Abant Tıp Dergisi

Abant Medical Journal

Abant Med J 2022;11(3):283-294, doi:10.47493/abantmedj.1065601

Effects of Phototherapy On Hematological Parameters in Newborns with Indirect Hyperbilirubinemia

İndirekt Hiperbilirubinemili Yenidoğanlarda Fototerapinin Hematolojik Parametreler Üzerine Etkileri

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Geliş Tarihi (*Received*): 31.01.2022 **Kabul Tarihi (*Accepted*):** 29.06.2022 **Yayın Tarihi (*Published*):** 30.12.2022

Abstract

Objective: Indirect hyperbilirubinemia is an important problem in newborns and phototherapy has an important role in treatment. The aim of this study is to evaluate the effects of phototherapy on hematological parameters in newborns with indirect hyperbilirubinemia.

Materials and Methods: January 2021- March 2022, 60 newborns (term = 30 and preterm = 30) diagnosed and treated for indirect hyperbilirubinemia were included in this study.

Results: Twelve of the term babies (40%) had either Rh (n = 3) or ABO incompatibility (n = 9). Ten of the preterms (33%) had either Rh (n = 3) or ABO incompatibility (n = 7). The median values of phototherapy time of term and preterm newborns were 24 (range, 6-40) and 11 hours (range, 4-36), respectively. After phototherapy, WBC and RBC counts, Hb, MCV and RDW values of term newborns decreased significantly. In preterm newborns white blood cell count, red blood cell count, hemoglobin, mean corpuscular volume of red blood cells, red blood distribution width (WBC and lymphocyte, counts and Hb, MCV and RDW) values decreased significantly, while a statistically significant increase in mean corpuscular hemoglobin concentration (MCHC) values and the percentage of monocyte counts were determined.

Conclusion: Our study suggests that phototherapy has various effects on hematological parameters. Some of these effects can be explained by Rh or ABO incompatibility, but prospective studies including more patients are needed to explain the changes in hematological parameters in newborns without Rh or ABO incompatibility.

Keywords: Newborn, Indirect Hyperbilirubinemia, Phototherapy, Hematologic Parameters

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Öz

Amaç: İndirekt hiperbilirubinemi yenidoğanlarda önemli bir sorundur ve tedavide fototerapi önemli biryere sahiptir. Bu çalışmanın amacı indirekt hiperbilirubinemili yenidoğanlarda fototerapinin hematolojik parametreler üzerindeki etkilerini değerlendirmektir.

Gereç ve Yöntemler: Ocak 2021- Mart 2022 tarihleri arasında indirekt hiperbilirubinemi tanısı alan ve tedavi edilen 60 yenidoğan (term = 30 ve preterm = 30) bu çalışmaya dahil edildi.

Bulgular: Yenidoğan dönemlerinin 12'sinde (%40) Rh uyuşmazlığı (n = 3) veya ABO uyuşmazlığı (n = 9) vardı, erken doğmuş yenidoğanların 10'unda (%33) Rh uyuşmazlığı (n = 3) veya ABO uyuşmazlığı vardı. (n = 7). Zamanında ve erken doğmuş yenidoğanların medyan fototerapi süreleri sırasıyla 24 (dağılım, 6-40) ve 11 saat (aralık, 4-36) idi. Fototerapi sonrası term bebeklerde beyaz küre sayısı, kırmızı küre sayısı, hemoglobin, kırmızı kan hücreleri ortalama korpüsküler hacmi, kırmızı kan dağılım genişliği (WBC ve RBC, Hb, MCV ve RDW) değerlerinin istatistiksel olarak anlamlı oranda azaldığı saptandı. Preterm yenidoğanlarda WBC ve lenfosit, Hb, MCV ve RDW değerlerinde istatistiksel olarak anlamlı oranda azalma olurken, ortalama korpüsküler hemoglobin konsantrasyonu (MCHC) değerleri ve monosit yüzdelerinde artış saptandı.

Sonuç: Çalışmamız fototerapinin bazı hematolojik parametreler üzerine etkisi olduğunu düşündürmektedir. Bu etkilerin bir kısmı Rh veya ABO uyuşmazlığı ile açıklanabilir, ancak Rh veya ABO uyuşmazlığı olmayan yenidoğanlarda hematolojik parametrelerdeki değişiklikleri açıklamak için daha fazla hastada prospektif çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Yenidoğan, Direk Hiperbilirubinemi, Fototerapi, Hematolojik Parametreler

Atıf/Cite as: Yılmaz F. H., Kara B., Ertan K. Effects of Phototherapy on Hematological Parameters in Newborns with Indirect Hyperbilirubinemia. Abant Med J. 2022; 11(3): 283-294, doi:10.47493/abantmedj.1065601

