,10-17,30	15,90-17,10		15,70-17,50	15,70-18,30		16,10-17,80	15,80-17,60	
PCT (%)															
Mean ± SD	0,21 ± 0,03	0,21 ± 0,03	0,987	0,22 ± 0,04	0,22 ± 0,04	0,715	0,19 ± 0,03	0,19 ± 0,02	0,777	0,20 ± 0,04	0,20 ± 0,06	0,750	0,23 ± 0,04	0,23 ± 0,04	0,452
Meadian	0,20	0,20		0,22	0,21		0,18	0,18		0,19	0,19		0,23	0,22	
Range	0,15—0,27	0,15-0,29		0,11-0,30	0,16-0,33		0,14-0,26	0,14-0,24		0,14-0,34	0,06-0,41		0,18-0,34	0,15-0,30	
Hs-CRP (mg/dL)															
Mean ± SD	0,36 ± 0,35	0,23 ± 0,23	0,053	0,36 ± 0,29	0,31 ± 0,21	0,287	1,18 ± 0,20	0,42 ± 0,40	0,273	1,25 ± 1,99	0,71 ± 0,79	0,107	0,51 ± 0,23	0,53 ± 0,40	0,814
Meadian	0,29	0,15		0,30	0,33		0,33	0,22		0,55	0,33		0,57	0,34	
Range	0,02-1,29	0,03-0,80		0,02-1,10	0,02-0,78		0,11-7,23	0,02-1,37		0,02-9,29	0,02-2,46		0,15-0,97	0,16-1,37	
ESR (mm/h)															
Mean ± SD	9,93 ± 0,85	9,93 ± 0,80	1,000	15,65 ± 1,07	14,75 ± 0,91	0,526	9,90 ± 0,86	8,81 ± 0,66	0,626	15,37 ± 1,10	16,08 ± 1,17	0,703	14,06 ± 1,03	15,26 ± 1,21	0,539
Meadian	7,00	8,00		14,00	12,00		6,00	8,00		12,50	14,00		12,00	12,00	
Range	2,00-30,00	2,00-28,00		2,00-47,00	2,00-39,00		2,00-29,00	2,00-22,00		2,00-35,00	2,00-44,00		2,00-44,00	2,00-43,00	
PASI															
Mean ± SD	4.68 ± 1.40	2,30 ± 1,82	**0,000**	7.03 ± 4.40	1,93 ± 1,83	**0,000**	14.01 ± 10,30	2,87 ± 1,72	**0,002**	14.70 ± 7.43	1,85 ± 2,38	**0,000**	7.40 ± 4.22	1,12 ±1,54	**0,000**
Meadian	5,00	1,80		6,00	1,60		10,60	2,20		15,70	1,20		6,20	0,60	
Range	2,20-6,40	0,00-6,00		2,40-24,80	0,00-6,60		5,00-33,60	0,40-5,60		4,80-32,40	0,00-11,20		3,20-16,20	0,00-4,20	

RDW: Red blood cell distribution width, MPV: Mean platelet volume, PDW: Platelet volume distribution width, PCT: Plateletcrit, hs-CRP: High sensitivity C reactive protein, ESR: Erythrocyte sedimentation rate, PASI: Psoriasis area and severity index

DISCUSSION

Psoriasis is a chronic inflammatory autoimmune disease characterized by an excessively aberrant hyperproliferation of keratinocytes. In the complex pathogenesis of psoriasis, T cell-mediated inflammation involving Th1/Th2 homeostasis, the Th17/Treg balance and the IL-23/Th17 axisis thought to be the main mechanism in degradation of epidermal kinetics. Immunological dysfunction in psoriasis involves the cross-talk between immune cells and cytokines which lead to a chronic systemic inflammation, not limited just only to skin [17]. Numerous studies have investigated the role of several markers in systemic inflammation and in the development of systemic comorbidities in patients with psoriasis [18-22]. In the literature, it was reported that tumor necrosis factor alpha [23], interleukin 1 [24], interleukin 6 [25], interleukin 23 [25], intercellular adhesion molecule [26], adiponectin [27], leptin [27], LDL-C [28], lipoprotein-a [29], CRP [30] and serum amyloid A [31] have significant correlations between the severity of inflammation and the risk of other comorbidities but there is still a lack of generally accepted marker for assessing the severity of psoriasis and systemic inflammation.

