Archives of Dermatological Research (2021) 313:491–498
https://doi.org/10.1007/s00403-020-02129-3

ORIGINAL PAPER

Can monocyte to HDL cholesterol ratio and monocyte to lymphocyte ratio be markers for inflammation and oxidative stress in patients with vitiligo? A preliminary study

Abdullah Demirbaş[1] · Ömer Faruk Elmas[2] · Mustafa Atasoy[3] · Ümit Türsen[4] · Torello Lotti[5]

Received: 12 May 2020 / Revised: 30 July 2020 / Accepted: 8 August 2020 / Published online: 20 August 2020

Abstract

Both systemic inflammation and oxidative stress play crucial roles in the pathogenesis of vitiligo. In recent studies, monocyte to high-density lipoprotein cholesterol ratio (MHR), monocyte to lymphocyte ratio (MLR), neutrophil to lymphocyte ratio (NLR), platelet to lymphocyte ratio (PLR), mean platelet volume (MPV) and plateletcrit (PCT) have been shown to reflect inflammation and oxidative stress in chronic inflammatory and autoimmune diseases. In this study, we aimed to investigate the hematological and inflammatory parameters in patients with vitiligo and to evaluate their possible relationship with disease severity. The parameters including MHR, MLR, NLR, PLR, MPV, and PCT were retrospectively investigated in patients with vitiligo and healthy controls. Disease severity was evaluated using the vitiligo extent tensity index (VETI) score. A total of 180 patients with vitiligo, and age–gender-matched 180 healthy controls were enrolled in the study. MHR, MLR, PLR, PCT values were found to be significantly higher in patients with vitiligo ($p < 0.05$). MPV and NLR values showed no statistically significant difference between the two groups. A positive correlation was also detected between MHR and MLR values, disease duration, and VETI score ($p < 0.05$). We suggest that MHR and MLR can be used as markers of inflammation and oxidative stress in patients with vitiligo. Both markers may also reflect disease severity.

Keywords HDL cholesterol · Inflammation · Monocyte · Oxidative stress · Vitiligo · Vitiligo extent tensity index

Introduction

Vitiligo is an acquired skin disease characterized by depigmented macules with the loss of functional melanocytes in the skin [1]. The worldwide incidence varies between 0.5 and 2%. Although the average age of onset is around 20 years, it can occur at any age [2, 3]. The etiopathogenesis of the entity is clearly unknown but it has been reported to be associated with various factors including genetic factors, autoimmune factors, oxidative stress, neuro-humoral, and auto-cytotoxic mechanisms [2, 4]. The interaction between oxidative stress and autoimmune factors has particularly been accused of causing melanocyte loss [5, 5]. It has been reported that reactive oxygen species (ROS) levels are found to be higher in the skin with active vitiligo. ROS reduces the formation of dendrites of melanocytes, weakens the adhesion of melanocytes to the basal layer, and causes their separation. Melanocyte migration caused by this separation has been shown to trigger the immune process starting in the epidermis. ROS has also been shown to increase the release of pro-inflammatory cytokines and mediators and to accelerate the separation of melanocytes from the basal layer [7].

Monocytes (MN) are the main sources of pro-inflammatory and oxidative cytokines [8]. High-density lipoprotein cholesterol (HDL-C) inhibits the oxidation of low-density lipoprotein cholesterol (LDL-C) and prevents its negative effects on the endothelium. For this reason, HDL-C shows anti-inflammatory and antioxidant effects [9–11]. Monocytes

✉ Abdullah Demirbaş
abdullah_demrba@yahoo.com

1 Department of Dermatology, Konya Numune Hospital, Konya, Turkey

2 Department of Dermatology, Kırşehir Ahi Evran University, Kırşehir, Turkey

3 Department of Dermatology, Health Science University, Kayseri City Hospital, Kayseri, Turkey

4 Department of Dermatology, Mersin University, Mersin, Turkey

5 Department of Dermatology, Guglielmo Marconi University, Rome, Italy

to HDL-C ratio (MHR) has been suggested as a marker of systemic inflammation and oxidative stress in many inflammatory diseases [12–14]. Inflammatory processes usually increase the number of monocytes while decreasing lymphocytes. In this context, monocyte–lymphocyte ratio (MLR) is another parameter used as an inflammatory and prognostic marker in many autoimmune disorders, cardiovascular diseases, cancer, and tuberculosis [15–18].

Neutrophils (NE), potent sources of neutrophil elastase, matrix metalloproteinase, and cytokines, are the key cells of inflammation. In contrast, lymphocytes (LY) have significant anti-inflammatory properties [19]. It has been suggested that the neutrophil–lymphocyte ratio (NLR) can be a simple and reliable indicator of the inflammation in various diseases.

