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Original Article

# Study of platelet indices in patients with acute exacerbation of chronic obstructive pulmonary disease

Pulmonology

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## ABSTRACT

**Background:** Chronic obstructive pulmonary disease (COPD) is associated with high-grade systemic inflammation such as elevated blood leukocyte counts, acute phase proteins, and inflammatory cytokines. Involvement of activated platelets and their indices in the pathophysiology of COPD is not surprising due to its central role in hemostasis and thrombosis.

**Objective:** to study platelet indices in patients with acute exacerbation of COPD (AECOPD).

**Methodology:** 100 patients with AECOPD and 100 patients with stable COPD matched for age and gender were included in this case-control study. Age, gender, smoking status, and index were recorded. Spirometric-indices (FVC%, $FEV_1$%, $FEV_1$/FVC ratio), arterial blood gases, hepatic, renal functions tests, erythrocyte sedimentation rate (ESR), total leucocyte count (TLC), platelet (PLTs) count, mean platelets volume (MPV), platelet distribution width (PDW), plateletcrit (PCT%), and platelet large cell ratio (P-LCR) were measured.

**Results:** Compared to the stable COPD group, the AECOPD group had lower MPV, PDW, and P-LCR with higher PCT%. The TLC, PLTs count, and ESR were significantly increased in AECOPD patients. PDW was inversely correlated with $FEV_1$ and the $FEV_1$/FVC ratio in the exacerbation group but not in the stable group. PCT% and $FEV_1$/FVC ratio were positively correlated in AECOPD group while they were inversely correlated in the stable group. The PCT% and smoking index were positively correlated in the AECOPD group. The P-LCR and $FEV_1$/FVC ratio were inversely related in the AECOPD. Regarding ACOPD severity, the PCT% and P-LCR significantly differed between patients with mild, moderate, and severe exacerbation, while PLTs count, MPV, or PDW did not differ.

**Conclusion:** Platelet-indices, which measure platelet activity, can be considered as a simple, and minimally invasive biomarker for COPD exacerbation. PLTs count and MPV are important indicators of COPD exacerbation.

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**Keywords:** Acute exacerbation, chronic obstructive pulmonary disease, COPD, platelet indices.

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## INTRODUCTION

Multiple organ systems, including the bones, heart, and endocrine glands, may be negatively impacted by chronic obstructive pulmonary disease (COPD). High levels of inflammatory cytokines, oxidative stress, and the activation of circulating inflammatory cells have all been linked to COPD in recent studies. Blood levels of C-reactive protein (CRP), fibrinogen, and proinflammatory cytokines are increased in patients with stable COPD [1]. It has been hypothesized that platelets (PLTs) activation is linked to inflammation, COPD, and cardiovascular diseases. Interleukin-6, C-reactive protein, fibrinogen, and lipopolysaccharide-binding protein all rise when inflammation worsens, and vice versa[2].

Even though they are small, PLTs are among the most active parts of the blood. The first functions for these cells are to stop fibrosis and keep the blood from clotting. Recent research has shown that they are useful in more than one way. PLTs are the first cells to gather at an injury site. They change their shape quickly by forming pseudopodia, releasing granular material from their cytoplasm, and clumping together [3].


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The PLTs activation marker, mean platelet volume (MPV) goes down with age and changes based on the ratio of PLTs production and destruction. Changes in MPV seem to be linked to how much inflammation there is in a number of inflammatory diseases, but it's not clear what this means [4]. No definitive study has compared the MPV of patients with stable COPD to those with AECOPD [4]. In number of studies, an increased MPV value has been linked to stable COPD. During an AECOPD, proinflammatory cytokines and acute-phase reactants interfere with megakaryopoiesis, which causes small-sized PLTs to be released from the bone marrow. Cigarette smoking is linked to a higher MPV, and it has been shown that quitting of smoking lowers it [5].

Since MPV is higher in people who are at risk for thromboembolic illness, measuring PLTs volume has been suggested as a way to tell if PLTs is active. Increases in MPV have been seen in cardiovascular diseases, peripheral arterial diseases, and cerebrovascular diseases, which suggests that MPV may be a biomarker of inflammation in these diseases. More research shows that people with COPD have problems with how their PLTs work and how their coagulation system works. Some signs of PLTs dysfunction in these patients are a shorter PLTs half-life, larger PLTs, PLTs aggregation, higher fibrinogen levels in the blood, and PLTs activation both in vitro and in vivo [6].