RDW which is a quantitative measure of the variability in the size of erythrocytes is mainly used in the differential diagnosis of anemia. Furthermore, recent studies have indicated that RDW may be used also as a marker of inflammation in many diseases such as cardiovascular disease [5,9], pulmonary hypertension [8], rheumatoid arthritis [10], inflammatory bowel disease [6,7,12], celiac disease [32] and metabolic syndrome [33]. It has been reviewed that chronic inflammation results in disorders of iron metabolism and decreases both production of and bone marrow responsiveness to erythropoietin, resulting in impaired hematopoiesis and increased RDW levels [34]. Complete blood count which includes RDW is one of the most common diagnostic tests in hospital admissions and it is easy, rapid and inexpensive to perform; as such, we think RDW might be a practical marker to assess the systemic inflammation and severity in psoriasis. However, in our study, we did not find any correlation between RDW and PASI. And also, we showed that different therapies did not influence RDW. Literature review has yielded some studies evaluating RDW in psoriasis patients. Firstly, Kim et al. [35] conducted a retrospective study on 261 psoriasis patients and 102 healthy controls and they found that the mean RDW was significantly higher in patients with psoriasis compared with healthy controls but RDW was not correlated with PASI. In their study, they had some limitations such as not excluding patients with anemia or other inflammatory diseases and including patients on methotrexate therapy which may cause to anemia. In another study of Dogan et al. [36], it was also showed that psoriatic inflammation can simultaneously cause RDW elevation. Like the study of Kim et al. [35] and Dogan et al. [36], our findings supply the positive association between RDW and psoriasis. We did not find any change in RDW levels on the 8th week of antipsoriasis therapies. Balavi et al. [37] found a decrease in RDW levels on the 3th month of antipsoriasis therapy. Based on their studies, we think that we need to monitor patients longer to determine the decrease in RDW level.

We disigned this prospective study excluding the possible confounding factors such as anemia and psoriatic arthritis. And also, we excluded patients with a history of acute or chronic infection or any systemic inflammatory disease. As these factors might have an influence on RDW, future studies should consider these confounders, as well, while investigating the asscociation between RDW and psoriasis.

Evaluating the results of our study, we concluded that MPV, PDW and PCT that are parameters used to indicate platelet size, distribution of platelet size, the rate of platelet count to blood and platelet activity are not sensitive or spesific enough to predict the severity of inflammation in psoriasis patients. We think that, new studies are needed to show the role of platelets in psoriasis.

In this study, we compared inflammatory markers as ESR and hs-CRP between psoriasis patients and controls, and we analysed the effects of different therapies on these markers over a period of 8 weeks. We found that mean hs-CRP and ESR levels were higher in psoriasis patients than in the controls and the difference was significant for hs-CRP,

but not for ESR (p=0.02, for hs-CRP and p=0.081, for ESR). Several studies indicating increased CRP levels in psoriasis patients suggest that systemic inflammation provides a predisposition for development of cardiovascular diseases and other comorbidities [38,39]. Based on these results, we may conclude that screening the patients for hs-CRP may be useful to assess the risk of other comorbidities in psoriasis. In this study, not any statistically significant decrease was observed in hs-CRP and ESR levels under five different therapies, although all therapy groups experienced clinical improvements and statistically significant reductions in PASI scores. Our results seem to show that antipsoriasis therapies do not have any effect on systemic inflammation parameters in the blood. However, we did not follow-up the patients for a long time, we evaluated the parameters on the 8th week of therapies. Eight weeks therapy may not be a sufficient time to evaluate the decrease in systemic inflammation parameters for psoriasis.