Platelets (PLT) have been shown to play remarkable roles in inflammatory reactions and immune response. Platelet–lymphocyte ratio (PLR) and NLR have been reported to show a correlation in chronic inflammatory conditions. Mean platelet volume (MPV), an indicator of platelet function and activation, has been reported to reflect immunological and inflammatory status [19–22]. Plateletcrit (PCT) refers to the percentage of platelet volume in the blood and has been considered as a better prognostic factor than MPV in inflammatory conditions [23]. The effectivity and reliability of these markers have been investigated in various dermatological diseases including psoriasis, Behçet's disease, recurrent aphthous stomatitis, and pemphigus vulgaris [20, 24–26].

In this study, we aimed to investigate these hematological and inflammatory parameters in patients with vitiligo and to evaluate their possible relationship with disease severity.

Materials and methods

Subjects

This study included patients diagnosed with vitiligo, and age- and gender-matched healthy volunteers, between January 2019 and December 2019. The parameters including age, gender, disease duration, vitiligo extent tensity index (VETI) score and laboratory results (MN (K/µL), HDL-C (mg/dl), NE (K/µL), PLT, (K/µL), LY (K/µL), MPV (K/µL), PCT (%), MHR, MLR, NLR and PLR) were retrospectively reviewed for each patient. The same laboratory parameters were also reviewed for each control.

Patients with any systemic disease or another cutaneous disorder, and those who received any topical and systemic treatment in the last six months were excluded.

Calculation of VETI score

A total of five different affected body areas (head, upper extremities, trunk, lower extremities, genital), and five different stages reflecting the severity of the disease were evaluated to calculate VETI score.

Stage 0 = Normal skin.

Stage 1 = Hypopigmentation.

Stage 2 = Complete depigmentation with black hairs and perifollicular pigmentation.

Stage 3 = Complete depigmentation with black hairs without perifollicular pigmentation.

Stage 4 = Complete depigmentation with white and black hairs, and with or without perifollicular pigmentation.

Stage 5 = Complete depigmentation with significant whitening in hairs.

The extent of the lesional area was assessed using the rule of nines. The total body VETI was calculated using the following formula.

VETI score: (Percentage of head involvement × stage) + (Percentage of trunk involvement × stage) 4 + (Percentage of upper extremity involvement × stage) 2 + (Percentage of lower extremity involvement × stage) 4 + (Percentage of genital organ involvement × stage) 0.1 [27].

Statistical analysis

The data obtained were analyzed using SPSS (statistical package for social sciences) 23.0 statistical software. The data were described as number and percentage or mean and standard deviation unless stated otherwise. Student's *t* test was used to compare quantitative data between two independent groups. Spearman correlation analysis was applied to assess the continuous variables. All data were measured at 95% confidence intervals, and the threshold for statistical significance was set at $p < 0.05$.

Ethics approval

All the procedures followed the Helsinki declaration and the study was approved by the KTO Karatay University Institutional Review Board (Decision date and number: 2020/006). Written Informed consent was also obtained from all the subjects.

Results

A total of 180 patients (93 females, 87 males) with vitiligo and 180 (90 females, 90 males) age- and gender-matched healthy controls were included in the study. The mean ages of the patients and controls were 29.56 ± 9.8

and 29.61 ± 9.66, respectively ($p > 0.05$). The mean disease duration was 7.42 ± 7.48 years. The mean VETI score was 2.8 ± 3.13. MN, PCT, MHR, MLR, and PLR values were found to be statistically significantly higher in the patients compared to the control group ($p < 0.05$) (Figs. 1, 2). On the other hand, HDL-C, NE, and LY values were statistically significantly higher in the control group ($p < 0.05$). PLT, MPV, and NLR values showed no statistically significant difference between the groups ($p > 0.05$).

There was a moderate positive correlation between MHR, and MLR, VETI, and disease duration. MLR, NLR, and PLR values also showed a moderate positive correlation. A weak negative correlation was detected between MHR and PLR. All demographic and laboratory parameters have been shown in Tables 1, 2 and 3. The correlations between laboratory parameters, disease duration, and VETI scores have been presented in Table 4.

Discussion

Patients with vitiligo have high levels of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-a), interleukin-2 (IL-2), IL-6, and IL-8, and oxidative factors including ROS and free radicals. Autoimmune, oxidative, and cytotoxic mechanisms have been accused of causing increased levels of these inflammatory parameters [31, 32]. Tue et al. found that serum IL-6, IL-1 β, and granulocyte–macrophage colony-stimulating factor (GM-CSF) levels were significantly higher in patients vitiligo compared to healthy controls [33]. In the study of Ala et al., the levels of interferon-γ (IFN-γ), a pro-inflammatory cytokine, were found to be higher in patients with vitiligo compared to controls. In the same study, the levels of IL-10, an anti-inflammatory cytokine, were reported to be lower [34]. These studies support the role of systemic inflammation in vitiligo [31–35].

