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Association of ABO/Rh blood groups with clinical features in Behçet's disease – a retrospective study

Асоцијација ABO/Rh крвних група са клиничким карактеристикама у Бехчетовој болести: ретроспективна студија

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SUMMARY

Introduction/Objective Behçet's disease is a chronic multisystem inflammatory disorder with heterogeneous manifestations. Identifying associated factors may improve understanding of pathogenesis and support individualized management. This study aimed to evaluate the association between ABO blood groups, Rh factor, and clinical and laboratory features of Behçet's disease.

Methods This retrospective study included 160 patients with Behçet's disease followed at the Rheumatology Department of Fırat University Hospital between January 2010 and May 2025. Demographic data and laboratory parameters, including hematological, biochemical, and inflammatory markers, were retrieved from electronic medical records. Patients were grouped as blood group O or non-O and as Rh-positive or Rh-negative, and comparative analyses were performed to evaluate differences in clinical and laboratory findings.

Results Of the 160 patients, 140 were Rh-positive and 20 Rh-negative. Age and most laboratory parameters were similar between Rh groups, except for higher erythrocyte sedimentation rate values in Rh-positive patients (p = 0.043). Compared with blood group O patients (n = 50), non-O patients (n = 110) had higher white blood cell counts (p = 0.008), neutrophil counts (p = 0.010), and alanine aminotransferase levels (p = 0.009), while hemoglobin levels were lower in group O patients (p = 0.048). Clinical manifestations were largely comparable; however, articular involvement was more frequent in Rh-negative than in Rh-positive patients (50% *vs*. 27.1%, p = 0.037).

Conclusion ABO blood groups and Rh factor were not associated with most clinical or laboratory features of Behçet's disease. Increased articular involvement in Rh-negative patients suggests a potential association warranting further investigation.

Keywords: Behçet disease; blood group; Rh factor; arthritis

САЖЕТАК

Увод/Циљ Бехчетова болест је хронични мултисистемски упални поремећај са хетерогеним манифестацијама. Идентификација повезаних фактора може побољшати разумевање патогенезе и подржати индивидуализовано лечење. Ова студија имала је за циљ да процени везу између АБО група крви, *Rh* фактора и клиничких и лабораторијских карактеристика.

Методе Ова ретроспективна студија обухватила је 160 пацијената са Бехчетовом болешћу праћених на Одељењу за реуматологију Универзитетске болнице Фират од јануара 2010. до маја 2025. год. Демографски подаци и лабораторијски параметри, укључујући хематолошке, биохемијске и маркере упале, преузети су из електронских медицинских картона. Пацијенти су подељени у групе према крвној групи 0 или не-0 и *Rh*-позитивном или Rh-негативном статусу, а упоредне анализе су спроведене ради процене клиничких и лабораторијских разлика.

Резултати Од 160 пацијената, 140 је било *Rh*-позитивно, а 20 *Rh*-негативно. Старост и већина лабораторијских параметара били су слични између *Rh* група, осим виших вредности брзине седиментације еритроцита код *Rh*-позитивних пацијената (p = 0,043). У поређењу са групом О (*n* = 50), пацијенти који нису групе О (*n* = 110) имали су већи број леукоцита (*p* = 0.008), неутрофила (*p* = 0,010) и ниво аланин аминотрансферазе (*p* = 0,009), док су нивои хемоглобина били нижи код групе О (*p* = 0,048). Клиничке манифестације биле су упоредиве; међутим, захваћеност зглобова била је чешћа код *Rh*-негативних него код *Rh*-позитивних пацијената (50% у односу на 27,1%, *p* = 0,037).

Закључак АБО групе крви и *Rh* фактор нису били повезани са већином клиничких и лабораторијских карактеристика Бехчетове болести. Повећана захваћеност зглобова код *Rh*-негативних пацијената указује на потенцијалну повезаност која захтева даље истраживање.

Кључне речи: Бехчетова болест, крвна група, *Rh* фактор, артритис

INTRODUCTION

Behçet's disease is a chronic, relapsing, multisystem inflammatory disorder characterized by recurrent oral aphthous ulcers, genital ulcers, uveitis, arthritis, gastrointestinal involvement, and neurological manifestations. It predominantly affects young adults between the ages of 20 and 30 and is classified as a variable vessel vasculitis due to its capacity to involve blood vessels of all sizes and types. The exact etiology remains unclear, but genetic predisposition, particularly the HLA-B51 allele, and environmental triggers are believed to play significant roles in disease pathogenesis. Clinical presentation is highly heterogeneous, and disease severity can vary considerably between patients. Early recognition and comprehensive management are crucial to prevent irreversible organ damage and improve long-term outcomes [1, 2, 3].

