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# Blood Level of Polymorphonuclear Neutrophil Leukocytes and Bronchial Hyperreactivity in Chronic Obstructive Pulmonary Disease

Vesna Cukic

Clinic for Pulmonary Diseases and Tuberculosis "Podhrastovi", Clinical Centre of Sarajevo University, Bosnia and Herzegovina

Corresponding author: Vesna Cukic, Bjelave 99 Sarajevo. Tel. 061 480-228, E-mail : vesna-cukic@hotmail.com

## ABSTRACT

**Introduction:** Polymorphonuclear neutrophil leukocytes (PMNL) have an important defensive role against various microorganisms and other agents, but by liberating various substances, first of all the superoxide anion ( $O_2^-$ ), they can damage the bronchial mucosa and influence the development of bronchial inflammation which is the fundamental of bronchial hyperreactivity (BHR). **Objective:** to show the role of the PMNL for development and level of BHR in patients with chronic obstructive pulmonary disease (COPD). **Material and methods:** We observed 160 patients with COPD treated in Clinic for Pulmonary Diseases and TB "Podhrastovi" Sarajevo during three years: from 2012 to 2014. They were divided into groups and subgroups according to the first registration of BHR in the course of illness and to the number of exacerbations of the disease in one year. The number of blood PMNL was measured in a stable state of disease at the beginning and at the end of investigation. **Results:** The number of blood PMNL was significantly greater in patients with 3 or more exacerbations per one year ( $p < 0.01$ ). Patients with BHR had significantly greater number blood PMNL than patients without BHR ( $p < 0.05$ ). Patients with 3 exacerbations per year had a statistically significant increase of number of PMNL between first and last examination ( $p < 0.01$ ). **Conclusion:** There is statistically significant correlation between the number of blood PMNL and the level of BHR in COPD, but future examination need to be done to determine real role and mode of action of PMNL for these processes.

**Key words:** polymorphonuclear neutrophil leukocytes, BHR, COPD.

## 1. INTRODUCTION

Bronchial hyperreactivity (BHR) is condition in which airways show a much bigger bronchoconstrictive response to various provocative specific and non-specific agents than it is normal (1). In the condition of BHR these agents in small quantities, much under the threshold of normal reactivity, get to development of more expressive airway obstruction expressed like bronchospasm (1, 2). If the degree of BHR is bigger it is easier to provoke bronchospasm (1, 3). Bronchial inflammation, which is caused by various mechanisms, is a fundamental for development of BHR (1, 2, 3). Polymorphonuclear neutrophil leukocytes (PMNL) have an important defensive role against various microorganisms and other agents (4), but by liberating various substances, first of all the superoxide anion ( $O_2^-$ ) they can damage the bronchial mucosa (3, 4, 5, 6) and so they have influence on the development of bronchial inflammation. Free  $O_2^-$ : (a) forms membrane lipid peroxidases, altering membrane integrity; (b) irre-

versibly alters matrix constituents, e.g. collagen and hyaluronic acid; (c) inactivates protective  $\alpha_1$ -proteinase inhibitor, thereby allowing elastase to act unchecked; (d) can hydrolyze arachidonic acid to form substances chemotactic for other PMNL, thus perpetuating the inflammatory response (5, 6, 7).

While there is a plausible relationship between eosinophils, interleukin-13/4, enhanced mucous secretion and enhanced airway closure in causing AHR (airway hyperresponsiveness in the allergic, non obese asthmatic, it seems just as likely that the cause of neutrophilic inflammation and associated AHR in COPD could involve a similar sort of mechanism (8).

## 2. OBJECTIVE

Objective of the study was to show the role of the PMNL for development and level of BHR in patients with chronic obstructive pulmonary disease (COPD).

### 3. MATERIAL AND METHODS

We observed 160 patients with COPD treated in Clinic for Pulmonary Diseases and TB «Podhrastovi» Sarajevo during three years: from 2012 to 2014 and from that amount, 120 patients had registered BHR, and 40 had not. Patients with BHR were divided into groups and subgroups according to the time of the first registration of BHR in the course of disease and to the number of exacerbations of the disease in the one year. The first group (I) consists of patients with BHR registered in the first year of the diagnosis of COPD, second group (II) of patients with BHR registered from 1 to 3 years, and third group (III) consists of patients with COPD where BHR is registered more than 3 years after the diagnosis of COPD. Each group was divided into subgroups according to number of exacerbations of the disease in one year as follows: (a) one or less exacerbations in one year, (b) 2-3, and (c) more than 3 exacerbations of disease during one year. Patients without BHR were divided into subgroups according to the number of exacerbations during one year. The number of blood PMNL was measured in a stable state of disease at the begging and at the end of investigation.