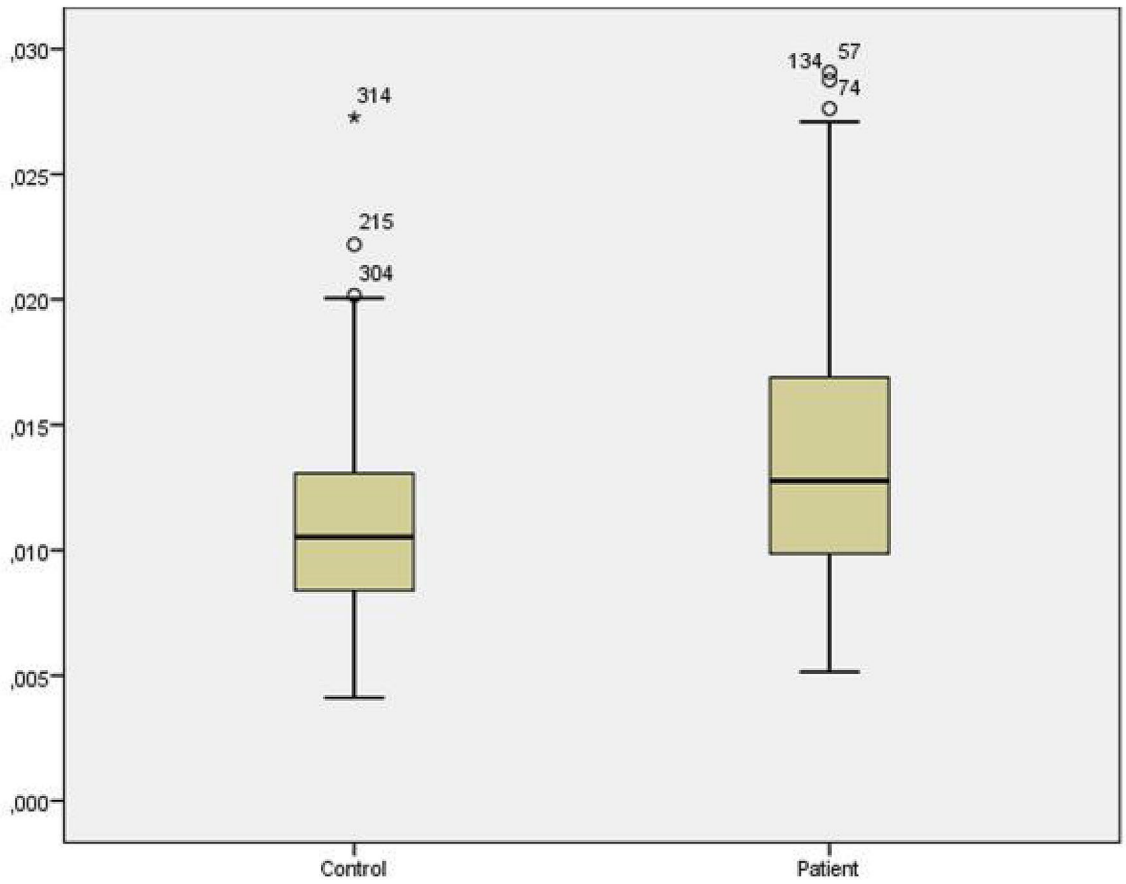

Fig. 1 Monocyte/HDL cholesterol ratio (MHR) for the patients and controls

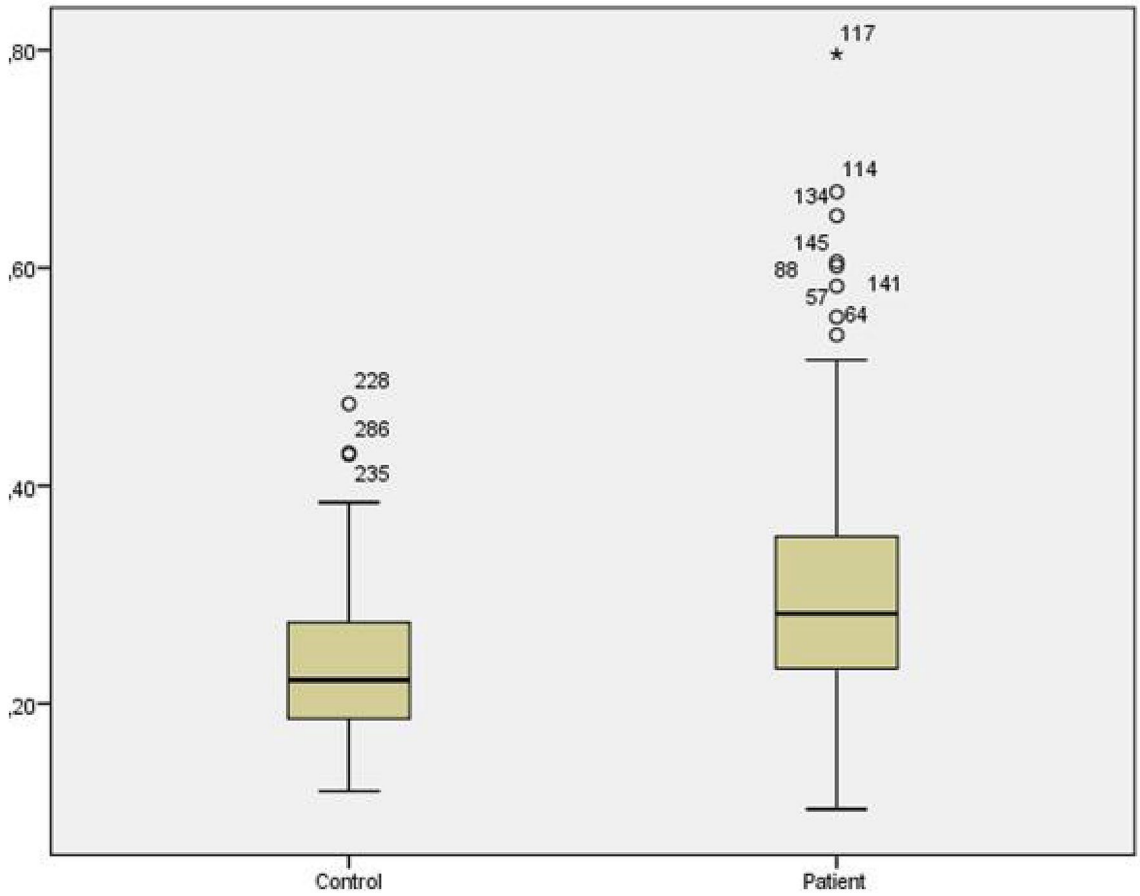

Fig. 2 Monocyte/lymphocyte ratio (MLR) for the patients and controls

MHR, MLR, NLR, PLR, MPV, and PCT are considered as cost-effective and simple laboratory parameters indicating systemic inflammation in many diseases [36, 37]. Anti-inflammatory and antioxidant effects of HDL-C are well described. On the contrary monocytes have a crucial role in inflammatory and oxidative processes. Therefore, MHR is considered as a new prognostic marker indicating oxidative stress and inflammation in cardiovascular diseases [38, 39]. Kanbay et al. suggested that high level of MHR is a bad prognostic factor for cardiovascular events in patients with chronic kidney disease [14]. Açıkgöz et al. reported that MHR may be a marker of inflammation and an early predictor of vascular involvement in Behçet's disease [40]. Another study showed that MHR can be considered as a reliable marker of systemic inflammation in patients with psoriasis [41]. Similarly, it has been suggested that MLR can be a marker of systemic inflammation in several diseases including Behçet's disease, spondylarthritis, and cancer [42, 43]. In our study, MHR and MLR were found to be higher in patients with vitiligo compared to healthy controls. Besides, both parameters showed positive correlations with the VETI score. In this context, we suggest that both parameters may reflect disease severity.