Damage to the endothelium lining in smokers makes PLTs stick to the subendothelial collagen. This means that the number of PLTs in the blood of smokers and nonsmokers may differ. Platelets- studies that evaluate the link between smoking and fewer PLTs came to different conclusions. PLTs indices like PLTs distribution width (PDW), MPV and plateletcrit (PCT) may also be affected by infections, lung diseases, and heart diseases [7]. A plateletcrit (PCT%) value below the normal range shows that the bone marrow isn't producing enough PLTs to meet the needs of the body [8]. To make things worse, the nicotine in cigarettes causes oxidative stress, which in turn makes PLTs active and stick together and hurts the endothelium. Smoking has been linked to problems with how PLTs activate, stick together, and clot, all of which can cause thrombosis[9]. The MPV and PDW are biomarkers PLTs activation and can be found in a standard hematology analyzer [9]. The aim of this work was to study PLTs-indices in patients with AECOPD.

## SUBJECTS AND METHODS

This case-control study was conducted at chest diseases department, Al-Zahraa university hospital, Al-Azhar university, Cairo, Egypt. It was carried out during the period from March 2020 to September 2020. A 100 patients with COPD were enrolled in the study; 100 patients with AECOPD and 100 patients with stable COPD.

Patients with COPD and irreversible airflow obstruction (post-bronchodilator forced expiratory volume in one second ($FEV_1$) 80% of predicted and ($FEV_1$/FVC <0.7) were eligible for this study according to the updated diagnostic criteria provided by the GOLD 2021 [10]. Their $FEV_1$improved by <200 mL, or 12%, 20 minutes after taking four puffs (400 mcg) of Salbutamol via metered-dose inhaler. Patients with AECOPD are those who meet the Anthonisen criteria (1987**)** [11] while patients with stable COPD are those who not experienced an acute exacerbation in the past three weeks or not required modification of medication [10]. Based on Anthonisen criteria, the AECOPD patients were subclassified into type I (mild), type II (moderate) and type III (severe) exacerbation[11].

Patients known to have hematological disorders, bronchial asthma, coronary artery disease, active tuberculosis, cardiac failure, hepatic failure, renal failure, and systemic inflammatory illnesses were not included in the study.

The ethical review committee of faculty of medicine for girls, Al-Azhar University's, Cairo, Egypt, gave their approval of this study (IRB no. 202002169). The participants were given a description of the study's goals as well as its methods before they were enrolled in the study. All participants signed a written informed consent. They were free to leave the research at any time, with no need to provide a reason and without affecting their rights of medical treatment. All data were coded to protect the confidentiality of the participants.

A thorough history was obtained, including age, sex, smoking status, and smoking index (pack/year). Liver function tests and renal function tests were done using HITACH9-911 TM autoanalyzer to exclude patients with liver or kidney diseases.

Spirometry was carried out on (SPIROSIFT SP-5000, Japan), the following indices were recorded $FEV_1$/FVC ratio, $FEV_1$%, and FVC%. The best out of the three technical performance was reported in accordance with ATS [12]. The arterial blood gases (ABG) samples were collected after 15 minutes resting at room temperature and humidity and analysed using a "rapid lap analyzer 248" machine (Siemens Medical Solutions, Malvern, PA, US). The oxygen saturation % ($O_2$ sat%), arterial partial pressure of oxygen ($PaO_2$) mmHg, arterial partial pressure of carbon dioxide ($PaCO_2$) mmHg, power of hydrogen (pH), and bicarbonate concentration ($HCO_3$) were recorded.

As PLTs are sensitive and easily activated, the blood was withdrawn using a little amount of tourniquet pressure. Cubital vein blood was withdrawn and immediately deposited in tubes containing ethylene diaminetetraacetic acid (EDTA) (Becton Dickinson Vacuum). After gentle mixing at room temperature, the sample was examined using a haematological analyzer

within 1-2 hours after collection (Sysmex XE-21N, Kobe, Japan)[13].