### 4. RESULTS

Results are shown on the Table 1 and Table 2 and Figure 1 and Figure 2.

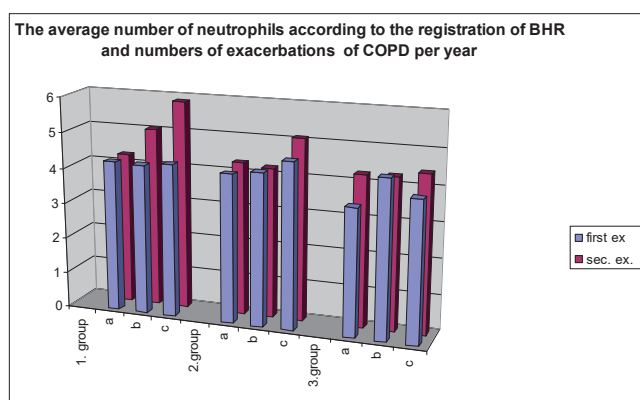


Figure 1. Legend: exam.= examination

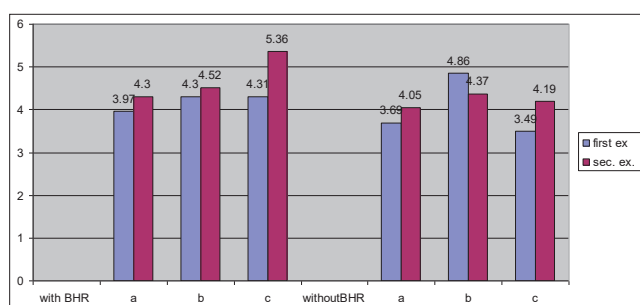


Figure 2. Legend: exam.= examination

The number of neutrophils in patients with BHR is statistically significant bigger in the I group (where the BHR is registered earlier in the course of illness) in comparison with the III group ( $p < 0.05$ ) in last examination.

The biggest and statistically significant increase of number of neutrophils between first and last examination was with patients in I group. ( $p < 0.01$ ). It happened owing to the patients with 3 or more exacerbations during one year.

NEUTROPHILS (n x 10 <sup>9</sup> /L)				
	First examination (mean value)	Last examination (mean value)	Diference	Significance of differences
Patients with BHR				
I Group: time of registration of BHR : 0-1 year ( 40 patients)				
a	4,24 S,D, 1,437	4,36 1,588	0,12 0,975	non,sign
b	4,21 S,D, 1,833	5,03 2,506	0,82 3,100	non,sign,
c	4,29 S,D, 1,469	5,86 3,148	1,57 3,443	SIGN, p<0,01
Total	4,25 S,D, 1,554	5,18 2,619	0,93 2,861	SIGN p<0,01
II Group: time of registration of BHR 1- 3 year ( 40 patients)				
a	4,17 SD 1,692	4,29 2,111	0,12 1,915	non,sign,
b	4,28 SD 1,284	4,20 1,395	-0,08 1,382	non,sign,
c	4,64 SD 1,589	5,08 2,108	0,44 2,587	non,sign
Total	4,37 SD 1,504	4,54 1,894	0,16 1,987	non,sign
III Group: time of registration of BHR - more than 3 year ( 40 patients)				
a	3,56 SD 1,075	4,25 1,702	0,69 1,548	SIGN p<0,05,
b	4,42 SD 2,296	4,26 1,903	-0,16 2,862	non, sign,
c	3,95 S,D, 1,269	4,79 2,125	0,84 2,069	non,sign
Total	3,95 S,D, 1,622	4,41 1,860	0,46 2,183	non,sign
All patients with BHR				
	4,20 S,D, 1,569	4,74 2,218	0,54 2,433	SIGN, p<0,01

Table 1. The average number of neutrophils according to the the time of the first registration of BHR in the course of COPD and to the number of exacerbations of disease in one year in patients with registered BHR Legend: subgroups: a= 1 or less exacerbations per year, b=2-3 exacerbations, c= more than 3 exacerbations, SD –standard deviation

All patients with BHR had a statistically significant increase of number of neutrophils between first and last examination ( $p < 0.01$ ).

The number of neutrophils in patients with BHR is statistically significant bigger in patients with more than 3 exacerbations of disease per one year comparing with patients with one or less exacerbations ( $p < 0.01$ ) at last examination. It is not present in group without BHR.