NLR, PLR and MPV are the other markers of systemic inflammation which have been shown to be predictors of prognosis in chronic inflammatory diseases [19, 21, 22]. These parameters have been reported to reflect disease activity and prognosis in patients with systemic lupus erythematosus, rheumatoid arthritis, and psoriasis [22, 44, 45]. NLR values have been shown to be higher in patients with vitiligo compared to controls [46]. In our study, NLR and MPV showed no statistically significant difference between the patients and controls. PLR levels, however, were found to be significantly higher in the patients group.

Table 1 The distributions of gender

Gender	Patients (*n*, %)	Controls (*n*, %)
Male	87 (48.3)	90 (50)
Female	93 (51.7)	90 (50)
Total	180 (100.0)	180 (100.0)

Table 2 Demographic features of the patients and controls

Group	*N*	Mean	S.D	*P* value
Age (year)				
Patient	180	29.56	9.8	0.82
Male	87	30.34	1.05	
Female	93	28.82	1.02	
Healthy control	180	29.61	966	
Male	90	30.01	1.001	
Female	90	29.2	1.04	
Disease duration (year)				
Patient	180	7.42	7.48	–
VETI score				
Patient	180	2.8	3.13	–

VETI vitiligo extent tensity index

PCT is another marker of systemic inflammation [23]. However, there are only a few studies investigating the relationship between PCT and dermatological diseases. In a recent study, in which we investigated the possible relationship between platelet parameters and discoid lupus erythematosus, PCT values showed no statistically significant difference between patients with discoid lupus erythematosus and healthy controls [47]. In the present study, PCT levels were found to be significantly higher in patients with vitiligo compared to the controls.