In the literature, there are several studies reporting close association between psoriasis and cardiovascular disease, obesity, diabetes, hypertension, dyslipidemia, metabolic syndrome, nonalcoholic fatty liver disease, cancer, anxiety and depression, and inflammatory bowel disease [40]. In our study, we found a significantly higher mean BMI in patients compared with controls. In the literature, Ferguson et al. [41] reported the risk of obesity in psoriasis patients lastly. In another population-based prospective cohort study of Han et. al [42], subjects with BMI of more than 30 were found to have a higher risk of psoriasis compared with the BMI 18.5-23 group. Our results and the literature support the risk of obesity in psoriasis. Obesity is a chronic disease and has also systemic inflammatory effects [43]. Adipocytokines and proinflammatory cytokines produced by the truncal adipose tissue have been found to be associated with insulin resistance also [44]. Pereira et al. [45] recently found a significant association between psoriasis and insulin resistance with an odds ratio of 2.63 of abnormal glucose homeostasis in psoriasis patients compared to controls. In the present study, we did not find any correlation between FBG and psoriasis but we think that evaluating FBG levels only is not enough to determine the risk of insulin resistance in patients with psoriasis. Further tests should be performed to show this association. Dyslipidemia was reported to be another comorbidity in psoriasis. The cytokines IL-1, IL-6, and TNF-alpha that are involved in the pathogenesis of psoriasis may alter the function of hepatocytes resulting in dyslipidemia [39]. The present findings show that LDL-C, TG and total cholesterol levels were higher and HDL-C was lower in patients with psoriasis than in the controls. Our results confirm that psoriatic patients require through lipid examinations.

The limitations of our study are the relatively small samples of therapy groups and short duration of follow-up. Additional studies, with larger sample sizes and longer follow-up periods, are required to more clearly understand the correlations between antipsoriasis therapy and serum inflammatory markers.

CONCLUSION

In conclusion, the present study indicates that TG, total cholesterol and BMI are higher in psoriasis patients and they should be screened for dyslipidemia and obesity. RDW and hs-CRP might be useful to detect systemic inflammation in psoriasis but platelet activating parameters and ESR do not show any changes in psoriasis. Antipsoriasis therapies do not seem to affect hemogram parameters including RDW, MPV, PDW, PCT and also, hs-CRP and ESR levels. Further studies are needed to elucidate the relationship between RDW and psoriasis severity.

CONFLICT OF INTEREST STATEMENT

Authors declare that they have no conflict of interest regarding this manuscript.

REFERENCES

[1] Davidovici BB, Sattar N, Prinz J, et al. Psoriasis and systemic inflammatory diseases: potential mechanistic links between skin disease and comorbid conditions. J Invest Dermatol 2010; 130: 1785-96.

[2] Srikanthan K, Feyh A, Visweshwar H, et al. Systematic Review of Metabolic Syndrome Biomarkers: A Panel for Early Detection, Management, and Risk Stratification in the West Virginian Population. Int J Med Sci. 2016; 13: 25-38.

[3] Esser N, Paquot N, Scheen AJ. Inflammatory markers and cardiometabolic diseases. Acta Clin Belg. 2015; 70: 193-9.

[4] Dagistan Y, Dagistan E, Citisli V. Evaluation of simple blood counts as inflammation markers for brain tumor patients. Neurol Neurochir Pol. 2016; 50: 231-5.

[5] Al-Najjar Y, Goode KM, Zhang J, et al. Red cell distribution width: an inexpensive and powerful prognostic marker in heart failure. Eur J Heart Fail. 2009; 11: 1155-62.

[6] Cakal B, Akoz AG, Ustundag Y, et al. Red cell distribution width for assessment of activity of inflammatory bowel disease. Dig Dis Sci. 2009; 54: 842-7.

[7] Clarke K, Sagunarthy R, Kansal S. RDW as an additional marker in inflammatory bowel disease/undifferentiated colitis. Dig Dis Sci. 2008; 53: 2521-3.

[8] Hampole CV, Mehrotra AK, Thenappan T, et al. Usefulness of red cell distribution width as a prognostic marker in pulmonary hypertension. Am J Cardiol. 2009; 104: 868-72.