In Behçet's disease, various factors such as age, sex, geographical region, and blood type can influence both the course of the disease and the pattern of symptoms experienced. These factors may affect the frequency, severity, and distribution of clinical manifestations, as well as the likelihood of specific organ involvement. For instance, certain populations may present with predominantly mucocutaneous features, while others are more prone to ocular or neurological complications. Understanding these demographic and geographical variations is essential for anticipating disease behavior, tailoring management strategies, and improving long-term patient outcomes [4, 5, 6].

Blood group types and Rh factor status may influence the symptom patterns observed in Behçet's disease. Some research suggests that individuals with non-O blood groups (A, B, or AB) may be more susceptible to vascular complications, such as thrombosis. Nonetheless, several studies have reported no significant association between ABO or Rh blood groups and

disease prevalence or manifestations, highlighting the need for larger and more comprehensive investigations [7, 8].

In this study, we aimed to explore the potential relationship between blood group types, Rh factor status, and the clinical characteristics of Behçet's disease. Previous research has suggested that immunohematological factors, including ABO blood groups and Rh positivity, may influence the manifestation and progression of various autoimmune and inflammatory disorders [9]. Given the heterogeneous nature of Behçet's disease, which presents with diverse patterns of mucocutaneous, ocular, vascular, and neurological involvement, identifying potential associations with blood group profiles could provide valuable insights into disease pathogenesis, prognosis, and individualized management strategies.

METHODS

A total of 160 patients diagnosed with Behçet's disease and followed up at the Rheumatology Department were included in this study. This was a single-center, retrospective observational study conducted in the rheumatology department of our institution, and patients who were under follow-up between January 2010 and May 2025 were enrolled. The study was conducted in accordance with the principles of the Declaration of Helsinki.

In our study, demographic data of the patients—including age and gender—were recorded. Additionally, laboratory parameters such as white blood cell (WBC) count, neutrophil count, lymphocyte count, hemoglobin level, platelet count, urea, creatinine, alanine aminotransferase (ALT), gamma-glutamyl transferase (GGT), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) levels were collected using the hospital's electronic medical record system.

The diagnosis of Behçet's disease in patients was made based on the 2013 International Criteria for Behçet's Disease (ICBD). According to these criteria, points were assigned as follows: 2 points for the presence of oral aphthous ulcers, 2 points for genital ulcers, 2 points for ocular lesions, 1 point for skin manifestations, 1 point for central nervous system involvement, 1 point for vascular lesions, and 1 point for a positive pathergy test. Patients with a total score of 4 or more were classified as having Behçet's disease and were included in the study [10].

Mucocutaneous findings included oral ulcers, genital ulcers, acneiform lesions, and overall mucocutaneous involvement. Ocular involvement was defined as the presence of uveitis confirmed by ophthalmologic examination. Pathergy test results were recorded as positive or negative according to standard clinical assessment. Neurologic involvement was defined based on documented neurological findings and/or imaging consistent with central nervous system involvement. Articular involvement was defined as the presence of clinically documented inflammatory arthritis or arthralgia.

Patients were classified into two groups based on their blood type: Group O and non-O blood types. In addition, they were further divided into two subgroups according to their Rh factor status (Rh-positive and Rh-negative). Comparative analyses were then conducted between these groups to evaluate potential differences in symptomatology and laboratory parameters, aiming to identify whether specific blood group profiles or Rh status were associated with distinct clinical patterns or laboratory findings in Behçet's disease.

Statistical Analysis: The normality of the data distribution was assessed using the Kolmogorov–Smirnov test. Variables that followed a normal distribution were presented as mean ± standard deviation, whereas non-normally distributed variables were reported as median and interquartile range (IQR). For continuous variables, comparisons between groups were made using the Student's t-test if the data were normally distributed, and the Mann–

Whitney U test if not. Categorical variables were compared using the Chi-square test; when the expected frequencies were low, Fisher's exact test was used instead. A p-value of less than 0.05 was considered statistically significant.