Although the relationship between NLR, PLR, and MPV with vitiligo has been previously investigated, to the best of our knowledge, this is the first study investigating the relationship between MHR, PCT, and MLR with vitiligo [46, 48]. In this study, we also investigated the relationship between these parameters, and the disease tensity and severity.

The main limitation of our study is its retrospective nature. So, we were not able to evaluate the possible co-effects of some of the patient's characteristics such as smoking history and dietary habits, which may also affect MHR.

Table 3 The mean values of the laboratory parameters for the patients and controls

Group	*N*	Mean	S.d	*P* value
MN (K/μL)				
Patient	180	0.58	0.13	0.0001
Healthy control	180	0.53	0.12	
HDL-C (mg/dl)				
Patient	180	45.1	8.38	0.000008
Healthy control	180	49.24	8.53	
NE (K/μL)				
Patient	180	4.6	1.28	0.003
Healthy control	180	4.95	1.19	
PLT (K/μL)				
Patient	180	284.99	53.61	0.068
Healthy control	180	275.87	51.28	
LY (K/μL)				
Patient	180	2.03	0.51	0.0002
Healthy control	180	2.32	0.48	
MPV (K/μL)				
Patient	180	8.64	1.19	0.614
Healthy control	180	8.59	1.31	
PCT (%)				
Patient	180	0.24	0.04	0.015
Healthy control	180	0.23	0.04	
MHR				
Patient	180	0.013	0.004	0.0025
Healthy control	180	0.011	0.003	
MLR				
Patient	180	0.3	0.1	0.00004
Healthy control	180	0.23	0.06	
NLR				
Patient	180	2.39	0.86	0124
Healthy control	180	2.19	0.66	
PLR				
Patient	180	148.84	47.31	0.00004
Healthy control	180	123.253	35.58	

MN monocyte, *HDL-C* high-density lipoprotein cholesterol, *NE* neutrophil, *PLT* platelet, *LY* lymphocyte, *MPV* mean platelet volume, *PCT* plateletcrit, *MHR* monocyte to high-density lipoprotein cholesterol ratio, *MLR* monocyte to lymphocyte ratio, *NLR* neutrophil to lymphocyte ratio, *PLR* platelet to lymphocyte ratio, *S.d* standard deviation, $P < 0.05$ is defined statistically significant and shown in bold

The second limitation is the relatively small sample size. Therefore, more studies with larger sample sizes are needed to empower conclusions deduced in the present study.

Table 4 The correlation analysis between the disease durations, VETI score, and laboratory parameters

	MN	HDL	NE	PLT	LY	MPV	PCT	MHR	MLR	NLR	PLR	VETI	Disease duration
MN	**1**	−0.41	0.24	0.07	0.11	0.05	0.08	0.85	0.59	0.12	−0.05	0.46	0.43
HDL-C	**−0.41**	**1**	−0.06	0.04	−0.09	0.01	0.06	−0.81	−0.21	0.06	0.1	−0.34	−0.3
NE	**0.24**	**−0.06**	**1**	−0.05	0.12	0.02	−0.002	0.19	0.08	0.68	−0.09	0.02	0.04
PLT	**0.07**	**0.04**	**−0.05**	**1**	0.81	−0.39	0.69	0.01	−0.01	−0.11	0.55	−0.01	−0.02
LY	**0.11**	**−0.09**	**0.12**	**0.81**	**1**	−0.03	0.08	0.12	−0.69	−0.59	−0.75	0.03	0.08
MPV	**0.05**	**0.01**	**0.02**	**−0.39**	**−0.03**	**1**	0.23	0.03	0.06	0.03	−0.22	0.05	0.01
PCT	**0.08**	**0.06**	**−0.002**	**0.69**	**0.08**	**0.23**	**1**	0.004	−0.01	−0.07	0.36	-0.002	−0.01
MHR	**0.85**	**−0.81**	**0.19**	**0.01**	**0.12**	**0.03**	**0.004**	**1**	0.49	0.04	−0.09	0.49	0.43
MLR	**0.59**	**−0.21**	**0.08**	**−0.01**	**−0.69**	**0.06**	**−0.01**	**0.49**	**1**	0.55	0.54	0.29	0.25
NLR	**0.12**	**0.06**	**0.68**	**−0.11**	**-0.59**	**0.03**	**−0.07**	**0.04**	**0.55**	**1**	0.44	−0.00016	−0.01
PLR	**−0.05**	**0.1**	**−0.09**	**0.55**	**−0.75**	**−0.22**	**0.36**	**−0.09**	**0.54**	**0.44**	**1**	−0.03	−0.05
VETI	**0.46**	**−0.34**	**0.02**	**−0.01**	**0.03**	**0.05**	**−0.002**	**0.49**	**0.29**	**−0.000163**	**−0.03**	**1**	0.52
Disease duration	**0.43**	**−0.3**	**0.04**	**−0.02**	**0.08**	**0.01**	**−0.01**	**0.43**	**0.25**	**−0.01**	**−0.05**	**0.52**	**1**

MN monocyte, *HDL-C* high-density lipoprotein cholesterol, *NE* neutrophil, *PLT* platelet, *LY* lymphocyte, *MPV* mean platelet volume, *PCT* plateletcrit, *MHR* monocyte to high-density lipoprotein cholesterol ratio, *MLR* monocyte to lymphocyte ratio, *NLR* neutrophil to lymphocyte ratio, *PLR* platelet to lymphocyte ratio, *VETI* vitiligo extent tensity index

Funding None.