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Introduction

Indirect hyperbilirubinemia is one of the most common problems encountered in newborns. It is also one of the most common reason for hospitalizing newborns, especially at first week of the life. Despite that bilirubin-related complications and deaths have been reduced with phototherapy and exchange transfusion, and rhesus immunoglobulin prophylaxis in the presence of rhesus (Rh) incompatibility, hyperbiluribinemia still maintains its importance, especially in underdeveloped and developing countries. The main causes of neonatal hyperbilirubinemia are (i) hemolytic conditions which include ABO incompatibility, Rh incompatibility, subgroup incompatibility, glucose 6 phosphate dehydrogenase deficiency, and/or some others; (ii) dehydration due to lack of proper feeding, (iii) breast milk jaundice, (iv) prematurity, (v) cephalohematoma; (vi) polycythemia; and (vii) other factors (1-3).

Today, the treatment of indirect hyperbilirubinemia is phototherapy and exchange transfusion if necessary. In addition, intravenous immunoglobin administration also may be lifesaving in severe hemolytic diseases of the newborn (4). Apart from these treatments, there are some drugs in use with unproven efficacy such as phenobarbital, ursodeoxycholic acid, metalloporphyrins, and clofibrate.

Phototherapy has some acute and possible long-term side effects. Acute side effects are interference with maternal-infant interaction, imbalance between thermal environment and insensible water loss, electrolyte disturbance, disorder of circadian rhythms, and Bronze baby syndrome. The possible long-term side effects which may be related with photherapy are allergic diseases, melanocytic nevi, melanoma, skin cancer, patency of ductus arteriosus and retinal damage (5). The studies showing the possible unfavorable effects of phototherapy on hematological parameters are quite limited (6-10).

In this study, we aimed to evaluate the effects of phototherapy on hematological parameters in newborns with indirect hyperbilirubinemia.

Materials and Methods

Population and Methods

Date

The charts of newborns who received phototherapy for indirect hyperbilirubinemia in the January 2021-March 2022 were retrospectively analyzed.

Design

This study is a retrospective cross-sectional study.

Hypothesis

Our null hypothesis (H0) is that phototherapy has no effect on hematological parameters. Our alternative hypothesis (H1) is that phototherapy has effect on hematological parameters.

The charts of the newborns who received phototherapy with the diagnosis of indirect hyperbilirubinemia were retrospectively analyzed. Newborns who had complete blood counts one hour before phototherapy starts and one hour after phototherapy ends were included in the study. The newborns included in this study were divided into two groups as preterm and term. The indirect causes of hyperbilirubinemia in the newborns included in the study were as follows; Rh and ABO incompatibility, sepsis, neonatal polycythemia, lactation failure jaundice. The exclusion criteria were as follows; a history of bleeding, preeclampsia or eclampsia, chorioamnionitis, chronic disease, premature rupture of membranes, diabetes, thyroid disease, smoking or receiving drugs such as anticonvulsant, antidepressant, insulin, chemotherapy or cortisone (Except preterm. Because in preterms, cortisone is used for intrauterine use for lung development), exchanged patients, patients who have used IVIG in patients with direct cooms-positive

blood group incompatibility, patients whose complete blood counts was not studied before and after phototherapy. Also, the neonates with birth asphyxia were excluded (6).

If ABO and Rh blood group incompatibility is known in term and preterm babies, bilirubin was measured at 4-hour intervals after birth on the first day, and complete blood count was performed within the first hour after birth. One hour after phototherapy was terminated, complete blood count and bilirubin were checked.

If there was no blood group incompatibility, complete blood count and bilirubin were measured in the preterms within 1 hour and at the 24th hour after birth. Complete blood count and bilirubin were measured at the 24th hour of term.

The bilirubin level at which to provide phototherapy was decided as according to Bhutani nomogram.

In the study, bilateral phototherapy devices were applied to the babies if they were receiving intensive treatment and care in the third stage, and phototherapy was applied with intensive phototherapy devices if their mothers were caring. The duration of application was specific to the patient. The newborns' demographic features including gender, birth weight, gestational age, the age at admission, and duration of phototherapy, newborns' and their mothers' blood groups, complete blood counts before and after phototherapy have been noted.

Ethical Considerations

For this study, the approval was obtained from the local ethics committee of Selcuk University Faculty of Medicine (No: 2021/85). As this study was a retrospective cross-sectional study, informed consent was not obtained from the patients or their guardians. This study was carried out according to the principles of the Declaration of Helsinki and the Good Clinical Practice guidelines.

Statistical Analysis

In this study, GraphPadPrisim 9 Software was used for statistical analysis (La Jolla, CA, USA). The frequency and percentage values were are given for categorical data. As descriptive statistics, mean ± standard deviation values were used for numeric data with normal distribution, and median (Quartile 1 and Quartile 3) values were used for numeric data without normal distribution. In comparison of hematological parameters before and after phototherapy, paired sample t test was used for comparisons if it satisfied the necessary assumptions for paired t test, and Wilcoxon signed rank test was used if it did not satisfy the necessary assumptions. If alpha (p) value was <.05, it was considered statistically significant.