Ethics: This study involving human participants was reviewed and approved by the local ethics committee (decision date: 04.09.2025; decision number: 2025/12-16). Because this was a retrospective chart-review using de-identified records, the procedures were not explained to participants and no written informed consent was obtained (consent requirement was waived for this retrospective analysis).

RESULTS

A total of 160 patients were included in the analysis, comprising 50 individuals in the Group O and 110 in the Non-O Group (Table 1). The comparison of demographic and laboratory parameters showed that age was similar between the two groups (41.67 ± 10.68 vs. 42.77 ± 11.99 years, p = NS). White blood cell count (8.71 vs. 7.32 $\times 10^9$/L; p = 0.008) and neutrophil count (5.68 vs. 4.66 $\times 10^9$/L; p = 0.010) were significantly higher in the Non-O Group compared with the Group O. Hemoglobin levels were lower in Group O patients compared with the Non-O Group [13.35 (9.9–16.1) vs. 14.15 (4.6–16.4) g/dL; p = 0.048]. No significant differences were observed in lymphocyte count, platelet count, urea, creatinine, uric acid, GGT, ESR, or CRP values between the groups (all p > 0.05). However, ALT levels were significantly higher in the Non-O Group than in the Group O [19 (6–170) vs. 14 (7–81) U/L; p = 0.009] (Table 2).

Of 160 patients, 140 were Rh-positive, and 20 were Rh-negative. The mean age was similar between Rh-positive (42.80 ± 11.77 years) and Rh-negative patients (39.85 ± 10.01 years), with no statistically significant difference (p = 0.554). White blood cell counts were slightly

higher in Rh-positive patients [median: 8.44 (0.96–27.26) ×10⁹/L] compared with Rh-negative patients [7.19 (0.86–15.92) ×10⁹/L], but the difference was not significant (p = 0.254). Similarly, neutrophil counts showed no significant variation between Rh-positive [6.34 (1.22–42.00) ×10⁹/L] and Rh-negative [5.63 (2.50–11.58) ×10⁹/L] groups (p = 0.456). Lymphocyte counts were also comparable between groups (2.15 ± 0.87 vs. 1.99 ± 0.86 ×10⁹/L; p = 0.461). Hemoglobin and platelet levels did not differ significantly (p = 0.407 and p = 0.159, respectively). Likewise, urea and creatinine levels showed no meaningful differences (p = 0.942 and p = 0.954, respectively), and uric acid, ALT, GGT, and CRP values were comparable across both groups (all p > 0.05). The only parameter showing a statistically significant difference was the erythrocyte sedimentation rate (ESR), which was higher in Rh-positive patients [median: 22.5 (1–143) mm/h] compared with Rh-negative patients [14 (3–41) mm/h] (p = 0.043) (Table 3).

The comparison of clinical findings between patients with Group O (n = 49) and non-O blood groups (n = 111) revealed no statistically significant differences in mucocutaneous, ocular, or systemic manifestations. Oral ulcers were highly prevalent in both groups (98.0% in Group O vs. 97.3% in the non-O group, p = 0.641), while genital ulcers were more frequent in the non-O group (78.4%) compared with the Group O group (67.3%), although this difference was not statistically significant (p = 0.137). Mucocutaneous involvement was nearly universal in both groups (98.0% vs. 100%, p = 0.306). Acneiform lesions were observed in 49.0% of patients in the Group O and in 63.6% of those in the non-O group (p = 0.166). Uveitis was present in 44.9% of Group O patients compared with 36.0% of non-O patients (p = 0.158). Pathergy test positivity was relatively low and comparable between groups (50.0% vs. 46.4%, p = 0.836). Similarly, neurologic involvement rates were comparable (12.2% vs. 14.4%, p = 0.713), and articular involvement did not differ significantly between the two groups (32.7% vs. 28.8%, p

= 0.793). Overall, these findings indicate no significant association between ABO blood group and the clinical spectrum of Behçet's disease (Table 4).

In the comparison of clinical manifestations between Rh-positive and Rh-negative patients, oral ulcers were highly prevalent in both groups, observed in 97.9% of Rh-positive and 95% of Rh-negative patients, with no statistically significant difference (p = 0.417). Genital ulcers were more frequent among Rh-positive patients (77.1%) compared with Rh-negative patients (60.0%); however, this difference did not reach statistical significance (p = 0.098).