Compliance with ethical standards

Conflict of interest The authors declare that there are no conflicts of interest financial or otherwise related to the material presented herein.

Ethical approval All the procedures followed the Helsinki declaration and the study was approved by the KTO Karatay University Institutional Review Board (Decision date and number: 2020/006).

Informed consent Written Informed consent was also obtained from all the subjects.

References

1. Ortonne JP, Bahadoran P, Fitzpatrick TB, Mosher DB, Hory Y (2003) Hypomelanoses and hypermelanoses. In: Freedberg IM, Eisen AZ, Wolff K, et al. (eds) Fitzpatrick's dermatology in general medicine, 6th edn. The McGraw-Hill Companies Inc, USA, pp 836–881
2. Alikhan A, Felsten LM, Daly M, Petronic-Rosic V (2011) Vitiligo: a comprehensive overview: part I. Introduction, epidemiology, quality of life, diagnosis, differential diagnosis, associations, histopathology, etiology, and work-up. J Am Acad Dermatol 65:473–491. https://doi.org/10.1016/j.jaad.2010.11.061
3. Ezzedine K, Lim H, Suzuki T, Katayama I, Hamzavi I, Lan C et al (2012) Revised classification/nomenclature of vitiligo and related issues: the vitiligo global issues consensus conference. Pigm Cell Melanoma R 25:E1–E13. https://doi.org/10.1111/j.1755-148X.2012.00997.x
4. Njoo MD, Westerhof W (2001) Vitiligo: pathogenesis and treatment. Am J Clin Dermat 2(3):167–181. https://doi.org/10.2165/00128071-200102030-00006
5. Maresca V, Roccella M, Roccella F, Camera E, Del Porto G, Passi S et al (1997) Increased sensitivity to peroxidative agents as a possible pathogenic factor of melanocyte damage in vitiligo. J Invest Dermatol 109:310–313. https://doi.org/10.1111/1523-1747.ep12335801
6. Schallreuter K (1999) Successful treatment of oxidative stress in vitiligo. Skin Pharmacol Phys 12:132–138. https://doi.org/10.1159/000029867
7. Laddha NC, Dwivedi M, Mansuri MS, Gani AR, Ansarullah M, Ramachandran A et al (2013) Vitiligo: interplay between oxidative stress and immune system. Exp Dermatol 22:245–250. https://doi.org/10.1111/exd.12103
8. Ancuta P, Wang J, Gabuzda D (2006) CD16+ monocytes produce IL-6, CCL2, and matrix metalloproteinase-9 upon interaction with CX3CL1-expressing endothelial cells. J Leukoc Biol 80:1156–1164. https://doi.org/10.1189/jlb.0206125
9. Hessler JR, Robertson AL Jr, Chisolm GM (1979) LDL-induced cytotoxicity and its inhibition by HDL in human vascular smooth muscle and endothelial cells in culture. Atherosclerosis 32:213–229. https://doi.org/10.1016/0021-9150(79)90166-7
10. Li XP, Zhao SP, Zhang XY, Liu L, Gao M, Zhou QC (2000) Protective effect of high density lipoprotein on endothelium-dependent vasodilatation. Int J Cardiol 73:231–236. https://doi.org/10.1016/S0167-5273(00)00221-7
11. Parthasarathy S, Barnett J, Fong LG (1990) High-density lipoprotein inhibits the oxidative modification of low-density lipoprotein. Biochim Biophys Acta 1044(2):275–283. https://doi.org/10.1016/0005-2760(90)90314-N
12. Canpolat U, Aytemir K, Yorgun H, Şahiner L, Kaya EB, Çay S et al (2015) The role of preprocedural monocyte-to-high-density lipoprotein ratio in prediction of atrial fibrillation recurrence after cryoballoon-based catheter ablation. Ep Europace 17:1807–1815. https://doi.org/10.1093/europace/euu291
13. Canpolat U, Çetin EH, Cetin S, Aydin S, Akboga MK, Yayla C et al (2016) Association of monocyte-to-HDL cholesterol ratio with slow coronary flow is linked to systemic inflammation. Clin Appl Thromb Hemost 22:476–482. https://doi.org/10.1177/1076029615594002

