Int J Burn Trauma 2020;10(4):101-106
www.IJBT.org /ISSN:2160-2026/IJBT0113141

Original Article

Red cell distribution width and neutrophil-to-lymphocyte ratio as a predictive factor in treatment of pediatric patients with burns

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Received April 23, 2020; Accepted June 22, 2020; Epub August 15, 2020; Published August 30, 2020

Abstract: Background: Red cell distribution width (RDW) is associated with mortality in certain diseases. Neutrophil-to-lymphocyte ratio [NLR] is being used as a decisive parameter in inflammatory diseases. The association between morbidity and RDW-NLR in children with burns is unclear. We aimed to evaluate effectivity of these markers in children with burn. Methods: Retrospectively the treatment records of 39 children with second-degree superfisial, second-degree deep, and third-degree burns were evaluated. First group included patients those treated with grafts and second group included those treated with topical agents. Total body surface area [TBSA], age, RDW, NLR, sex, and albumin values were evaluated. The association of RDW and NLR with both groups were analysed. Results: Patients in group 2 had mild increase in RDW and NLR values but it was not more statistically significant than in group 1. A positive relationship between NLR and length of hospital stay, TBSA and length of hospital stay, and RDW and lymphocyte values was found. A negative correlation between albumin values and length of hospital stay was found. Conclusion: NLR is associated with morbidity in patients with burns; although RDW has not any relationship with morbidity in pediatric scald burns.

Keywords: Red cell distribution width, neutrophil-to-lymphocyte ratio, burn, pediatric surgery, injury

Introduction

Red cell distribution width (RDW) which can be determinated by complete blood count (CBC) demonstrates knowledge about the heterogeneity in the size of erythrocytes. Also greater heterogeneity in MCV (anisocytosis) due to disruption in erythrocyte development or degeneration results with higher RDW values [1]. Ineffective erythropoiesis and erythrocyte destruction increases RDW values [2]. Several studies have identified RDW as a powerful marker of morbidity and mortality in different groups of patients with cardiovascular disease [3], chronic dialysis [4], obstructive sleep apnea syndrome [5], inflammatory bowel syndrome [6], acute or chronic heart failure [7], cardiac arrest [8], pulmonary embolism [9], severe sepsis and septic shock [10], and even community acquired pneumonia [11]. In a recent study authors showed a significant interrelation between RDW and 28-day mortality in patients with septic shock and severe sepsis. In follow-up period there was a positive correlation between increased RDW values and mortality [10].

The CBC of patients also gives information about neutrophil to lymphocyte ratio (NLR) used as a decisive parameter of inflammatory disorders [12]. Several studies reported correlation between NLR and Familial Mediterranean Fever [13], cystic fibrosis [14], cervical carcinoma [15], gastric cancer [16], and Henoch-Schonlein purpura [17]. NLR especially has a negative correlation with prognosis in systemic inflammation and also the relation between the seriousness of the illness and the grade of neutrophilia and lymphocytopenia was shown [12]. In a laboratory-based study a cut-off value of < 5 for NLR was reported to determine the diagnosis of infection or sepsis [18].

CBC and routine biochemical analyses including electrolytes, albumin, and glucose values are measured in initial management of burn injury. We aimed to evaluate association of these markers (RDW-NLR) with morbidity in children with burn, since there is no study to evaluate this relationship.

Clinical significance of this research; evaluating these parameters would be effective in predicting the morbidity of burns. Additionally, if a decisive marker can be put forward, it will assist in establishing treatment strategies and it also can be used in planning length of hospital stay.

Materials and methods

Subjects

Retrospectively analyse of medical records of children with scald burns who were treated at the Konya Education and Research Hospital Burn Unit between September 2013 and October 2014 were performed. First group included patients those treated with grafts and second group included those treated with topical agents.

The evaluation included the following aspects: age, sex, burn degree, total body surface area (TBSA), RDW, NLR, length of hospital stay, and morbidity and mortality.

Inclusion and exclusion criteria

Since our burn unit does not have permission from the Ministry of Health to treat burned pediatric patients with a total body surface area [TBSA] of over 25%, patients having burns of higher than 25% TBSA were the exclusion criteria in this study. Also patients with first degree burn were excluded. Second-degree superfisial, second-degree deep and third-degree burns were the inclusion criteria. The clinical status of those patients was stabilized in our department and they were immediately transferred to burn centers by helicopter or land ambulance.