[9] Lappé JM, Horne BD, Shah SH, et al. Red cell distribution width, C-reactive protein, the complete blood count, and mortality in patients with coronary disease and a normal comparison population. Clin Chim Acta. 2011; 412: 2094-9.

[10] Lee WS, Kim TY. Relation between red blood cell distribution width and inflammatory biomarkers in rheumatoid arthritis. Arch Pathol Lab Med. 2010; 134: 505-6.

[11] Lippi G, Targher G, Montagnana M, et al. Relation between red blood cell distribution width and inflammatory biomarkers in a large cohort of unselected outpatients. Arch Pathol Lab Med. 2009; 133: 628-32.

[12] Molnar T, Farkas K, Szepes Z, et al. RDW can be a useful additional marker in diagnosing Crohn's disease and ulcerative colitis. Dig Dis Sci. 2008; 53: 2828–9.

[13] Patel KV, Semba RD, Ferrucci L, et al. Red cell distribution width and mortality in older adults: a meta-analysis. J Gerontol A Biol Sci Med Sci. 2010; 65: 258-65.

[14] Pan Y, Muheremu A, Wu X, et al. Relationship between platelet parameters and hepatic pathology in patients with chronic hepatitis B infection - a retrospective cohort study of 677 patients. J Int Med Res. 2016; 44: 779-86.

[15] Matowicka-Karna J. Markers of inflammation, activation of blood platelets and coagulation disorders in inflammatory bowel diseases. Postepy Hig Med Dosw (Online). 2016; 70: 305-12.

[16] Makhlouf HA, Sadek SH, Nafady AA. Platelet function in diabetic and non-diabetic patients with chronic obstructive pulmonary disease: A case control study. Clin Respir J. 2016. doi: 10.1111/crj.12477

[17] Deng Y, Chang C, Lu Q. The Inflammatory Response in Psoriasis: A Comprehensive Review. Clin Rev Allergy Immunol. 2016; 50: 377-89.

[18] Dreiher J, Weitzman D, Davidovici B, et al. Psoriasis and dyslipidaemia: a population-based study. Acta Derm Venereol. 2008; 88: 561-5

[19] Farías MM, Serrano V, de la Cruz C. Psoriasis and obesity: a review and practical recommendations. Actas Dermosifiliogr 2011; 102: 505-9.

[20] Shapiro J, Cohen AD, David M, et al. The association between psoriasis, diabetes mellitus, and atherosclerosis in Israel: a case-control study. J Am Acad Dermatol. 2007; 56: 629–34.

[21] Späh F. Inflammation in atherosclerosis and psoriasis: common pathogenic mechanisms and the potential for an integrated treatment approach. Br J Dermatol. 2008; 159: 2: 10-7.

[22] Ucak S, Ekmekci TR, Basat O, et al. Comparison of various insulin sensitivity indices in psoriatic patients and their relationship with type of psoriasis. J Eur Acad Dermatol Venereol. 2006; 20: 517-22.

[23] De Simone C, Carbone A, Caldarola G. Etanercept therapy for psoriasis in a patient with numerous comorbidities. Am J Clin Dermatol. 2010; 11: 49–50.

[24] Prens EP, Benne K, van Damme J, et al. Interleukin-1 and interleukin-6 in psoriasis. J Invest Dermatol. 1990; 95: 121S-124S.

[25] Fitch E, Harper E, Skorcheva A, et al. Pathophysiology of psoriasis: recent advances on IL-23 and Th17 cytokines. Curr Rheumatol Rep. 2007; 9: 461-7.

[26] Ghazizadeh R, Shimizu H, Tosa M, et al. Pathogenic mechanisms shared between psoriasis and cardiovascular disease. Int J Med Sci. 2010; 7: 284-9.

[27] Gerdes S, Osadtschy S, Rostami-Yazdi M, et al. Leptin, adiponectin, visfatin and retinol-binding protein-4 - mediators of comorbidities in patients with psoriasis? Exp Dermatol. 2012; 21: 43-7.

[28] Coimbra S, Oliveira H, Reis F, et al. Circulating levels of adiponectin, oxidized LDL and C-reactive protein in Portuguese patients with psoriasis vulgaris, according to body mass index, severity and duration of the disease. J Dermatol Sci. 2009; 55(3): 202–4.