14. Kanbay M, Solak Y, Unal HU, Kurt YG, Gok M, Cetinkaya H et al (2014) Monocyte count/HDL cholesterol ratio and cardiovascular events in patients with chronic kidney disease. Int Urol Nephrol 46:1619–1625. https://doi.org/10.1007/s11255-014-0730-1
15. Chen L, Zeng H, Yang J, Lu Y, Zhang D, Wang J et al (2018) Survival and prognostic analysis of preoperative inflammatory markers in patients undergoing surgical resection for laryngeal squamous cell carcinoma. BMC Cancer 18:816. https://doi.org/10.1186/s12885-018-4730-x
16. Du J, Chen S, Shi J, Zhu X, Ying H, Zhang Y et al (2017) The association between the lymphocyte-monocyte ratio and disease activity in rheumatoid arthritis. Clin Rheumatol 36:2689–2695. https://doi.org/10.1007/s10067-017-3815-2
17. Naranbhai V, Kim S, Fletcher H, Cotton MF, Violari A, Mitchell C et al (2014) The association between the ratio of monocytes: lymphocytes at age 3 months and risk of tuberculosis (TB) in the first two years of life. BMC Med 12:120. https://doi.org/10.1186/s12916-014-0120-7
18. Yuan C, Li N, Mao X, Liu Z, Ou W, Sy W (2017) Elevated pretreatment neutrophil/white blood cell ratio and monocyte/lymphocyte ratio predict poor survival in patients with curatively resected non-small cell lung cancer: results from a large cohort. Thoracic Cancer 8(4):350–358. https://doi.org/10.18632/oncotarget.14136
19. Imtiaz F, Shafique K, Mirza SS, Ayoob Z, Vart P, Rao S (2012) Neutrophil lymphocyte ratio as a measure of systemic inflammation in prevalent chronic diseases in Asian population. Int Archiv Med 5(1):2. https://doi.org/10.1186/1755-7682-5-2
20. Asahina A, Kubo N, Umezawa Y, Honda H, Yanaba K, Nakagawa H (2017) Neutrophil–lymphocyte ratio, platelet–lymphocyte ratio and mean platelet volume in Japanese patients with psoriasis and psoriatic arthritis: response to therapy with biologics. J Dermatol 44:1112–1121. https://doi.org/10.1111/1346-8138.13875
21. Briggs C (2009) Quality counts: new parameters in blood cell counting. Int J Lab Hematol 31:277–297. https://doi.org/10.1111/j.1751-553X.2009.01160.x
22. Erre GL, Paliogiannis P, Castagna F, Mangoni AA, Carru C, Passiu G et al (2019) Meta-analysis of neutrophil-to-lymphocyte and platelet-to-lymphocyte ratio in rheumatoid arthritis. Eur J Clin Invest 49:e13037. https://doi.org/10.1111/eci.13037
23. Tang J, Gao X, Zhi M, Zhou HM, Zhang M, Chen HW et al (2015) Plateletcrit: a sensitive biomarker for evaluating disease activity in C rohn's disease with low hs-CRP. J Digest Dis 16:118–124. https://doi.org/10.1111/1751-2980.12225
24. Kridin K, Shihade W, Zelber-Sagi S (2018) Mean platelet volume in pemphigus vulgaris. Angiology 69:303–307. https://doi.org/10.1177/0003319717718329
25. Pancar GS, Eyupoglu O (2016) Red cell distribution width and mean platelet volume in patients with pityriasis rosea. J Clin Med Res 8(6):445. https://doi.org/10.1470/jocmr2535w
26. Vaya A, Rivera L, Todoli J, Hernandez JL, Laiz B, Ricart JM (2014) Haematological, biochemical and inflammatory parameters in inactive Behçet's disease. Its association with red blood cell distribution width. Clin Hemorheol Micro 56:319–324. https://doi.org/10.3233/CH-131744
27. Feily A (2014) Vitiligo Extent Tensity Index (VETI) score: a new definition, assessment and treatment evaluation criteria in vitiligo. Dermatol Pract Concept 4:81. https://doi.org/10.5826/dpc.0404a18
28. Spritz RA (2012) Six decades of vitiligo genetics: genome-wide studies provide insights into autoimmune pathogenesis. J Invest Dermatol 132:268–273. https://doi.org/10.1038/jid.2011.321
29. Harris JE (2016) Cellular stress and innate inflammation in organ-specific autoimmunity: lessons learned from vitiligo. Immunol Rev 269:11–25. https://doi.org/10.1111/imr.12369
30. Richmond JM, Frisoli ML, Harris JE (2013) Innate immune mechanisms in vitiligo: danger from within. Curr Opin Immunol 25:676–682. https://doi.org/10.1016/j.coi.2013.10.010
