New Marker for Suspected Open Globe Injury (Perforation or Penetration): Neutrophil-to-lymphocyte Ratio and Platelet-to-lymphocyte Ratio

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Authors’ contributions

This work was carried out in collaboration among all authors. Author KY designed the study, performed the statistical analysis, Author Reşat Duman wrote the protocol. Author Rahmi Duman wrote the first draft of the manuscript. Authors ZY and EC managed the analyses of the study. Author MCS managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/OR/2020/v12i230145
Editors:
(1) Kota V. Ramana, University of Texas Medical Branch, USA.
Reviewers:
(1) Chikezie Grand Ihesiulor, Abia State University, Nigeria.
(2) Gabor Nemeth, Borsod-Abauj-Zemplen County Hospital and University Teaching Hospital, Hungary.
Complete Peer review History: http://www.sdiarticle4.com/review-history/56259

Received 10 February 2020
Accepted 18 April 2020
Published 25 April 2020

ABSTRACT

Purpose: To compare the strength of the relationship between the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) results of patients with or without open globe injury (perforation and penetration) in the acute period of orbital trauma.

Materials and Methods: Forty patients with open globe injury and twenty-five patients without open globe injury in the acute period of orbital trauma were enrolled in this retrospective study. Complete blood count measurement results of all subjects were assessed.

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Results: There was a significant difference in neutrophil-to-lymphocyte ratio and the platelet-to-lymphocyte ratio between orbital trauma with open globe injury group and without open globe injury group (p=0.001, p=0.006).

Conclusion: Our results of the blood count measurements suggest that the NLR and PLR at first three hours may predict ocular perforation/penetration and the clinicians have to alert are a risk factor of open globe injury.

Keywords: Orbital perforation; neutrophil; lymphocyte; platelet.

1. INTRODUCTION

The first examination of the patient with eye trauma should be done by an experienced ophthalmologist in the examination. In an orbital trauma patient; perforation and penetration should always be kept in mind. Clinical signs and symptoms of the patients are important in the differential diagnosis. It should be remembered that subconjunctival hemorrhage may hide the underlying orbital trauma with open globe injury (WOGI). Depending on the localization of the intraocular foreign body, the sensation of pain may sometimes be absent, and the patient may be asymptomatic. Hyphema and cataracts can develop in patients after both blunt and perforated injuries. In some orbital trauma with open globe injury patients, intraocular pressure may be normal or elevated [1].

The Birmingham Eye Trauma Terminology System (BETT) was developed classifying the subtypes of ocular trauma to the globe in 2002 (2). Open globes are injuries in which there is a full-thickness wound to the globe. It can be classified into penetrating (entrance wound), perforating (entrance and exit wounds) globe injury [2]. There are also studies to expand the BETT classification [3].

In various studies, the peripheral blood results of the patients were analyzed and the relationship between the blood leukocyte level measured after trauma and the severity and prognosis of the trauma was investigated [4,5]. Laboratory tests such as full blood count, serum electrolytes and arterial blood gases are used in the evaluation of the trauma patients during the acute phase. In the previous studies show that leukocytosis, hypokalemia, and acidosis are predictive factors of the severity of injury [6,7]. There is no study evaluating alterations in the complete blood count in suspected orbital trauma with open globe injury. The purpose of this retrospective study was to compare the NLR and PLR results of patients with or without open globe injury (WOOGI) (perforation or penetration) in the acute period of orbital trauma and to determine the predictive factor of these parameters in open globe injury.

2. MATERIALS AND METHODS

The study was given institutional review board approval and was conducted according to the tenets of the Declaration of Helsinki.

2.1 Subjects

Medical records attained from 184 patients in Afyonkarahisar Health Sciences University Faculty of Medicine, Department of Ophthalmology who had orbital trauma between January 2013 and February 2017 were reviewed retrospectively. The ophthalmological records of the patients were evaluated in detail and 65 patients with orbital trauma were included in the study. The patients were grouped according to with or without open globe injury in 2 groups. Forty patients in the first group had open globe injury; the second group included twenty-five patients with blunt orbital trauma without open globe injury. Data about the demographic profile, trauma hour, initial MRI (magnetic resonance imaging) scans records, initial blood sample records, and clinical presentation were recorded. Exclusion criteria were orbital fractures, cases that remained in the intensive care unit a clinical history for any blood disease, malignancies, steroid therapy, and infection.