Results

January 2021- March 2022, 60 newborns diagnosed with indirect hyperbilirubinemia and treated were included in this study. Thirty of the newborns were term and 30 were preterm.

Demographic Features

The demographic features of both term and preterm newborns are shown in Table 1.

The ethnicity of term newborns was Turkish (n = 16, 53%) and Syrian refugees (n = 14, 47%). The term newborns' gestational age ranged from 37 to 41 weeks (median, 39 weeks). There were 16 males (53%) and 14 females (47%) with a median age of five days (1-11 days) at admission. The median birth weight of the term newborns was 3075 grams (range, 2300-4315).

In preterm newborns, 13 were Turkish (43%) and 17 were Syrian refugees (57%). Their gestational age ranged from 26 to 35.5 weeks (median, 33 weeks). The gender distribution of preterm newborns was as six males (20%) and 24 females (80%). Their ages at admission ranged from one to 15 days (median, one day). The median birth weight of the preterm newborns was 2100 grams (range, 870-2940).

Effects of Phototherapy on Hematologic Parameters

Twelve of the neonatal terms (40%) had either Rh incompatibility (n = 3) or ABO incompatibility (n = 9), 10 of the preterm newborns (33%) had either Rh incompatibility (n = 3) or ABO incompatibility (n = 7). The median durations of phototherapy in term and preterm newborns were 24 (range, 6-40) and 11 hours (range, 4-36), respectively.

In Term Newborns

The effect of phototherapy on hematological parameters in term newborns is shown in Table 2 and Figure 1. The mean term newborns'white blood cells counts after the phototherapy were significantly lower than those before phototherapy (p = .0187) (Figure 1a). The decrease in WBC count was significantly more obvious in term babies with either RH or ABO imcompatibility (p = .027). While there was no statistically significant decrease in WBC counts analysed before and after phototherapy in term newborns with neither Rh nor ABO incompatibility (p =.82).

Mean red blood cell counts were significantly lower after phototherapy in all term newborns, term newborns with either Rh or ABO incompatibility, as well as in term neonates with neither Rh nor ABO incompatibility (p values: .0007, .0385, and. 0099, respectively) (Figure 1b).

Similarly, mean Hb levels were significantly lower after phototherapy in all term newborns, term newborns with either Rh or ABO incompatibility, and in term newborns with neither Rh nor ABO incompatibility (p values: .0001, .0225, .0031, respectively) (Figure 1c).

The term newborns' mean MCV level were significantly lower after phototherapy than those before phototherapy (p = .0036) (Figure 1d). The decrease in MCV level was significantly more obvious in term babies with either RH or ABO incompatibility (p = .0036), while there was no statistically significant decrease in term newborns with neither Rh nor ABO incompatibility (p =.3).

The RDW values were lower after phototherapy in all term newborns, term newborns with either Rh or ABO incompatibility, and in term newborns with neither Rh nor ABO incompatibility (p values: <.0001, .0107, .0065, respectively) (Figure 1e).

No statistically significant difference was found in between MCH, MCHC, platelet counts, MPV, PDW, lymphocyte counts and the counts and percentage of leukocyte subgroups in term newborns analysed before and after phototherapy (Table 2).

In Preterm Newborns Preterm Newborns

The preterm newborns' white blood cell counts, Hb levels, red cell distribution width and lymphocyte counts, were statistically lower after phototherapy phototherapy than before phototherapy (p = .002, p=.0131, p = .0036, p = .0081, respectively) (Figure 2a, Figure 2b, Figure 2e, Figure 2f). The decrease in WBC count, Hb level, RDW and lymphocyte count after phototherapy were significantly more obvious in preterm babies with either RH or ABO incompatibility (p = .0058, p = .0112, p = .0529, p = .0119, respectively). While there was no statistically significant decrease in WBC count, Hb level, RDW of preterm newborns without either Rh or ABO incompatibility (p =.08, p=.21, p = .043 and p = .57, respectively).

Mean corpuscular hemoglobin concentrations and the monocyte percentages of all preterm newborns were significantly higher after phototherapy than before phototherapy (p = .0083 and p= <.0001) (Figure 2d and Figure 2g). The monocyte percentages were also significantly higher in preterm newborns with Rh or ABO incompatibility, and in preterm newborns without either Rh or ABO incompatibility after phototherapy (p=.0009 and p=.0067, respectively). The increase in MCV level after phototherapy was significantly more obvious in preterm newborns with either RH or ABO imcompatibility (p = .0277), while there was no statistically significant decrease in preterm newborns without either Rh or ABO incompatibility (p =.07).