Mucocutaneous involvement was present in all Rh-positive patients (100%) and in 95.0% of Rh-negative patients (p = 0.125). Acneiform lesions were reported in 57.9% of Rh-positive and 65% of Rh-negative individuals (p = 0.567), while uveitis occurred in 39.3% and 35% of patients, respectively (p = 0.713). Pathergy test positivity showed similar rates between the two groups (11.4% vs. 15%, p = 0.457), and neurologic involvement was also comparable (14.3% vs. 10%, p = 0.457). Importantly, articular involvement was significantly more frequent in Rh-negative patients (50%) than in Rh-positive patients (27.1%) (p = 0.037), suggesting a potential association between Rh factor and joint involvement in Behçet's disease (Table 5).

DISCUSSION

In our study, patients were first categorized according to blood groups and Rh factor into Rh-positive (n = 140) and Rh-negative (n = 20) groups. Comparative analyses were conducted between these groups using demographic variables, such as age, and a range of laboratory parameters, including WBC count, Neu count, Lymph count, Htc, Hb, Plt count, urea, creatinine, uric acid, ALT, AST, ESR, and CRP. No statistically significant differences were found between Rh-positive and Rh-negative groups in most demographic and laboratory

parameters, except for ESR, which was higher in Rh-positive patients. Sincan et al., in their study involving 3000 blood donors, reported no significant differences in complete blood count (CBC) parameters, except for red cell distribution width (RDW). Similarly, in our study, no statistically significant differences were observed between the two groups in either CBC or biochemical parameters [11].

Numerous studies have explored whether blood group antigens influence laboratory markers in healthy individuals. For example, Al-Mawali et al. (2018) found that in a large healthy population, there were no significant differences in RBC, WBC, or platelet indices across ABO blood groups, underscoring a minimal hematological impact of these blood types in the general population [12]. In our study, when blood groups were categorized into group O and non-O, statistical analyses were performed to compare age, WBC, Neu, Lymph, Htc, Hb, Plt, urea, creatinine, uric acid, ALT, AST, ESR, and CRP values. Significant differences were found in WBC ($p = 0.008$), neutrophil count ($p = 0.010$), hemoglobin ($p = 0.048$), and ALT levels ($p = 0.009$), while other parameters showed no statistically significant differences between the groups. These statistical variations may be attributable to the non-normal distribution of the variables and the relatively small sample size, which could limit the robustness of the findings.

A previous study has explored the association between blood groups and the clinical manifestations of rheumatologic diseases, including Behçet's disease. Findings from these investigations suggest that certain ABO and Rh blood group types may influence disease susceptibility, severity, and symptom patterns [13, 14]. For instance, some research has reported variations in mucocutaneous or ocular manifestations depending on blood group type [13]. Although the underlying mechanisms remain unclear, it has been proposed that immunohematologic factors, such as antigenic determinants on red blood cells, could modulate inflammatory and immune responses, thereby affecting disease expression [14]. In our study,

comparison between blood group O and non-O patients revealed no statistically significant differences in the frequency of oral ulcers, genital ulcers, uveitis, mucocutaneous lesions, acneiform eruptions, neurological involvement, articular involvement, or pathergy test positivity. This indicates that, in our cohort, ABO blood group did not appear to influence the distribution of Behçet's disease manifestations.

However, when comparing Rh-positive and Rh-negative patients, a statistically significant difference was observed in articular involvement, which was more frequent in Rh-negative individuals ($p = 0.037$). The reason for this association is not fully understood, but it is possible that immunohematological variations linked to the Rh antigen could influence immune complex deposition or inflammatory cascades within synovial tissues. Rh antigens are known to modulate immune cell recognition and cytokine profiles, potentially contributing to differential inflammatory responses [15-16]. Previous studies investigating the association between Rh factor and autoimmune disease susceptibility are limited and have produced inconsistent results, with no clearly established mechanistic link [17]. In our cohort, Rh factor status appeared to be associated with differences in clinical expression of Behçet's disease, particularly with respect to articular involvement ($p = 0.037$). These findings suggest that Rh status may represent a potential modifier of disease phenotype and warrant further evaluation in larger, prospective studies.

This study has several important limitations that should be acknowledged. First, the relatively small sample size may reduce the statistical power and limit the robustness of the conclusions. Second, its retrospective design introduces potential biases inherent to such studies. Furthermore, being a single-center investigation restricts the generalizability of the findings to wider populations. Another key limitation is the lack of adjustment for potential confounders such as age, sex, and disease duration, which may have influenced the observed associations.