[29] Pietrzak A, Kadzielewski J, Janowski K, et al. Lipoprotein (a) in patients with psoriasis: associations with lipid profiles and disease severity. Int J Dermatol. 2009; 48: 379-87.

[30] Coimbra S, Oliveira H, Reis F, et al. C-reactive protein and leucocyte activation in psoriasis vulgaris according to severity and therapy. J Eur Acad Dermatol Venereol. 2010; 24: 789-96.

[31] Dogan S, Atakan N. Is serum amyloid A protein a better indicator of inflammation in severe psoriasis? Br J Dermatol. 2010; 163: 895–6.

[32] Sategna Guidetti C, Scaglione N, Martini S. Red cell distribution width as a marker of coeliac disease: a prospective study. Eur J Gastroenterol Hepatol. 2002; 14: 177–81.

[33] Sánchez-Chaparro MA, Calvo-Bonacho E, González-Quintela A, et al. Higher red blood cell distribution width is associated with the metabolic syndrome: results of the Ibermutuamur Cardiovascular Risk assessment study. Diabetes care 2010; 33: e40.

[34] Bujak K, Wasilewski J, Osadnik T, et al. The Prognostic Role of Red Blood Cell Distribution Width in Coronary Artery Disease: A Review of the Pathophysiology. Dis Markers. 2015; 2015: 824624.

[35] Kim DS, Shin D, Jee H, et al. Red blood cell distribution width is increased in patients with psoriasis vulgaris: A retrospective study on 261 patients. J Dermatol. 2015; 42: 567.

[36] Doğan S, Atakan N. Red blood cell distribution width is a reliable marker of inflammation in plaque psoriasis. Acta Dermatovenerol Croat. 2017; 25: 26-31.

[37] Balevi A, Olmuşçelik O, Ustuner P, et al. Is there any Correlation between Red Cell Distribution Width, Mean Platelet Volume Neutrophil Count, Lymphocyte Count, and Psoriasis Area Severity Index in Patients Under Treatment for Psoriasis? Acta Dermatovenerol Croat. 2018; 26: 199-205.

[38] Vadakayil AR, Dandekeri S, Kambil SM, et al. Role of C-reactive protein as a marker of disease severity and cardiovascular risk in patients with psoriasis. Indian Dermatol Online J. 2015; 6: 322-5.

[39] Takahashi H, Iinuma S, Honma M, et al. Increased serum C-reactive protein level in Japanese patients of psoriasis with cardio- and cerebrovascular disease. J Dermatol. 2014; 41: 981-5.

[40] Ni C, Chiu MW. Psoriasis and comorbidities: links and risks. Clin Cosmet Investig Dermatol. 2014; 7: 119-32.

[41] Ferguson LD, Brown R, Celis-Morales C, et al. Association of central adiposity with psoriasis, psoriatic arthritis and rheumatoid arthritis: a cross-sectional study of the UK Biobank. Rheumatology (Oxford). 2019 May 25 (doi: 10.1093/rheumatology/kez192).

[42] Han JH, Lee JH, Han KD, et al. Increased risk of psoriasis in subjects with abdominal obesity: A nationwide population-based study. J Dermatol. 2019 May 31 (doi: 10.1111/1346-8138.14939).

[43] Fleming P, Kraft J, Gulliver WP, et al. The Relationship of Obesity with the Severity of Psoriasis: A Systematic Review. J Cutan Med Surg. 2015; 19: 450-6.

[44] Coban M, Tasli L, Turgut S, et al. Association of Adipokines, Insulin Resistance, Hypertension and Dyslipidemia in Patients with Psoriasis Vulgaris. Ann Dermatol. 2016; 28: 74-9.

[45] Pereira RR, Amladi ST, Varthakavi PK. A study of the prevalence of diabetes, insulin resistance, lipid abnormalities, and cardiovascular risk factors in patients with chronic plaque psoriasis. Indian J Dermatol. 2011; 56: 520-6.