No statistically significant difference was observed between RBC, MCH, platelet count, MPV, PDW, neutrophil number and percentage, eosinophil number and percentage, lymphocyte percentage and monocyte count of preterm newborns evaluated before phototerapy and after phototerapy.

Discussion

In this study, changes in various hematological parameters were observed after therapeutic phototherapy for neonatal hyperbilirubinemia.

The studies investigating the effect of phototherapy on hematological parameters are quite limited.6-8 In the study of Timilsina et al. (11) with 120 patients, it was found that phototherapy was associated with a significant decrease in absolute monocyte count and platelet count and increased lymphocyte count and MCH. Hematological parameters that were affected in the results of this study were considered normal in our study. We think that this different result may be related to the causes of indirect hyperbilirubinemia in infants.

Altuntas et al. (6) investigated the effect of phototherapy on WBC parameters and neutrophil volume, volume conductivity scatter (VCS) parameters in 74 newborns with indirect hyperbiluribinemia. While our study reported no changes in eosinophils and basophils, Altuntas et al. (6) found a decrease in leukocyte and neutrophil counts and an increase in eosinophil and basophil counts in newborns who received phototherapy. However, they determined that it had no effect on lymphocyte or monocyte counts. In addition, they observed a significant decrease in neutrophil volume values and a significant increase in neutrophil scatter values after PT.

In another study by Aydin et al. (7), 306 newborns with indirect hyperbilirubinemia were included. In this study, the most common cause of indirect hyperbilirubinemia was ABO incompatibility. The authors indicated a low eosinophil count with a high bilirubin suppression of vascular cell adhesion molecule-1 before phototherapy compared to the control group. They emphasized that the decrease in bilirubin levels after phototherapy and consequently decrease in the pressure on vascular cell adhesion molecule-1 may increase the number of eosinophils. In the study which investigated the effect of phototherapy on lymphocyte subset in newborns with indirect hyperbilirubinemia, the authors determined that the patients' the percentage of CD19+ lymphocyte was lower than control group before phototherapy (8). After phototherapy, it was observed that the low percentage of CD19+ lymphocytes approached the control group. The authors tried to explain this by the inhibitory effect of unconjugated hyperbilirubinemia on CD19 B cells, similar to Khan and Poduval (12). In another study done in Turkey by Karabayir et al. (13), CD4+ lymphocytes were found to increase after eight hours of phototherapy. We cannot discuss such an outcome in our study because we did not compare lymphocyte subgroups.

In our study, a decrease in leukocyte and erythrocyte counts, and Hb, MCV and RDW values were found in term newborns after phototherapy. The decrease in leukocyte count was statistically significant in those with Rh or ABO incompatibility. However, this decrease was not statistically significant in newborns without either Rh or ABO incompatibility. It was observed that the decrease in both erythrocytes count, Hb, and RDW levels was observed in term newborns with Rh or ABO incompatibility and in term newborns without Rh or ABO incompatibility. However, interestingly, a statistically significant decrease in MCV value was observed only in term newborns with Rh or ABO incompatibility.

In preterm newborns, while the leukocyte and lymphocyte count, HB, MCV, and RDW values decreased, MCHC value and monocyte percentage increased. Changes in MCV and monocyte percentage were detected in preterm newborns both with Rh or ABO incompatibility and without Rh or ABO incompatibility. It suggests that Rh or ABO incompatibility plays a more important role in the changes in hematological parameters after phototherapy in all newborns. However, changes in hematological parameters observed in newborns without Rh or ABO incompatibility do not mean to ignore the possible effects of phototherapy.

In our study, platelet count did not change after phototherapy in either term babies or preterm babies. Maj Sanjeev Khera et al. (14) in 2011 found that 35% of the 100 neonates studied had thrombocytopenia after phototherapy. Unlike, Timilsinaet al. (11) and Pishva et al. (15) observed that in their study platelet counts has decreased. It has been emphasized in the literature that this decrease in platelet level may be due to the effect of phototherapythe deterioration of the oxidant-antioxidant balance or the temporary decrease in general DNA, RNA and protein synthesis (10).

There are limitations in our study. Fistly there were not enough newborns with Rh and ABO incompatibility. Another limitation is that we did not include the healthy newborn control group who did not receive phototherapy. If had it been done, we might have some idea of possible normal physiological changes in various blood cell counts. Because of the limited resources, further hematological parameters could not be included in the study.

Conclusion

Our results suggest that although the major causes of hematological changes at newborns treated with phototherapy are related with Rh or ABO incompatibility. Changes in hematological parameters observed in newborns without Rh or ABO incompatibility also may be related to phototherapy.

Ethics Committee Approval: The approval was obtained from the local ethics committee of Selcuk University Faculty of Medicine (No: 2021/85).