These limitations highlight the need for future multicenter, prospective studies with larger cohorts to validate and extend the present results.

CONCLUSION

Our study demonstrates that ABO blood groups do not significantly influence the distribution of clinical manifestations in Behçet's disease. However, Rh factor status, particularly Rh negativity, appears to be associated with increased frequency of articular involvement. These findings suggest that immunohematologic factors linked to the Rh system may play a role in modulating disease expression. Further large-scale, prospective studies are warranted to clarify the mechanisms underlying this association and to evaluate the potential of Rh factor as a modifier of disease phenotype in Behçet's disease.

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Data availability: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of interest: None declared.

REFERENCES

1. Alpsoy E. Behçet's disease: a comprehensive review with a focus on epidemiology, etiology and clinical features, and management of mucocutaneous lesions. J Dermatol. 2016;43(6):620–32. [DOI:10.1111/1346-8138.13381] [PMID:27075942]
2. Lavalle S, Caruso S, Foti R, Gagliano C, Cocuzza S, La Via L, et al. Behçet's Disease, Pathogenesis, Clinical Features, and Treatment Approaches: A Comprehensive Review. Medicina (Kaunas). 2024;60(4):562. [DOI: 10.3390/medicina60040562] [PMID: 38674208]
3. Yildiz M, Haslak F, Adrovic A, Sahin S, Koker O, Barut K, et al. Pediatric Behçet's disease. Front Med (Lausanne). 2021;8:627192. [DOI:10.3389/fmed.2021.627192] [PMID: 33614684]
4. Hatemi G, Uçar D, Uygunoğlu U, Yazıcı H, Yazıcı Y. Behçet syndrome. Rheum Dis Clin North Am. 2023;49(3):585–602. [DOI:10.1016/j.rdc.2023.03.010] [PMID: 37331734]
5. Murphy R, Moots RJ, Brogan P, Çelik AF, Clement-Jones M, Coulson I, et al. British Association of Dermatologists and British Society for Rheumatology living guideline for managing people with Behçets 2024. Br J Dermatol. 2024;191(5):e8-e25. [DOI: 10.1093/bjd/ljae263] [PMID: 39253835]
6. Hatemi G, Tukek NB, Esatoglu SN, Ozguler Y, Taflan SS, Uygunoglu U, et al. Infliximab for vascular involvement in Behçet's syndrome. Clin Immunol. 2023;253:109682. [DOI: 10.1016/j.clim.2023.109682] [PMID: 37385325]
7. Bektas E, Büyükdemir A, Yalcinkaya Y, Artim Esen B, Inanc M, et al. ABO blood groups and increased risk for the development of vascular involvement in Behçet's disease. Clin Exp Rheumatol. 2024;42(1):123–9. [DOI: 10.55563/clinexprheumatol/475an5] [PMID: 39404478]
8. Al-Askar M. Is there an association between periodontal diseases and ABO blood group? Systematic review and meta-analysis. Quintessence Int. 2022;53(5):424–31. [DOI: 10.3290/j.qi.b2644845] [PMID: 35119242]
9. Hong Y, Mu S, Wang L. Association between ABO blood group system and autoimmune liver disease. Front Med (Lausanne). 2025;12:1696577. [DOI: 10.3389/fmed.2025.1696577] [PMID: 41333778]
10. Kiafar M, Faezi ST, Kasaeian A, Baghdadi A, Kakaei S, Mousavi SA, et al. Diagnosis of Behçet's disease: clinical characteristics, diagnostic criteria, and differential diagnoses. BMC Rheumatol. 2021;5(1):2. [DOI: 10.1186/s41927-020-00172-1] [PMID: 33446282]
11. Sincan G, Erdem F, Bulut E, Sincan S. Complete blood count parameters in apheresis platelet donors according to ABO and Rh blood groups. Bagcilar Med Bull. 2022;7(3):256–261. [DO I: 10.4274/BMB.galenos.2022.2022-05-040]
12. Al-Mawali A, Pinto AD, Al-Busaidi R, Al-Lawati RH, Morsi M. Comprehensive haematological indices reference intervals for a healthy Omani population: First comprehensive study in Gulf Cooperation Council (GCC) and Middle Eastern countries based on age, gender and ABO blood group comparison. PLoS One. 2018;13(4):e0194497. [DOI: 10.1371/journal.pone.0194497] [PMID: 29621271]
13. Liu FH, Guo JK, Xing WY, Bai XL, Chang YJ, Lu Z, et al. ABO and Rhesus blood groups and multiple health outcomes: an umbrella review of systematic reviews with meta-analyses of observational studies. BMC Med. 2024;22(1):206. [DOI: 10.1186/s12916-024-03423-x] [PMID: 38769523]
14. Abegaz SB. Human ABO blood groups and their associations with different diseases. BioMed Res Int. 2021;2021:6629060. [DOI: 10.1155/2021/6629060] [PMID: 33564677]
15. Floch A. Molecular genetics of the Rh blood group system: alleles and antibodies—a narrative review. Ann Blood. 2021;6:26. [DOI: 10.21037/aob-20-84]
16. Rana R, Ranjan V, Kumar N. Association of ABO and Rh blood group in susceptibility, severity, and mortality of coronavirus disease 2019: a hospital-based study from Delhi, India. Front Cell Infect Microbiol. 2021;11:767771. [DOI: 10.3389/fcimb.2021.767771] [PMID: 34796130].
17. Salem GI, Gamal NM, Talaat EA, El-Hammady DH, Hammam N, Gheita TA. Clinical impact of the ABO blood type in patients with rheumatic diseases: is there a link to the ABO and Rhesus?. Mediterr J Rheumatol. 2021;32(3):237–43. [DOI: 10.31138/mjr.32.3.237] [PMID: 34964027]