We employed the impedance approach for measurements of PLTs and its indices, this approach depends on the increase in electrical impedance induced by a cell passing through an aperture in a flow cytometer. PLTs were recognized in this manner as the increase in impedance is linked to cell volume[14]. From the original PLTs histogram, the analyzer generates a (lognormal) distribution curve, enabling PLTs to be separated from non-PLTs fragments and red blood cells (RCCs). PLTs indices were derived from this impedance distribution curve. The following indices were reported MPV, PDW, PCT%, and platelets large cell ratio (P-LCR). [15]

**Statistical analysis**

The data were analysed by SPSS (Statistical Package for the Social Sciences). The parametric data was presented as a mean and standard deviation (SD). Percentages and frequency distributions were used to present qualitative data. The Chi-square ($X^2$) test was used to compare qualitative data between the groups. The Mann-Whitney U test was used for comparison of non-parametric data and the Student t-test was used for comparison of parametric data between the two groups. The Kruskal-Wallis test was utilized for the study of non-parametric data involving more than two groups. The margin of error was set to be 5%, with a 95% confidence range. The PLTs, spirometric indices, and ABG indices were all correlated with one another using correlation coefficient. For all used statistical test, the p-value $< 0.05$ was considered significant.

## RESULTS

Table (1) shows the AECOPD group has a significant increase in current smoking status and smoking index compared to the stable COPD group ($p < 0.05$). The total leucocytic count (TLC), PLTs count, urea, Alanine aminotransferase (ALT), and erythrocyte sedimentation rate (ESR) were significantly higher in AECOPD group.

Table (2) shows that there was significant reduction of FVC%, $FEV_1$%, and $FEV_1$/FVC ratio in AECOPD patients compared to stable patients. The AECOPD group had significantly higher $PaCO_2$ and $HCO_3$, with significantly lower pH, $PaO_2$, and $O_2$ saturation %. Table (3) shows that the MPV, PDW, and P-LCR were significantly decreased (p-value< 0.05), while the PCT% was significantly increased in AECOPD patients compared to stable COPD patients.

**Table (1): Comparison of demographic data and studied laboratory parameters between stable COPD group and exacerbated COPD group**

| Items | | Groups | | Stat. test | P-value |
|---|---|---|---|---|---|
| | | AECOPD (n = 100) | Stable COPD (n = 100) | | |
| **Age / years** | Median (IQR) | 61 (58 – 67) | 61(60 – 65) | MW=4941 | 0.884 |
| **Sex** | Male | 89 (89%) | 84 (84%) | $X^2 = 1.07$ | 0.301 |
| | Female | 11 (11%) | 16 (16%) | | |
| **Smoking status** | Current Smokers | 80 (80%) | 56 (56%) | $X^2 = 13.3$ | 0.001* |
| | Non Smokers | 7 (7%) | 17 (17%) | | |
| | Ex-Smokers | 13 (13%) | 27 (27%) | | |
| **Smoking index / pack/y** | Median (IQR) | 25 (16 – 35) | 17 (10 – 21) | MW= 2806.5 | 0.001* |
| **TLC $10^9$/L** | Mean ± SD | 9.08± 2.7 | 7.1± 1.7 | t = 6.2 | 0.001* |
| **PLTs count $10^9$/L** | Median (IQR) | 295 (222.3–349.8) | 239 (190 – 300) | MW=3454.5 | 0.001* |
| **ESR mm/h** | Median (IQR) | 34 (22 – 45) | 15.5 (9.25 – 20) | MW =1246 | 0.001* |
| **ALT U/L** | Median (IQR) | 17 (12 – 20) | 20 (13.5 – 22) | MW=3915.5 | 0.008* |
| **AST U/L** | Median (IQR) | 18 (17 – 22) | 19 (18 – 22) | MW=4227.5 | 0.057 |
| **Creatinine mg/dl** | Median (IQR) | 0.8 (0.7 – 1) | 0.8 (0.7 – 0.9) | MW= 4827 | 0.668 |
| **Urea mg/dl** | Median (IQR) | 25 (20 – 31) | 20 (19 – 27) | MW= 3892 | 0.007* |

MW: Mann-Whitney U, T: Independent sample t-test, AST: Aspartate transaminase, ESR: Erythrocyte sedimentation rate, ALT: Alanine aminotransferase, TLC: Total leucocytic count**, PLT** :Platelet count **,** IQR :Interquartile range *****: Significant: p-value (< 0.05)

Table (4) demonstrates that the PDW was negatively correlated with $FEV_1$/FVC ratio and $FEV_1$% in AECOPD group, while in stable group it was not correlated with any studied variables. PCT% was positively correlated with $FEV_1$/FVC ratio and smoking index in AECOPD, while in stable group it was positively correlated with $FEV_1$/FVC ratio. The P-LCR was negatively correlated with $FEV_1$/FVC ratio in AECOPD group.