Informed Consent: As this study was a retrospective cross-sectional study, informed consent was not obtained from the patients or their guardians.

Conflict of Interest: Authors declared no conflict of interest.

Financial Disclosure: Authors declared no financial support.

Acknowledgement: None.

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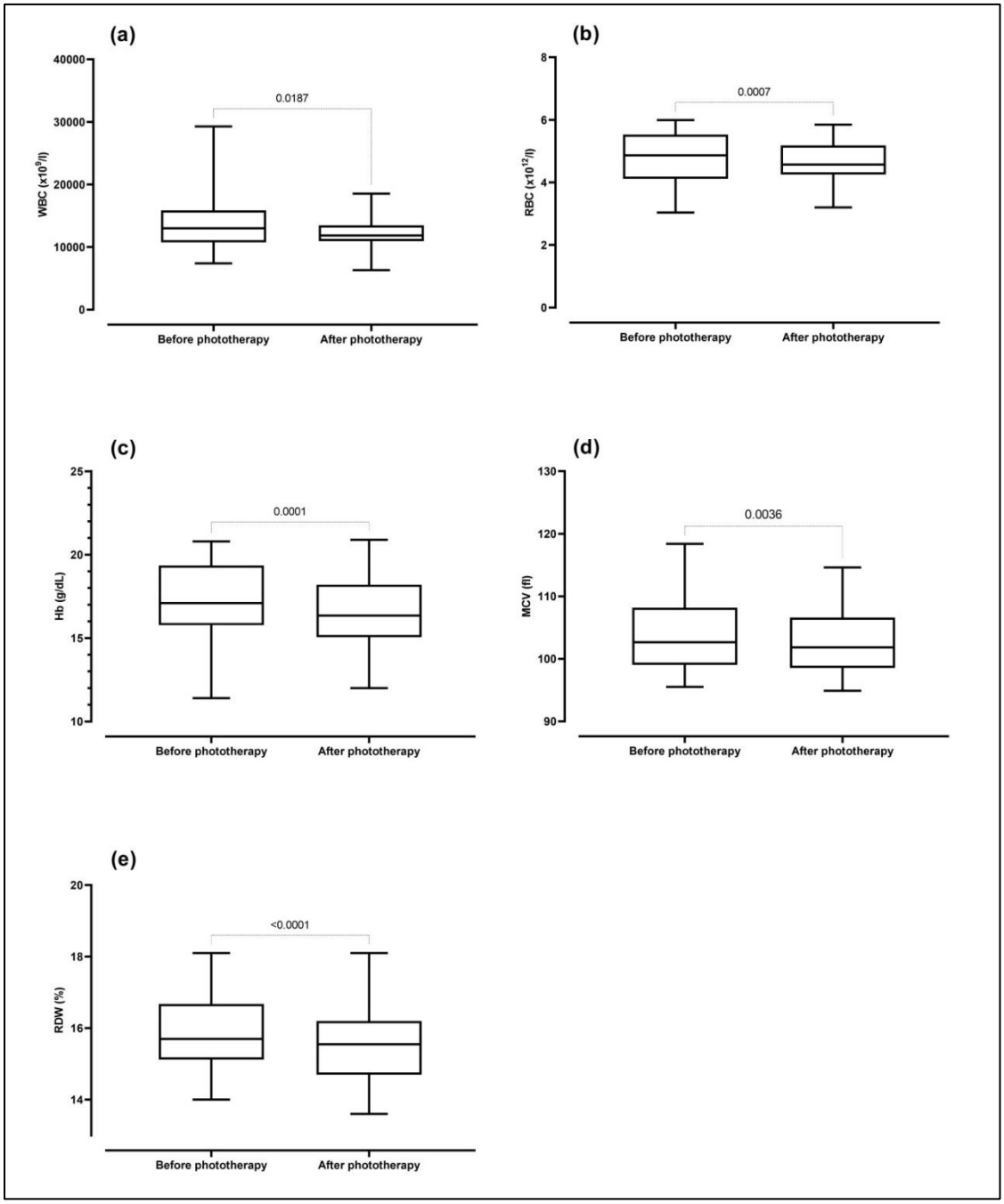
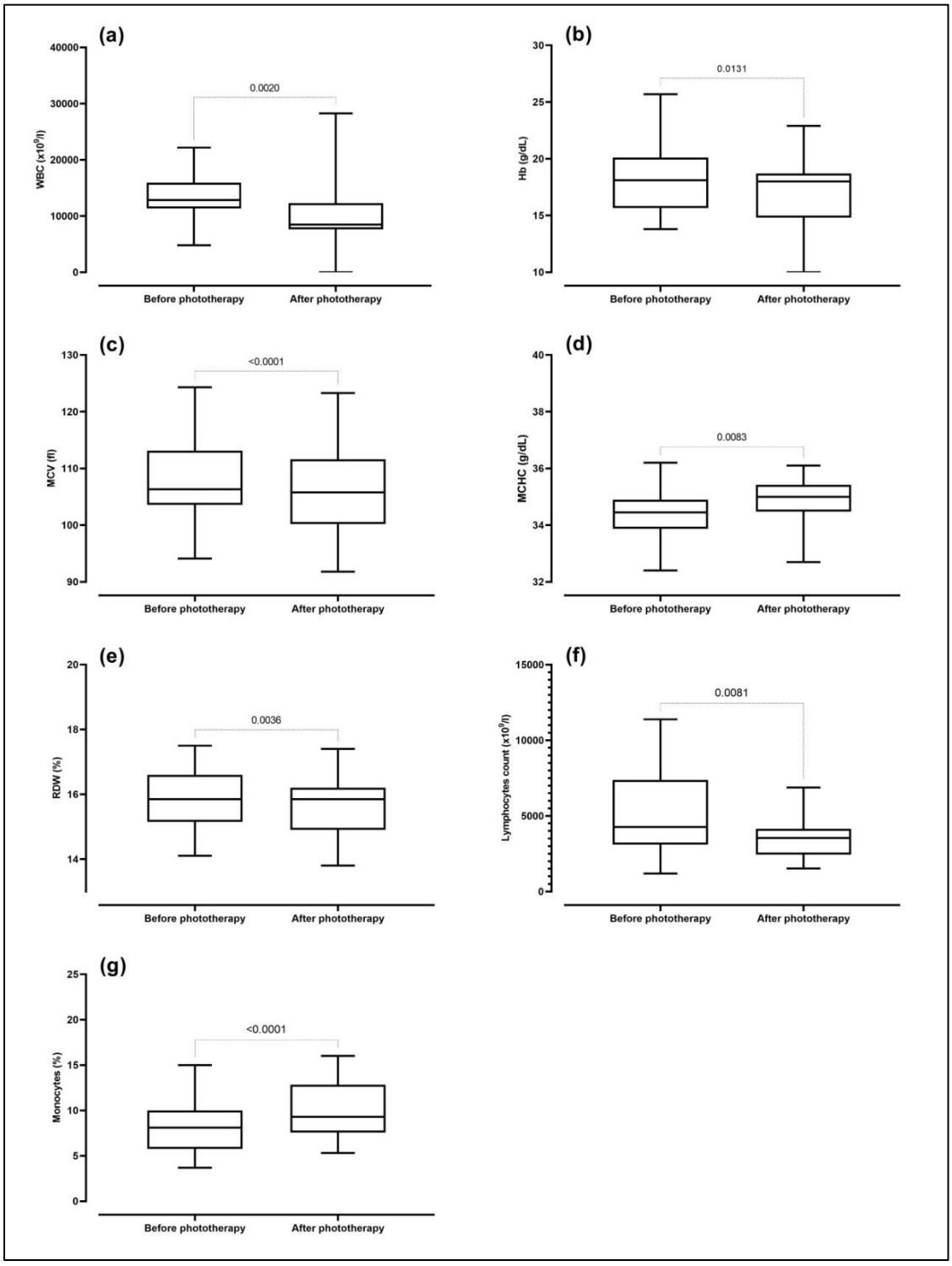