Table 1. Distribution of ABO blood groups in the study population (n = 160)

Blood group category	n	% (of total)
O	50	31.3%
Non-O (Total)	110	68.8%
A	71	44.4%
B	32	20%
AB	7	4.4%

Values are expressed as n (%); percentages were calculated based on the total study population (n = 160); non-O includes blood groups A, B, and AB

Table 2. Demographic and laboratory parameters between blood groups

Parameter	**O group (median, range) n : 50**	**Non-O group (median, range) n: 110**	**p**
Age (years)	42 (19–68)	43 (18–71)	
WBC × 10^9/L	7.32 (0.86–25.10)	8.71 (0.97–27.26)	**0.008***
Neu × 10^9/L	4.66 (1.22–22.40)	5.68 (1.24–17.50)	**0.010***
Lymph ×10^9/L	1.96 (1.27–4.79)	2.13 (1.10–4.61)	0.530*
Hb g/dL	13.35 (9.9–16.1)	14.15 (4.6–16.4)	**0.048***
Plt × 10^9/L	267 (129–530)	277 (23–602)	0.821*
Urea mg/dL	26 (11–58)	27 (10–87)	0.296*
Creatinine mg/dL	0.8 (0.41–1.16)	0.8 (0.4–1.4)	0.326*
Uric acid mg/dL	4.05 (2.6–8)	4.5 (2–10.4)	0.232*
ALT U/L	14 (7–81)	19 (6–170)	**0.009***
GGT U/L	13 (5–102)	23.50 (10–177)	0.197*
ESR mm/hour	21.5 (1–82)	19.5 (2–143)	0.857*
CRP mg/L	6.1 (0.03–157)	6.13 (0.04–131)	0.994*

WBC – white blood cell count; Neu – neutrophils; Hb – hemoglobin; Plt – platelets; ALT – alanine aminotransferase; GGT – gamma-glutamyl transferase; ESR – erythrocyte sedimentation rate; CRP – C-reactive protein;

* – Mann–Whitney U test

Table 3. Demographic and laboratory parameters between Rh groups

Parameter	Rh+ group (n:140)	Rh – group (n:20)	p
Age (years)	42.80 ± 11.77	39.85 ± 10.01	0.554
WBC × 10⁹/L	8.44 (0.96–27.26)	7.19 (0.86–15.92)	0.254*
Neu × 10⁹/L	6.34 (1.22–42.00)	5.63 (2.50–11.58)	0.456*
Lymph × 10⁹/L	2.15 ± 0.87	1.99 ± 0.86	0.461
Hb g/dL	13.8 (4.6–16.0)	14.1 (10.4–16.4)	0.407*
Plt × 10⁹/L	281 (129–750)	82.7 (2.3–407)	0.159*
Urea mg/dL	27 (10–87)	83.2 ± 14.5	0.942*
Creatinine mg/dL	0.80 (0.40–1.40)	0.76 (0.41–1.10)	0.954*
Uric acid mg/dL	4.48 ± 1.35	4.24 ± 1.02	0.563
ALT U/L	18 (6–170)	16 (12–45)	0.404*
GGT U/L**	21.50 (1–177) (n = 92)	55.5 (5–102) (n = 13)	0.333*
ESR mm/hour	22.5 (1–143)	14 (3–41)	0.043*
CRP mg/L	6.16 (0.03–157)	4.65 (3–131)	0.484*