**Table (2): Comparison of spirometric indices and arterial blood gases indices between stable COPD group and exacerbated COPD group**

| Items | | Groups | | MW | p-value |
|---|---|---|---|---|---|
| | | AECOPD (n = 100) | Stable COPD (n = 100) | | |
| **FVC%** | Median (IQR) | 47.5 (38 – 70.7) | 68.3 (65.5 –87.9) | 2557 | 0.001* |
| **$FEV_1$%** | Median (IQR) | 34.5 (23 – 49.3) | 69.5 (66.6 –76) | 1440.5 | 0.001* |
| **$FEV_1$/FVC ratio** | Median (IQR) | 55.7 (47 – 64.1) | 66.6 (64.9 – 68) | 1739 | 0.001* |
| **PH** | Median (IQR) | 7.33 (7.32 – 7.34) | 7.4 (7.35 – 7.43) | 84 | 0.001* |
| **$PaCO_2$ mmHg** | Median (IQR) | 62.5 (60 – 64) | 53 (51 – 55) | 77.5 | 0.001 * |
| **$PaO_2$ mmHg** | Median (IQR) | 54 (51 – 57) | 60 (58 – 62) | 1129.5 | 0.001 * |
| **$HCO_3$ mmol/l** | Median (IQR) | 30 (29.2 – 31.9) | 24.7 (23.1 – 26.3) | 24 | 0.001 * |
| **$O_2$ sat. %** | Median (IQR) | 85 (84 – 86) | 93 (90 – 95) | 0.01 | 0.001 * |

MW: Mann-Whitney U; IQR :Interquartile range, $FEV_1$%: Forced expiratory volume in 1st second % predicted, FVC%: Forced vital capacity % predicted, pH: Power of hydrogen, $PaCO_2$: Partial arterial pressure of carbon dioxide, $PaO_2$: Partial arterial pressure of oxygen, $HCO_3$:Bicarbonate, *:Significant: p-value (< 0.05)

**Table (3): Comparison of platelet indices between stable COPD group and exacerbated COPD group**

| Items | | Groups | | MW | P-value |
|---|---|---|---|---|---|
| | | AECOPD (n = 100) | Stable COPD (n = 100) | | |
| **MPV fl** | Median (IQR) | 8.7 (8 – 9) | 9.1 (8.9 – 10) | 2064 | 0.001 * |
| **PDW fl** | Median (IQR) | 11 (10.5 – 11.8) | 14.3 (12.2 – 17) | 1937 | 0.001 * |
| **PCT %** | Median (IQR) | 0.21 (0.18 – 0.28) | 0.2 (0.1 – 0.2) | 3967.5 | 0.010 * |
| **P-LCR** | Median (IQR) | 22.01 (15.8 – 26.2) | 28.8 (24.2 – 31) | 2632 | 0.001 * |

MW: Mann-Whitney U; MPV: Mean platelet volume, PDW: Platelet distribution width, PCT%: Plateletcrit, P-LCR: Platelet Large Cell Ratio, fl: femtoliter, IQR :Interquartile range, *:Significant: p-value (< 0.05)

**Table (4): Correlation of platelet indices with spirometric indices and arterial blood gases, smoking index in COPD group and exacerbated COPD group**