2.2 Analysis of Blood Samples

All blood samples were EDTA (ethylenediaminetetraacetic acid) based anticoagulated and complete blood count performed immediately in an analyzer used in our laboratory (Beckman Coulter LH 780, Beckman Coulter, Miami, USA) for the determination of the complete blood cell counts and differential counts of leukocytes. These laboratory data were obtained at 15-30 minutes after blood collection from the patient.
The LH 780 is an automated analyzer with a throughput capability of 110 samples per hour (CBC/DIFF only) [8,9]. The analyzer generates a CBC (complete blood count); with a corrected WBC (white blood cell) in the presence of interference, a WBC differential. The WBC count is derived by an impedance technology. Classification of WBC is performed by size discrimination (>35 ft). Interfering particles such as NRBC (nucleated red blood cell), not analyzed red cells, giant PLTs that hover near this threshold potentially may be included in the WBC count. If any interfering particles are detected, the LH 780 generates a suspect message ‘cellular interference’ and will correct the WBC count.

2.3 Statistical Analyses

Statistical analyses were performed using SPSS software (version 18; SPSS Inc., Chicago, IL, USA). $P$ values < 0.05 were considered statistically significant. Distributions of normality of the parameters were checked with the Kolmogorov-Smirnov test (p>0.05). Differences between groups were compared using an unpaired $t$-test or analysis of variance (ANOVA) for normally distributed variables and a Mann-Whitney U test or Kruskal-Wallis test for non-normally distributed variables. Bivariate correlations were evaluated using the Pearson or Spearman rank correlation coefficient for non-normally distributed variables.

3. RESULTS

The study evaluated sixty-five consecutive orbital trauma patient datasets. The mean age was 42.12 ± 22.83 (range 10-85) in the group WOGI. The mean age was 48.44 ± 20.84 (range 11-88) in group WOOGI. There was no significant difference in the mean age when comparing the groups (p=0.195). 20 females (50%) in the group WOGI and 13 females (52%) in the group WOOGI. There was no significant difference in sex distribution when comparing the groups (p=0.983) (Table 1).

There was an increase in the number of neutrophils in the acute post-traumatic period, in both groups. Patients with open globe injury presented a higher mean neutrophil level compared with the other patients (p=0.04). The NLR was 3.73±2.27 in WOGI group and 2.07±0.86 in WOOGI group. Patients with open globe injury presented a higher mean NLR compared with the other patients (p=0.001).

The PLR was 128.23±53.61 in WOGI and 94.32±33.85 in WOOGI group. Patients with globe injury presented a higher mean PLR compared with the other patients (p=0.006) (Table 2). Basically, we found that mean neutrophils and NLR-PLR levels were significantly higher in WOGI group than in the WOOGI group.

The ROC analysis of the studied variables is shown in Fig. 2. According to this, the area under the ROC (AUROC) value of the NLR to distinguish patients WOGI and WOOGI were found to be 0.75. The best cut-off value was 1.65, with a sensitivity of 90% and a specificity of 36%. Also, PLR to distinguish patients with open globe injury and without open globe injury was found to be 0.68. The best cut-off value was 81.08, with a sensitivity of 85% and a specificity of 44% (Fig. 2).

### Table 1. Demographics of groups

<table>
<thead>
<tr>
<th></th>
<th>WOGI</th>
<th>WOOGI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (male/female)</td>
<td>20/20</td>
<td>12/13</td>
<td>0.983</td>
</tr>
<tr>
<td>Age (mean ± standard deviation) (year)</td>
<td>32.12±22.83</td>
<td>48.44±20.84</td>
<td>0.195</td>
</tr>
<tr>
<td>Side of eye (right/left)</td>
<td>18/22</td>
<td>12/13</td>
<td>0.852</td>
</tr>
</tbody>
</table>