WBC – white blood cell count; Neu – neutrophils; Hb – hemoglobin; Plt – platelets; ALT – alanine aminotransferase; GGT – gamma-glutamyl transferase; ESR – erythrocyte sedimentation rate; CRP – C-reactive protein;

* – Mann–Whitney U test

** – GGT values were analyzed in patients with available measurements only (n varies due to missing data); data are presented as mean ± standard deviation or median (range), as appropriate

Table 4. Comparison of symptoms by blood group category

Lesion type / category	Condition	O (n = 49)	Non-O (n = 111)	Total (n = 160)	p
Oral ulcer	Absent	1 (2%)	3 (2.7%)	4 (2.5%)	0.641
	Present	48 (98%)	108 (97.3%)	156 (97.5%)	
Genital ulcer	Absent	16 (32.7%)	24 (21.6%)	40 (25%)	0.137
	Present	33 (67.3%)	87 (78.4%)	120 (75%)	
Mucocutaneous	Absent	1 (2%)	0 (0%)	1 (0.6%)	0.306
	Present	48 (98%)	111 (100%)	159 (99.4%)	
Acneiform lesion	Absent	25 (51%)	40 (36.4%)	65 (40.9%)	0.166
	Present	24 (49%)	70 (63.6%)	94 (59.1%)	
Uveitis	Absent	27 (55.1%)	71 (64%)	98 (61.3%)	0.158
	Present	22 (44.9%)	40 (36%)	62 (38.8%)	
Pathergy test	Negative	6 (50%)	15	21 (13.1%)	0.836
	Positive	6 (50%)	13	19 (11.9%)	
Neurologic involvement	Absent	43 (87.8%)	95 (85.6%)	138 (86.3%)	0.713
	Present	6 (12.2%)	16 (14.4%)	22 (13.8%)	
Articular involvement	Absent	33 (67.3%)	79 (71.2%)	112 (70%)	0.793
	Present	16 (32.7%)	32 (28.8%)	48 (30%)	

Values are expressed as n (%); O – blood group O; Non-O – non-blood group O (A, B, or AB); categorical variables were compared using the χ^2 or Fisher's exact test;

$p < 0.05$ was considered significant

Table 5. Comparison of clinical manifestations according to Rh factor

Lesion type / category	Condition	Rh (+) (n:140)	Rh (–) (n:20)	Total	p
Oral ulcer	Absent	3 (2.1%)	1 (5%)	4 (2.5%)	0.417
	Present	137 (97.9%)	19 (95%)	156 (97.5%)	
Genital ulcer	Absent	32 (22.9%)	8 (40%)	40 (25%)	0.098
	Present	108 (77.1%)	12 (60%)	120 (75%)	
Mucocutaneous	Absent	0 (0%)	1 (5%)	1 (0.6%)	0.125
	Present	140 (100%)	19 (95%)	159 (99.4%)	
Acneiform lesion	Absent	58 (41.4%)	7 (35%)	65 (40.6%)	0.567
	Present	81 (57.9%)	13 (65%)	94 (58.8%)	
Uveitis	Absent	85 (60.7%)	13 (65%)	98 (61.3%)	0.713
	Present	55 (39.3%)	7 (35%)	62 (38.8%)	
Pathergy test	Negative	15 (10.7%)	6 (30%)	21 (13.1%)	0.457
	Positive	16 (11.4%)	3 (15%)	19 (11.9%)	
Neurologic involvement	Absent	120 (85.7%)	18 (90%)	138 (86.2%)	0.457
	Present	20 (14.3%)	2 (10%)	22 (13.8%)	
Articular involvement	Absent	102 (72.9%)	10 (50%)	112 (70%)	**0.037**
	Present	38 (27.1%)	10 (50%)	48 (30%)	

Values are expressed as n (%); O – blood group O; Non-O – non-blood group O (A, B, or AB;

categorical variables were compared using the χ^2 or Fisher's exact test;

$p < 0.05$ was considered significant