| Items | AECOPD | | Stable COPD | |
|---|---|---|---|---|
| | r | p-value | r | p-value |
| **PDW vs. FVC%** | -0.184 | 0.067 | -0.05 | 0.61 |
| **PDW vs. $FEV_1$%** | -0.224 | 0.025 * | -0.14 | 0.153 |
| **PDW vs. $FEV_1$/FVC ratio** | -0.203 | 0.043 * | 0.05 | 0.628 |
| **PDW vs. smoking index** | - 0.14 | 0.157 | 0.08 | 0.444 |
| **PCT % vs. FVC%** | 0.024 | 0.812 | -0.02 | 0.823 |
| **PCT% vs. $FEV_1$%** | 0.138 | 0.171 | -0.17 | 0.084 |
| **PCT% vs. $FEV_1$/FVC ratio** | 0.224 | 0.025 * | -0.26 | 0.010* |
| **PCT% vs. smoking index** | 0.23 | 0.019 * | -0.03 | 0.735 |
| **P-LCR vs. FVC%** | -0.077 | 0.449 | -0.11 | 0.274 |
| **P-LCR vs. $FEV_1$%** | -0.145 | 0.151 | -0.09 | 0.36 |
| **P-LCR vs. $FEV_1$/FVC ratio** | -0.256 | 0.01* | 0.07 | 0.478 |
| **P-LCR vs. smoking index** | 0.02 | 0.876 | -0.002 | 0.987 |
| **P-LCR vs. WBCs** | 0.093 | 0.355 | 0.04 | 0.673 |
| **P-LCR vs. pH** | 0.16 | 0.118 | 0.12 | 0.23 |
| **P-LCR vs. $PaCO_2$** | 0.13 | 0.211 | -0.03 | 0.768 |
| **P-LCR vs. $PaO_2$** | -0.11 | 0.276 | 0.04 | 0.732 |
| **P-LCR vs. $HCO_3$** | 0.10 | 0.311 | 0.03 | 0.778 |
| **P-LCR vs. $O_2$.Sat%** | -0.02 | 0.862 | -0.10 | 0.328 |

PDW: Platelet distribution width, PCT%: Plateletcrit, P-LCR: Platelet large cell ratio; (r): Pearson correlation coefficient, $FEV_1$%: Forced expiratory volume in 1st second % predicted, FVC%: Forced vital capacity **COPD group and exacerbated COPD group**, pH :Power of hydrogen , $PaCO_2$: Partial arterial pressure of carbon dioxide, $PaO_2$: Partial arterial pressure of oxygen, $HCO_3$: Bicarbonate, *:Significant: p-value (< 0.05)

Regarding severity of AECOPD, figure (1) demonstrates that 10 (10%) patients have severe AECOPD, (type I), 35 (35%) patients have moderate AECOPD (type II), and 55 (55%) patients have mild AECOPD (type III). Table (5) shows that the PCT% and P-LCR were significantly differed between patients with type I (mild), type II (moderate), and type III (severe) exacerbation (p value < 0.05) (figures 2, 3), while The PLTs, MPV, and PDW were non-significantly differed between patients with mild, moderate, and severe exacerbation (p value >0.05).