31. Pietrzak A, Bartosińska J, Hercogová J, Lotti TM, Chodorowska G (2012) Metabolic syndrome in vitiligo. Dermatol Ther 25:S41–S43. https://doi.org/10.1111/dth.12012
32. Pietrzak A, Lecewicz-Toruń B, Urban J (2000) Comparison of serum lipid in girls affected with vitiligo and control group. Annales Universitatis Mariae Curie-Sklodowska Sectio D: Medicina 55:269–274
33. Tu CX, Gu JS, Lin XR (2003) Increased interleukin-6 and granulocyte–macrophage clony stimulating factor levels in the sera of patients with non-segmental vitiligo. J Dermatol Sci 31:73–78. https://doi.org/10.1016/S0923-1811(02)00151-2
34. Ala Y, Pasha MK, Rao RN, Komaravalli PL, Jahan P (2015) Association of IFN-γ: IL-10 cytokine ratio with nonsegmental vitiligo pathogenesis. Autoimmune Dis 2015:423490. https://doi.org/10.1155/2015/423490
35. Lotti T, D'Erme AM (2014) Vitiligo as a systemic disease. Clin Dermatol 32:430–434. https://doi.org/10.1016/j.clindermatol.2013.11.011
36. Balta I, Balta S, Demirkol S, Ozturk C, Celik T (2014) Neutrophil-to-Lymphocyte Ratio May Predict Subclinical Atherosclerosis in Patients with Psoriasis. Echocardiography 31:1166–1167. https://doi.org/10.1111/echo.12668
37. Hoffmann JJ, Nabbe KC, van den Broek NM (2015) Effect of age and gender on reference intervals of red blood cell distribution width (RDW) and mean red cell volume (MCV). Clin Chem Lab Med 53:2015–2019. https://doi.org/10.1515/cclm-2015-0155
38. Usta A, Avci E, Bulbul CB, Kadi H, Adali E (2018) The monocyte counts to HDL cholesterol ratio in obese and lean patients with polycystic ovary syndrome. Reprod Biol Endocrinol 16:34. https://doi.org/10.1186/s12958-018-0351-0
39. Yılmaz M, Kayançiçek H (2018) A new inflammatory marker: elevated monocyte to HDL cholesterol ratio associated with smoking. J Clin Med 7:76. https://doi.org/10.3390/jcm7040076
40. Acikgoz N, Kurtoğlu E, Yagmur J, Kapicioglu Y, Cansel M, Ermis N (2018) Elevated monocyte to high-density lipoprotein cholesterol ratio and endothelial dysfunction in Behçet disease. Angiology 69:65–70. https://doi.org/10.1177/0003319717704748
41. Karabay EA, Demir D, Çerman AA (2020) Evaluation of monocyte to high-density lipoprotein ratio, lymphocytes, monocytes, and platelets in psoriasis. Anais Brasileiros de Dermatologia 95:40–45. https://doi.org/10.1016/j.abd.2019.05.002
42. Huang Y, Deng W, Zheng S, Feng F, Huang Z, Huang Q et al (2018) Relationship between monocytes to lymphocytes ratio and axial spondyloarthritis. Int Immunopharmacol 57:43–46. https://doi.org/10.1016/j.intimp.2018.02.008
43. Xiang J, Zhou L, Li X, Bao W, Chen T, Xi X et al (2017) Preoperative monocyte-to-lymphocyte ratio in peripheral blood predicts stages, metastasis, and histological grades in patients with ovarian cancer. Transl Oncol 10:33–39. https://doi.org/10.1016/j.tranon.2016.10.006
44. Kim DS, Shin D, Lee MS, Kim HJ, Kim DY, Kim SM et al (2016) Assessments of neutrophil to lymphocyte ratio and platelet to lymphocyte ratio in Korean patients with psoriasis vulgaris and psoriatic arthritis. J Dermatol 43:305–310. https://doi.org/10.1111/1346-8138.13061
45. Li L, Xia Y, Chen C, Cheng P, Peng C (2015) Neutrophil-lymphocyte ratio in systemic lupus erythematosus disease: a retrospective study. Int J Clin Exp Med 8(7):11026
46. Solak B, Dikicier BS, Cosansu NC, Erdem T (2017) Neutrophil to lymphocyte ratio in patients with vitiligo. Advances in Dermatology and Allergology/Postępy Dermatologii i Alergologii 34:468. https://doi.org/10.5114/ada.2017.71114

47. İslamoğlu ZGK, Demirbaş A (2019) Mean platelet volume and platelet distribution width levels in discoid lupus erythematosus patients: a case-control study. J Surg Med 3:561–563. https://doi.org/10.28982/josam.599953
48. Karagun E (2019) An Investigation of the Relationship between Involvement Sites in Vitiligo Patients and Autoimmune Diseases and Hematological Parameters. Int J Innov Res Med Sci 4:570–573. https://doi.org/10.23958/ijirms/vol04-i10/769