Patients with BHR have statistically significant bigger number of neutrophils than patients without BHR at last examination ( $p < 0.05$ ).

The biggest and statistically significant increase of number of neutrophils was in patients with 3 or more exacerbations per year ( $p < 0.01$ ). That increase was statistically significant bigger than in groups with 1 or less ( $p < 0.01$ ) and 2 to 3 exacerbations ( $p < 0.05$ ).

In patients without BHR the statistically significant increase of number of blood neutrophils between the first

NEUTROPHILS (n x 10 <sup>9</sup> /L)				
Number of exacerbations per one year	First examination (mean value)	Last examination (mean value)	Diference	Significance of differences
Patients with BHR (120 patients)				
A	3.97 S.D. 1.406	4.30 1.762	0.33 1.512	non.sign
B	4.30 S.D. 1.800	4.52 2.007	0.22 2.567	non.sign.
C	4.31 S.D. 1.451	5.36 2.618	1.05 2.885	SIGN. p<0,01
Total	4.20 S.D. 1.569	4.74 2.218	0.54 2.433	SIGN p<0.01
Patients without BHR (40 patients)				
NEUTROPHILS (n x 10 <sup>9</sup> /L)				
Number of exacerbations per one year	First examination (mean value)	Last examination (mean value)	Diference	Significance of differences
A	3.69 S.D 1.247	4.05 1.298	0.36 1.514	non. sign.
B	4.86 S.D 2.177	4.37 1.932	-0.49 2.865	non. sign.
C	3.49 S.D 1.076	4.19 1.183	0.67 1.305	SIGN p<0.01
Total	4.01 S.D 1.640	4.19 1.468	0.18 2.011	non.sign.
All patients with COPD (with and withot BHR)				
	4.16	4.62	0.46	SIGN
SD	1.586	2.091	2.353	p < 0,01

**Table 2.** Average number of neutrophils according to the number of exacerbations of COPD during one year in patients with and without registered BHR. Legend: subgroups: a= 1 or less exacerbations per year, b=2-3 exacerbations, c=more than 3 exacerbations; SD= standard deviation

and last examination was present in subgroup with more than 3 exacerbations per year (p< 0.05).

The difference in the level of increase of blood number of neutrophils between patients with and without BHR is not statistically significant.

### 5. DISCUSSION

BHR is condition in which airways show a much bigger bronchoconstrictive response to various provocative specific and non-specific agents than it is normal (1). Bronchial inflammation is the fundamental of BHR (1, 2). The more expressive inflammation of bronchial mucosa, the more expressive BHR is (2). If the level of BHR is bigger there is bigger number of exacerbations of disease (1, 2, 3). PMNL, which have an important defensive role against various microorganisms and other agents, also have an important role in the development of bronchial inflammation. PMNL activated by microorganisms and other substances cause the damage of bronchial mucosa by releasing first of all superoxide anyon (O<sup>2-</sup>) and also proteases and elastase, and in this way contribute to development of bronchial inflammation (3, 4, 5, 6, 7). Bronchial inflammation cause BHR in different ways – easier approach of irritant factors to afferent nerves, greater penetration of antigens to cells with various mediators, decreasing production of epithelium relaxing factor and neutral endopeptidases (2, 3).

In this investigation we have shown that there is relationship between the blood level of PMNL with the time of development of the BHR in the course of COPD and with the number of exacerbations of illness per year and so the connection between the blood level of PMNL and the level of BHR in COPD.

These results are not compatible with results of Magnussen and al. (9). In patients with COPD and bronchial cancer they did not find the difference in the degree of BHR (measured by methacholine test) after the application of chemotherapy which caused the significant decrease in the number of blood PMNL. Postma D. and al. (5) found the correlation between the production of O<sup>2-</sup> from PMNL and the degree of BHR, but concluded that production of O<sup>2-</sup> is not connected with the number of blood PMNL but with abnormalities of PMNL in patients with COPD. O' Byrne PM and al. (10) proved experimentally the role and importance of blood PMNL in the development of BHR to some bronchoconstrictor agents (such as ozone etc).

### 6. CONCLUSION

PMNL have an important role in the development and level of BHR with COPD by its influence on bronchial inflammation. There is significant correlation between the number of blood PMNL and the level of BHR in COPD, but future examination need to be done to determine real role and mode of action of PMNL for these processes.

**CONFLICT OF INTEREST: NONE DECLARED.**

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