Statistical analyses

Statistical analyses of data were conducted using IBM SPSS 24.0 (SPSS Inc, Chicago, Illinois, United States of America) packet computer program. Differences for groups were tested using the Mann-Whitney U-test. Correlations between data were tested using the Pearson Correlation system. *P* values as 0.150 in Age, 0.000 in TBSA, 0.730 in RDW, 0.001 in albumin, 0.869 in NLR, and 0.000 in length of hospital stay were expressed as medians. $P < 0.05$ was considered statistically significant.

Ethics committee approval

Study was designed according to Helsinki Declation and the patient's consent was taken from the families. There is no need for ethics committee approval for present retrospective study.

Result

Patient characteristics

This study included 39 scald burn pediatric cases. The patients in group 1 included 17 male and 10 female patients who were treated with bacitracin-neomycin sulfate pomade without graft application; the patients in group 2 included 5 male and 7 female patients who were treated with split thickness skin grafts. All patients in Group 1 had second-degree superficial burns, while in Group 2, 11 of the patients had deep second-degree burns, and one had a third-degree burn.

Data assessment

Patients in group 2 had mild increase in RDW and NLR values but it was not more statistically significant than in group 1. A positive interaction between NLR and length of hospital stay (P: 0.008 r: 72.0), TBSA and length of hospital stay (P: 0.015 r: 68.2), and RDW and lymphocyte values (P: 0.003 r: 77.4) was found. $P < 0.05$ was considered statistically significant. A negative correlation between albumin values and length of hospital stay was found. Median values are shown in **Table 1**. In Group 2, in a follow-up, a patient needed reconstructive surgery for a contracture in arm-axilla-shoulder (**Figure 1**), as well as a steroid injection for hypertrophic scars, while three patients used pressure garments (**Figure 2**) and two of them had rehabilitation.

Discussion

Burns in the pediatric population are a serious problem in our country and in the world. In most

Table 1. Median values

	Group 1	Group 2	p
Age	2	3.5	0.150
	[1-12]	[1-16]	
TBSA%	6	13.5	0.000
	[3-20]	[8-25]	
RDW%	14.6	14.4	0.730
	[11.9-21.9]	[12.2-21.0]	
Albumin [g/dL]	3.8	2.85	0.001
	[2.7-5.0]	[1.7-3.7]	
NLR	1.75	1.61	0.869
	[0.3-5.5]	[0.4-23.2]	
length of hospital stay	8	21.5	0.000
	[1-21]	[7-50]	
Sex [n]	Male: 17	Male: 5	
	Female: 10	Female: 7	

P < 0.05 was considered statistically significant, TBSA: total body surface area, RDW: Red cell distribution width, NLR: Neutrophil-to-lymphocyte ratio.

Figure 1. A. Flame burn, deep second-degree. B. Split thickness skin grafts (after treating pseudomonal infection).

of them, the etiology is scalding, as in our study [19]. In our retrospective study, we evaluated the predictivity of RDW and NLR values in burn management. We also tried to determine correlations with TBSA, albumin values and hospital stay duration. We aimed to show the relationship between these easy detectable, simple, cheap parameters and say something about the prognosis and morbidity of these patients. This is the first retrospective study examining the relationship between RDW and NLR in children with burns.

Red cell distribution width demonstrates knowledge about the heterogeneity in the size of erythrocytes is being used in anemias those including iron, vitamin B12, or folate deficiencies [11]. In patients with chronic dialysis was reported as a powerful marker. In a prospective multicenter study, non-surviving septic patients in an intensive care unit had higher RDW values than surviving patients; also an association with sepsis severity and mortality was reported during the first week [20]. In a retrospective study that evaluated 28-day mortality in patients with septic shock and severe sepsis, patients with an RDW of 14 or less had 13.1%, of 14.1-15.7% had 30.1%, and of 15.8% or greater had 44.9% mortality ratios respectively. The RDW values in gram-negative bacteremia were evaluated, and the mortality rate was meaningfully powerfull in the increased RDW group [21]. These results demonstrate that the pathophysiology resulting with increased RDW may affect the findings in inflammatory status. Heterogeneity in the size of erythrocytes occurs in burns. A significant decrease in the deformability of RBC was demonstrated in an experimental burn model [22]. Endoh et al. [23] showed that burn injury has an early hemolytic effect, due to erythrocyte fragility and membrane deformability. Therefore, an increase in RDW values can be expected in burn patients as Guo et al. [24] reported. Differently from present study they reported positive correlation between higher RDW and mortality, third-degree burn, TBSA and length of hospital stay. Also RDW levels were higher in infected burn patients in their report. We think that treating adult group with major burns including third degree burns, and also infected patients may explain the difference from our study. Contrary to this, we did not find any significance related to RDW values among patients