Fgure 1. The changes of (a) white blood cells, (b) red blood cells, (c) Hb, (d) MCV and (e9 RDW values in term newborns



Fgure 2. The changes of (a) white blood cells, (b) Hb, (c) MCV, (d) MCHC, (e) RDW, (f) lymphocyte counts, and (g) the percentage of monocyte in preterm newborns

Table 1.
The demographic features of newborns

	Term newborns	Preterm newborns
Ethnicity		
Turks	16 (53%)	13 (43%)
Refugee (from Syria)	14 (47%)	17 (57%)
Gender		
Male	16 (53%)	6 (20%)
Female	14 (47%)	24 (80%)
Median gestation age (weeks),	39	33
(range)	(37-41)	(26-35.5)
Median birth weight (grams),	3075	2100
(range)	(2300-4315)	(870-2940)
Median age at admission, (days),	5	1
(range)	(1-11)	(1-15)
Median duration of phototherapy, (hours)	24	11
(range)	(6-40)	(4-36)

Table 2.

Effect of Phototherapy on Hematological Parameters in Term Newborns

Parameters	Before Phototherapy (*M* ± *SD*)	After Phototherapy (*M* ± *SD*)	Difference (After – Before) (*M* ± *SD*)	t	df	p
WBC, (x 10^9/l)	14198 ± 5086	12141 ± 2528	-2057 ± 4523	2.491	29	.0187
Incompatibility	15115 ± 5187	11563 ± 2292	-3553 ± 4825	2.551	10	.027
No incompatibility*	12275 (Q1=10530, Q3=15863	11770 (Q1=10945, Q3=13878)	-30	NA	NA	.82
RBC, (x10^{12}/l)	4.843 ± 0.74	4.663 ± 0.65	-0.181 ± 0.26	3.799	29	.0007
Incompatibility	4.531 ± 0.88	4.343 ± 0.73	-0.188 ± 0.28	2.349	10	.0385
No incompatibility	5.052 ± 0.57	4.876 ± 0.51	-0.175 ± 0.26	2.904	17	.0099
Hb, (g/dL)	17.2 ± 2.3	16.5 ± 2.1	-0.72 ± 0.9	4.384	29	.0001
Incompatibility	16.2 ± 2.8	15.4 ± 2.2	-0.783 ± 1.023	2.652	10	.0225
No incompatibility	17.9 ± 1.8	17.2 ± 1.7	-0.678 ± 0.83	3.441	17	.0031
MCV, (fl)	103.8 ± 5.7	102.6 ± 4.7	-1.267 ± 2.187	3.173	29	.0036
Incompatibility	106.0 ± 7.8	103.4 ± 6.1	-2.642 ± 2.48	3.691	10	.0036
No incompatibility	102.4 ± 3.2	102.1 ± 3.6	-0.35 ± 1.398	1.062	17	.3
MCH, (pg)	35.7 ± 1.7	35.5 ± 1.7	-0.18 ± 0.5	1.779	29	.08
MCHC, (g/dL)	34.4 ± 0.9	34.6 ± 0.6	0.24 ± 0.9	1.378	29	.17
RDW, (%)	15.8 ± 1.0	15.6 ± 1.0	-0.2667 ± 0.3	4.662	29	<.0001
Incompatibility	16.2 ± 1.3	15.9 ± 1.1	-0.291 ± 0.3	3.132	10	.0107
No incompatibility	15.5 ± 0.8	15.3 ± 0.8	-0.222 ± 0.3	3.101	17	.0065
Platelets, (x 10^9/l)*	296500 (Q1=249750, Q3=36000)	294500 (Q1=260250, Q3=340250)	-100.0	NA	NA	.99
MPV, (fl)	9.6 (Q1=9.1, Q3=10.3)	9.6 (Q1=9.2, Q3=10.3)	0	NA	NA	.79
PDW, (%)*	16.4 ± 0.3	16.4 ± 0.26	-0.02 ± 0.17	0.712	29	.48
Neutrophil, (x 10^9/l)	4930 (Q1=3200, Q3=8578)	4330 (Q1=3345, Q3=7200)	-165	NA	NA	.17
Neutrophil, (%)	38.6 (Q1=28.6, Q3=56.2)	36.7 (Q1=29.8, Q3=53)	-1.25	NA	NA	.43
Lymphocyte, (x 10^9/l)	5348 ± 1332	4957 ± 1900	-390.7	1.378	29	.17
Lymphocyte, (%)	43.5 (Q1=31.3, Q3=49.6)	45.6 (Q1=27.3, Q3=52.2)	1800	NA	NA	.81
Monocyte, (x 10^9/l)	1348 ± 474.5	1308 ± 487.3	-40.0	0.726	29	.47
Monocyte, (%)	9.9 (Q1=6.6, Q3=12.8)	10.5 (Q1=8.3, Q3=13.8)	0.4	NA	NA	.22
Eosinophil, (x 10^9/l)	579.3 ± 342.5	594.3 ± 312.7	15.0 ± 213.1	0.385	29	.7
Eosinophil, (%)	4.7 ± 3.0	5.0 ± 2.6	0.3	0.945	29	.35

*Wilcoxon t test was used because it could not satisfy the necessary assumption for the paired t test. Therefore, median (Quartile 1 and 3) values were given as descriptive statistics. **NA**: not available, **WBC**: white blood cell, **RBC**: red blood cell, **Hb**: hemoglobin, **MCV**: mean corpuscular volume, **MCH**: mean corpuscular hemoglobin, **MCHC**: mean corpuscular hemoglobin concentration, **RDW**: red cell distribution width, **MPV**: mean platelet volume, **PDW**: platelet distribution width

Table 3.

Effect of Phototherapy on Hematological Parameters in Preterm Newborns

Parameters	Before Phototherapy ($M \pm SD$)	After Phototherapy ($M \pm SD$)	Difference (After – Before)($M \pm SD$)	t	df	p
WBC, (x 10^9/l)	13192 ± 4290	10427 ± 5599	-2765	3.394	29	.002
Incompatibility	13144 ± 3856	8473 ± 2281	-4671	3.590	9	.0058
No incompatibility	13216 ± 4588	11404 ± 6510	-1812 ± 4417	1.835	19	.08
RBC, (x10^{12}/l)*	4.960 (Q1=4.435, Q3=5.323)	4.825 (Q1=4.275, Q3=5.188)	-0.185	NA	NA	.12
Hb, (g/dL)	18.2 ± 2.7	17.2 ± 2.8	-0.99 ± 2.05	2.642	29	.0131
Incompatibility	19.1 ± 2.7	16.7 ± 3.2	-2.370 ± 2.36	3.180	9	.0112
No incompatibility*	17.8 (Q1=15.5, Q3=18.9)	18.0 (Q1=14.8, Q3=18.6)	-0.55	NA	NA	.21
MCV, (fl)*	106.3 (Q1=103.6, Q3=113.1)	105.8 (Q1=100.2, Q3=111.6)	-2.050	NA	NA	<.0001
Incompatibility	111.3 ± 8.4	108.7 ± 8.6	-2.610 ± 2.1	3.945	9	.0034
No incompatibility*	105.6 (Q1=103.5, Q3=111.7)	104.9 (Q1=100.8, Q3=107.9)	-2.050	NA	NA	.0003
MCH, (pg)*	37.4 (Q1=35.2, Q3=38.9)	36.7 (Q1=35.4, Q3=38.8)	-0.1	NA	NA	.17
MCHC, (g/dL)	34.4 ± 0.9	34.9 ± 0.7	0.54 ± 1.0	2.835	29	.0083
Incompatibility	33.9 ± 0.9	34.5 ± 0.8	0.65 ± 0.78	2.623	9	.0277
No incompatibility	36.6 ± 0.8	35.1 ± 0.7	0.48 ± 1.16	1.855	19	.07
RDW, (%)*	15.9 (Q1=15.2, Q3=16.6)	15.9 (Q1=14.9, Q3=16.2)	-0.25	NA	NA	.0036
Incompatibility*	16 (Q1=15.5, Q3=16.6)	15.4 (Q1=14.9, Q3=16.0)	-0.65	NA	NA	.0430
No incompatibility*	15.9 (Q1=15.1, Q3=16.6)	15.9 (Q1=15.1, Q3=16.6)	-0.1	NA	NA	.0529
Platelets, (x 10^9/l)*	214000 (Q1=179000, Q3=287250)	207500 (Q1=181500, Q3=269750)	1000	NA	NA	.81
MPV, (fl)*	9.6 (Q1=8.9, Q3=10.2)	9.5 (Q1=9.0, Q3=10.3)	0.05	NA	NA	.81
PDW, (%)*	16.4 (Q1=16.1, Q3=16.7)	16.5 (Q1=16.2, Q3=16.8)	0.1	NA	NA	.07
Neutrophil, (x 10^9/l)	6552 ± 3978	5991 ± 3996	-561 ± 4350	0.706	29	.48
Neutrophil, (%)	47.6 ± 20.3	52.2 ± 13.5	4.7 ± 26.2	0.974	29	.33
Lymphocyte, (x 10^9/l)	5177 ± 2786	3479 ± 1236	-1698 ± 3274	2.841	29	.0081
Incompatibility	7018 ± 2878	3280 ± 1521	-3738 ± 3763	3.141	9	.0119
No incompatibility*	3755 (Q1=2868, Q3=5468)	3655 (Q1=2443, Q3=4510)	75.0	NA	NA	.57
Lymphocyte, (%)	41.6 ± 21.0	35.0 ± 12.0	-6.5 ± 24.6	1.459	29	.15
Monocyte, (x 10^9/l)	1118 ± 672	1121 ± 752	2333 ± 351	0.036	29	.97
Monocyte, (%)	8.1 ± 3.0	10.0 ± 3.2	1.84 ± 2.1	4.744	29	< .0001
Incompatibility	6.1 ± 2.1	8.3 ± 2.1	2.3 ± 1.5	4.877	9	.0009
No incompatibility	9.2 ± 2.9	10.8 ± 3.3	1.6 ± 2.4	3.045	19	.0067
Eosinophil, (x 10^9/l)	287.3 ± 351.4	273.0 ± 343.6	-14.3 ± 165.9	0.473	29	.63
Eosinophil, (%)*	1.7 (Q1=0.6, Q3=2.3)	1.1 (Q1=0.2, Q3=5.1)	-0.05	NA	NA	.92

*Wilcoxon t test was used because it could not satisfy the necessary assumption for the paired t test. Therefore, median (Quartile 1 and 3) values were given as descriptive statistics. **NA**: not available, **WBC**: white blood cell, **RBC**: red blood cell, **Hb**: hemoglobin, **MCV**: mean corpuscular volume, **MCH**: mean corpuscular hemoglobin, **MCHC**: mean corpuscular hemoglobin concentration, **RDW**: red cell distribution width, **MPV**: mean platelet volume, **PDW**: platelet distribution width