ARAŞTIRMA MAKALESİ / *RESEARCH ARTICLE*

Investigation of Relationship between Erythrocyte Sedimentation Rate and Erythrocyte Indices

Eritrosit İndeksleri ve Eritrosit Sedimentasyon Hızı Arasındaki İlişkinin Araştırılması

Ergin Taşkın, Seda Çelik, Duygu Mine Yavuz, Fatih Kara

Department of Biochemistry, Faculty of Medicine, University of Kafkas, Kars, Turkey

ABSTRACT

Aim: *The aim of this study was to assess the whether there was a relationship between ESR and erythrocyte indices (red blood cell (RBC) count, hematocrit, hemoglobin, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and red cell distribution width (RDW)).*

Material and Method: *658 patients who had ESR levels of under 30 mm/h, who are aged between 18 and 50 years, and whose ESR and erythrocyte indices had been measured simultaneously in the same sample were included in the study.*

Results: *It was found that ESR was negatively correlated with all erythrocyte indices (RBC count, hematocrit, hemoglobin, MCV, MCH, MCHC, and RDW). ESR values in females and later adults were higher than that in males and young adults, respectively.*

Conclusion: *The erythrocyte factors, particularly hematocrit, must be considered when ESR results are interpreted.*

Key words: *erythrocyte sedimentation rate; erythrocyte indices; hematocrit*

ÖZET

Amaç: *Bu çalışmanın amacı, ESR ile eritrosit indeksleri (kırmızı kan hücresi (RBC) sayısı, hematokrit, hemoglobin, ortalama korpüsküler hacim (MCV), ortalama korpüsküler hemoglobin (MCH), ortalama korpüsküler hemoglobin konsantrasyonu (MCHC), kırmızı hücre dağılım genişliği (RDW) arasında bir ilişki olup olmadığını değerlendirmektir.*

Materyal ve Metot: *Çalışmaya ESR düzeyi 30 mm/h'nin altında, 18-50 yaş arasında, ESR ve eritrosit indeksleri aynı örnekte aynı anda ölçülen 658 hasta dahil edildi.*

Bulgular: *ESR'nin tüm eritrosit endeksleri (RBC sayısı, hematokrit, hemoglobin, MCV, MCH, MCHC ve RDW) ile negatif korelasyon gösterdiği bulundu. Kadın ve yaşlı erişkinlerde ESR değerleri, sırasıyla, erkek ve genç erişkinlerde olduğundan daha yüksekti.*

Sonuç: *Eritrosit faktörleri, özellikle hematokrit, ESR sonuçları yorumlanırken göz önünde bulundurulmalıdır.*

Anahtar kelimeler: *eritrosit sedimantasyon hızı; eritrosit indeksleri; hematokrit*

Introduction

Erythrocyte sedimentation rate (ESR) is one of the most commonly measured markers of inflammation or tissue injury in clinical practice[1]. It is the distance of fall of erythrocytes in the plasma and is expressed as millimeters in 1 hour[1]. High ESR levels suggest (a) infection, (b) noninfectious inflammatory disorders, (c) neoplasms, (d) or noninflammatory conditions such as pregnancy and drug use[1–3]. There are two main factors that may affect ESR: (a) the erythrocyte-related parameters such as size and number and (b) the non-erythrocyte-related parameters such as fibrinogen and immunoglobulins[4]. However, there are only a few studies that investigate effects on ESR of the erythrocyte-related parameters[5–6]. In this study, we aimed to assess the whether there was a relationship between ESR and erythrocyte indices including red blood cell (RBC) count, hematocrit, hemoglobin, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and red cell distribution width (RDW).

Material and Method

Ethical approval was obtained from local ethical committee of our faculty (25.04.2018/06). The study was achieved by searching the file records of the patients aged between 18 and 50 years who were examined in February 2018. Exclusion criteria included patients with ESR of over 30 mm/hour; active infectious, inflammatory, and malignant diseases; any chronic heart or renal disease; and medication use. A total

İletişim/Contact: *Ergin Taşkın, Kafkas Üniversitesi, Tıp Fakültesi Dekanlık Binası, B114, Kars, Türkiye* • ***Tel:*** *0544 499 42 30* • ***E-mail:*** *ergintaskin65@hotmail.com* • ***Geliş/Received:*** *30.01.2019* • ***Kabul/Accepted:*** *11.07.2019*

ORCID: *Ergin Taşkın, 0000-0002-1883-6055* • *Seda Çelik, 0000-0003-2055-3537* • *Duygu Mine Yavuz, 0000-0002-0425-0766* • *Fatih Kara, 0000-0002-9729-5380*

of 658 patients were included in the study. ESR and erythrocyte indices (RBC count, hematocrit, hemoglobin, MCV, MCH, MCHC, and RDW) had been measured simultaneously in the same sample. The patients were divided into two groups according to age: young adulthood (18–25 years old) and later adulthood (26–50 years old) and three groups according to MCV levels: macrocytic (>100 fL), normocytic (80–100 fL), and microcytic (<80 fL); to MCHC levels: hyperchromic (>36%), normochromic (31–36%), and hypochromic (<31%); to hemoglobin levels: low (<12 g/dL), normal (12–17 g/dL), and high (>17 g/dL) hemoglobin.