WOGI: with open globe injury group, WOOGI: without open globe injury group

### Table 2. Comparison of blood count parameters and ratios in groups

<table>
<thead>
<tr>
<th>CBC parameters (Mean ± SD)</th>
<th>WOGI (n=40)</th>
<th>WOOGI (n=25)</th>
<th>p values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total neutrophil number</td>
<td>6.86±2.79</td>
<td>5.53±2.03</td>
<td>.04*</td>
</tr>
<tr>
<td>Total lymphocyte number</td>
<td>2.09±0.69</td>
<td>3.06±1.89</td>
<td>.09</td>
</tr>
<tr>
<td>Total platelet number</td>
<td>245.85±70.04</td>
<td>241.56±45.94</td>
<td>.787</td>
</tr>
<tr>
<td>NLR</td>
<td>3.73±2.27</td>
<td>2.07±0.86</td>
<td>.001*</td>
</tr>
<tr>
<td>PLR</td>
<td>128.23±53.61</td>
<td>94.32±33.85</td>
<td>.006*</td>
</tr>
</tbody>
</table>

CBC: Complete blood count, NLR: Neutrophil-to-lymphocyte ratio, PLR: Platelet-to-lymphocyte ratio

*p<0.05 is significant. WOGI: with open globe injury group, WOOGI: without open globe injury group
4. DISCUSSION

According to the Birmingham Eye Injury classification (BETT), open-globe injuries involve the total thickness of the globe: cornea and/or sclera [2,10]. They range from a small self-sealing pin prick to globe rupture with total prolapse of intraocular contents [11].

Some findings may lead to the possibility of perforation and penetration, such as decreased visual acuity, chemosis, sub conjunctival hemorrhage, hyphema, IOP <10 mm Hg, distorted pupil, and relative displacement of the lens-iris diaphragm [10]. However, open globe injury can sometimes be difficult to diagnose in patients who do not fit the ophthalmologic examination. Open globe injury can sometimes be difficult to diagnose.

Complete blood count and radiological examinations are applied to confirm the clinical condition of the patient at the time of the first application of emergency service in each trauma cases. A complete blood count is a fast, cheap and widely available test [12].

The relationship between trauma, inflammatory processes and whole blood count has been investigated in some studies. Some studies in trauma patients suggested that leukocytosis may be a predictive value. In a retrospective study involving 713 blunt trauma patients [13], Akköse Ş et al found that white blood cell was correlated positively with injury severity score [14]. Morell et al. in their study of 156 blunt trauma patients showed that leukocytosis is correlated with the severity of lesions in trauma patients [6]. Santucci et al. found a statistically higher mean white blood cell count in 279 blunt trauma patients with a significant injury compared to those without injury [15].

Some studies claim that PLR and NLR are novel biomarkers that show the presence and severity of inflammation in the literature [16-18]. Calculating NLR and PLR are a simpler and cheaper method compared to measuring inflammatory cytokines [19,20]. The predictive value of NLR and platelet-to-lymphocyte ratio(PLR), on the progression and prognosis of several ophthalmologic diseases, has been investigated in different studies [21,22].

The changes in the ratios of the cells (NLR and PLR) seemed to us interesting to identify the severity of open globe injury (perforation and penetration). A routine complete blood count in the post-traumatic period may be a predictive factor to evaluate open globe injury unless there is clinical evidence of alterations. NLR has not yet been studied in open globe injury. In this retrospective study, significant differences in the number of leukocytes, neutrophils, and lymphocytes among the groups, were observed. According to ROC analysis, a cut-off value of 1.65 for NLR and a cut-off value of 81.54 for PLR were determined to distinguish between patients' WOGI and WOOGI groups. To the best of our knowledge, this is the first study to investigate the value of NLR and PLR to predict the distinguished value of patients WOGI and WOOGI.

The limitations of our study are that retrospective design and the few number patients included. Also, our study is that we did not monitor the change in NLR and PLR ratio in repeated
Fig. 2. Receiver operating characteristics curve (ROC) analysis for discrimination between patients WOGI and WOOGI groups

NLR, neutrophil-to-lymphocyte ratio; PLR, platelet to lymphocyte ratio; WOGI, with globe injury; WOOGI, without globe injury

measures. Further work to validate this measure in a larger, prospective setting and determine the underlying mechanisms that mediate outcome are necessary we can suspect that a high NLR is linked to an open globe injury.

5. CONCLUSION

In conclusion, we suggest that the NLR and PLR at first hour may predict open globe injury and the clinicians have to alert NLR and PLR are a risk factor of open globe injury.

CONSENT

All participants provided written informed consent for the collection of samples and subsequent analyses.

ETHICAL APPROVAL

As per international standard written ethical permission has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES