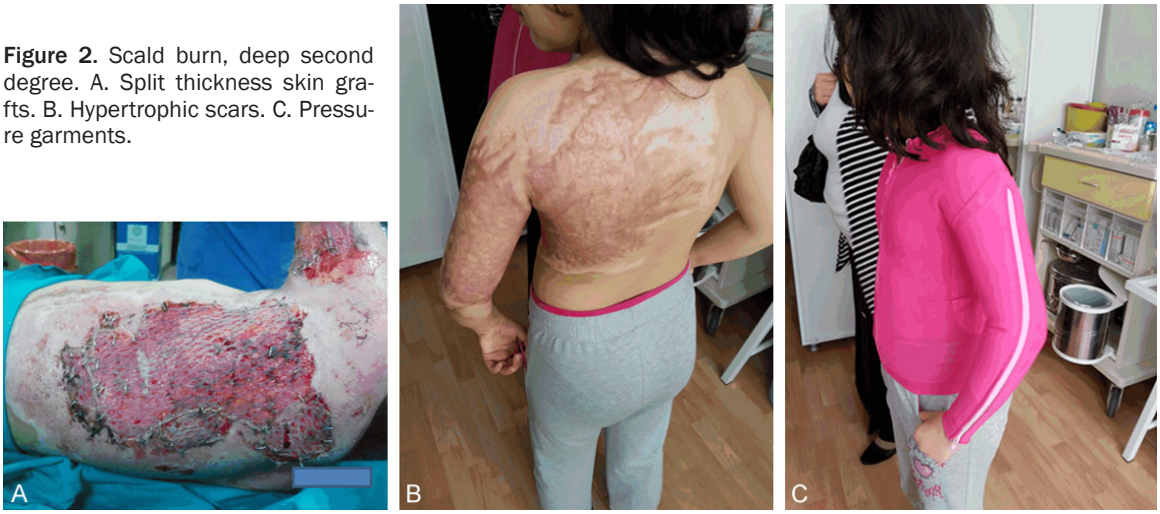

Figure 2. Scald burn, deep second degree. A. Split thickness skin grafts. B. Hypertrophic scars. C. Pressure garments.

treated with or without split thickness skin grafts. Therefore, we conclude that the response of the hematopoietic system to a burn may be relevant to destruction in the papillary or reticular dermis. Another explanation for this observation might be that we were not able to treat major burns. We believe that evaluation of RDW values in moderate and major burns would be more appropriate, and this is the scope of our further study.

The neutrophil-lymphocyte ratio [NLR] is a decisive parameter in inflammatory diseases [12]. Neutrophilia and lymphopenia occurs after tissue injury, severe trauma, major surgery, and sepsis syndrome. In retrospective studies related to Familial Mediterranean Fever [FMF], cystic fibrosis, and cervical carcinoma, NLR levels showed a correlation with the clinical status of diseases. As inflammation in Henoch-Schonlein purpura [HSP] neutrophil dominated, a study was conducted to determine the relationship between NLR and gastrointestinal bleeding in HSP - the study found that NLR significantly increased in HSP patients with gastrointestinal bleeding [17]. We found that NLR levels were higher in patients having high TBSA and deep burn degree and treated with a skin graft application. It is known that a leukocytosis, especially with neutrophilia, is usually observed that is dependent on the size of the burn wound in the first 24-48 hours following burns. The rapid release of bone marrow reserves is the reason for leukocytosis and neutrophilia. Thermal injury with unknown mechanisms causes T lymphocyte apoptosis. B lymphocytes also decrease rapidly and early after thermal injury [25]. Organ et al. used flow cytometric immunofluorescence analyses to investigate changes in the number and phenotype of lymphocytes in seven different lymphoid compartments and demonstrated that a burn injury results in dramatic alterations in lymphocyte numbers and subset percentages in different lymphoid compartments [26]. However, lymphopenia due to thermal injury was reported by Maldonado et al. [27]. Contrary to these observations, our study revealed that there were no differences among children with scald burns in terms of NLR. We think that study limitations as low patient number and not evaluating major burns may affect this. However, this study also demonstrated that there is a clear correlation between NLR and hospital stay length. Therefore, we can conclude that if a child has a high NLR, morbidity and length of hospital stay should be higher.

Conclusion

NLR has an association with morbidity in patients with burns; although RDW has not any relationship with morbidity in pediatric scald burns. However, there is a need to evaluate these data in different burn types and in a large population.

Disclosure of conflict of interest

None.

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