Statistical Analyses

Kolmogorov-Smirnov test was performed to analyse whether data follow normal distribution. Spearman's correlation test was used for data with abnormal distribution. The means of two groups were compared using Student's t-test (for data with normal distribution) or Mann-Whitney U test (for data with abnormal distribution). The means of three groups were compared using Kruskal-Wallis test. $p<0.05$ were regarded as significant.

Results

We found that ESR was negatively correlated with all erythrocyte indices (RBC count, hematocrit, hemoglobin, MCV, MCH, MCHC, and RDW) (Table 1). When data were grouped according to hemoglobin, MCV, and MCHC levels, significant differences in terms of ESR values were found between groups (Table 2–4). ESR values in females and later adults were higher than that in males and young adults, respectively (Table 5).

Discussion

ESR is a widely used laboratory test and plays a basic role in clinical management of many inflammatory or noninflammatory diseases[7]. It is well known that plasma proteins such as fibrinogen and immunoglobulins affect the ESR[8]. These plasma proteins decrease the negative electrostatic forces between erythrocytes, leading to the aggregation and increasing ESR[9]. However, the erythrocyte factors influencing on ESR are not sufficiently understood. We found that RBC count, hematocrit, hemoglobin, MCV, MCH, MCHC, and RDW are negatively correlated with ESR (Table 1). Which of these factors is directly

Table 1. *Correlations between ESR and erythrocyte indices*

	ESR	
Erythrocyte indices	r	p
Age	0.068	0.083
RBC count	-0.392	0.000
Hematocrit	-0.474	0.000
Hemoglobin	-0.471	0.000
MCV	-0.166	0.000
MCH	-0.189	0.000
MCHC	-0.183	0.000
RDW	-0.159	0.000

ESR, erythrocyte sedimentation rate; RBC, red blood cell; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; RDW, red cell distribution width.

Table 2. *Means and standard deviations of ESR values in the groups according to hemoglobin levels*

	ESR	
Hemoglobin Level	mean ± SD	p
Low (n=45)	20.56±7.46	0.000 (for all groups)
Normal (n=546)	13.81±7.48	
High (n=67)	7.00±5.21	

ESR, erythrocyte sedimentation rate.

Table 3. *Means and standard deviations of ESR values in the groups according to MCV levels*

MCV Level	ESR (mean ± SD)
Low (n=79)	17.01±8.66[a]
Normal (n=577)	13.14±7.55[b]
High (n=2)	5.50±2.12[a,b]

The different letters show statistically significant difference ($p<0.05$).
ESR, erythrocyte sedimentation rate; MCV, mean corpuscular volume.

Table 4. *Means and standard deviations of ESR values in the groups according to MCHC levels*

MCHC Level	ESR (mean ± SD)
Low (n=24)	18.37±8.57[a]
Normal (n=598)	13.38±7.73[b]
High (n=36)	13.61±7.38[b]

The different letters show statistically significant difference ($p<0.05$).
ESR, erythrocyte sedimentation rate; MCHC, mean corpuscular hemoglobin concentration.

Table 5. *ESR values according to age and gender*

	ESR (mean ± SD)	p
Gender		
Male (n=295)	10.05±6.79	p=0.000
Female (n=363)	16.44±7.37	
Age groups		
18–25 years old (n=156)	12.43±7.08	p=0.047
26–50 years old (n=502)	13.94±7.97	

ESR, erythrocyte sedimentation rate.

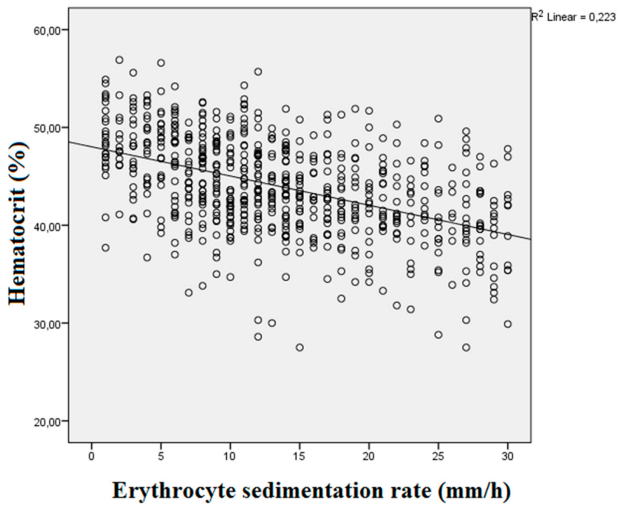

Figure 1. *Correlation between erythrocyte sedimentation rate (ESR) and hemotocrit.*

related to ESR is controversial. It has been suggested that larger erythrocytes cause higher ESR because surface-to-volume ratio (SVR) is lower in erythrocytes with high MCV compared to those with low MCV[9]. As SVR reduces, the negative charge in the erythrocyte surface decreases and ESR increases[9]. On the other hand, it appears to that the main determinant for ESR is hematocrit both in our study (Table 1 and Figure 1) and in the literature[10]. Sedimentation of erythrocytes occurs in several stages: (a) rouleaux formation, (b) formation of spheres, and (c) precipitation[10]. The radius of the precipitating spheres is inversely associated with hematocrit. As the radius increases, the precipitation accelerates[10].

We chose the patients who have ESR levels of under 30 mm/h, therefore it is expected that ESR levels have been affected by the erythrocyte factors rather than the plasma proteins. In our study, the fact that hematocrit levels are negatively correlated with ESR is coherent with the results of previous studies; however, we found that MCV levels are negatively correlated with ESR unlike the literature. This finding may be a result of the conditions that decrease both hematocrit and MCV as in iron deficiency anemia (IDA). The prevalence of IDA ranges from approximately 30% to 48% in developing countries[11]. Contrary to expectations, RDW wasn't positively correlated with ESR. This condition indicates that factors other than IDA have affected the results of our study.

We found that the young adults have lower ESR levels when compared with later adults (Table 5). Various researches have shown that elders are prone to have higher ESR levels when compared to that of young ones[12,13]. It was also seen that females have higher ESR values than that of males. This result may be explained by that females tend to have IDA, thus low hematocrit.

Consequently, the erythrocyte factors, particularly hematocrit, must be considered when ESR results are interpreted. In the light of literature, it may say that there is a need to more studies to understand whether other factors except for hematocrit are directly associated with ESR.

References

1. Markanday A. Acute phase reactants in infections: evidence-based review and a guide for clinicians. Open Forum Infect Dis 2015;2: ofv098.
2. Fincher RM, Page MI. Clinical significance of extreme elevation of the erythrocyte sedimentation rate. Arch Intern Med 1986;146:1581–3.
3. Erdoğdu Hİ, Atalay E. Yüksek eritrosit sedimentasyon hızının 25-hidroksi vitamin d ve c- reaktif protein düzeyleri ile ilişkisi. Sakarya Tıp Dergisi 2018;8:798–805.
4. Reinhart WH. Erythrocyte sedimentation rate--more than an old fashion? Ther Umsch 2006;63:108–12.
5. Ham TC, Curtis FC. Sedimentation rate of erythrocytes. Medicine (Baltimore)1938;17:447.
6. Vaya A, Sarnago A, Fuster O, Alis R, Romagnoli M. Influence of inflammatory and lipidic parameters on red blood cell distribution width in a healthy population. Clin Hemorheol Microcirc 2015;59:379–85.
7. Bray C, Bell LN, Liang H, Haykal R, Kaiksow F, Mazza JJ, et al. Erythrocyte sedimentation rate and c-reactive protein measurements and their relevance in clinical medicine. WMJ 2016;115:317–21.
8. Reinhart WH, Nagy C. Albumin affects erythrocyte aggregation and sedimentation. Eur J Clin Invest 1995;25:523–8.
9. Brigden M. The erythrocyte sedimentation rate. Postgraduate Medicine 1998;103:257–74.
10. Fabry TL. Mechanism of erythrocyte aggregation and sedimentation. Blood 1987;70:1572–6.
11. De Andrade Cairo RC, Rodrigues Silva L, Carneiro Bustani N, Ferreira Marques CD. Iron deficiency anemia in adolescents; a literature review. Nutr Hosp 2014;29:1240–9.
12. Smith EM, Samadian S. Use of the erythrocyte sedimentation rate in the elderly. Br J Hosp Med 1994;51:394–7.
13. Crawford J, Eye-Boland MK, Cohen HJ. Clinical utility of erythrocyte sedimentation rate and plasma protein analysis in the elderly. Am J Med 1987;82:239–46.