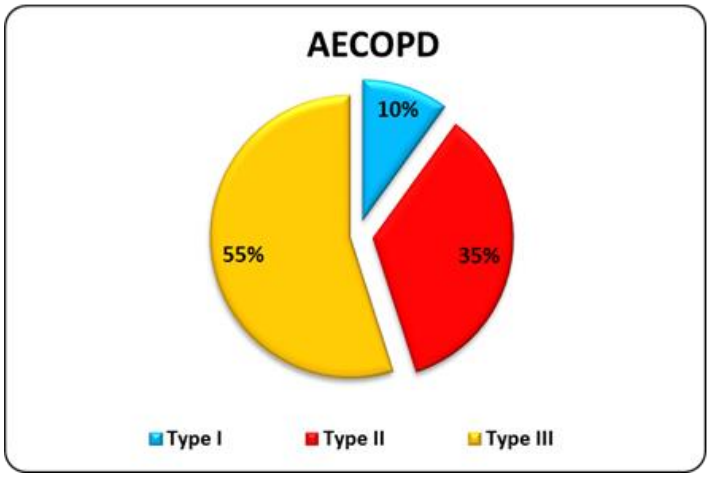


**Figure (1): Classification of AECOPD severity**

**Table (5): Relation of platelets and platelets indices with AECOPD severity**

| Items | | AECOPD severity | | | KW | p-value |
|---|---|---|---|---|---|---|
| | | Mild AECOPD (n = 10) | Moderate AECOPD (n = 35) | Severe AECOPD (n = 55) | | |
| **PLTs count** | **Median (IQR)** | 314 (187.8 – 362) | 282 (223 – 354) | 320 (219 – 349) | 0.2 | 0.902 |
| **MPV** | **Median (IQR)** | 8.8 (7.9 – 9.1) | 8.5 (8.2 – 8.9) | 8.7 (8 – 9) | 0.03 | 0.984 |
| **PDW** | **Median (IQR)** | 11.4 (9.9 – 11.8) | 10.8 (10.2–11.3) | 11.1 (10.6–13.5) | 5.9 | 0.051 |
| **PCT%** | **Median (IQR)** | 0.27 (0.2 – 0.28) | 0.23 (0.2 – 0.3) | 0.2 (0.14–0.24) | 7.7 | 0.021 * |
| **P-LCR** | **Median (IQR)** | 20.9 (13.5 – 23.6) | 18.5 (12.6–23.1) | 23.2 (20 – 29.6) | 12.5 | 0.002 * |

PLTs :Platelet count, MPV: Mean platelet volume, PDW: Platelet distribution width, PCT%: Plateletcrit, P-LCR: Platelet large cell ratio, KW: Kruskal Wallis Test, IQR: Interquartile range, *:Significant: p-value (< 0.05)

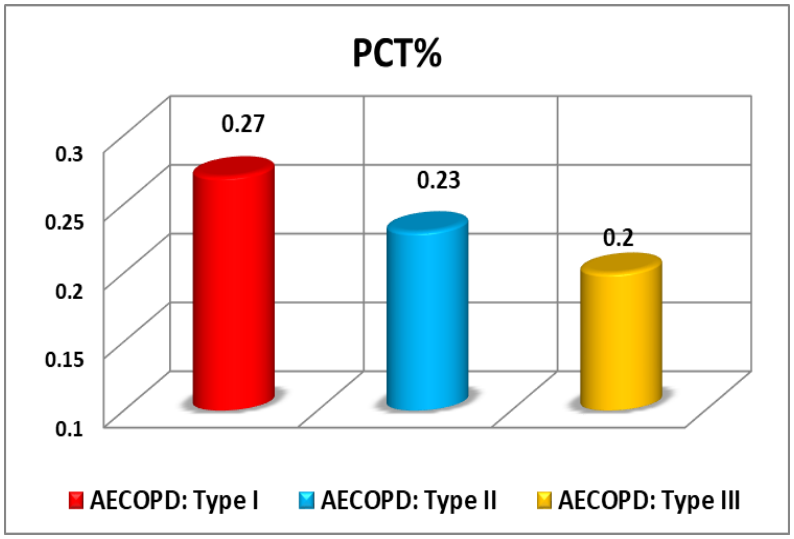


**Figure (2): Relation between AECOPD severity and plateletcrit (PCT%) in Acute exacerbation of chronic obstructive pulmonary group**

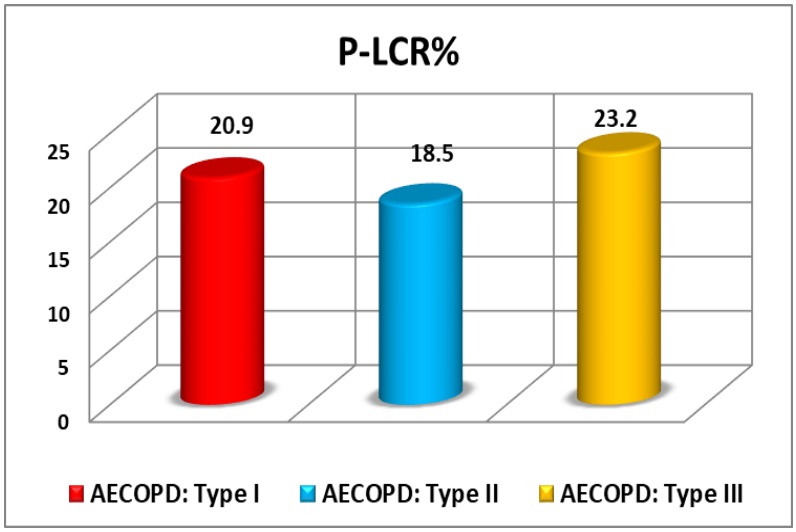


**Figure (3): Relation between AECOPD severity and platelet large cell ratio (P-LCR)**

## DISCUSSION

The high rates of mortality and morbidity caused by COPD accompanying respiratory and cardiovascular difficulties, as well as the disease's considerable healthcare costs, make it a major public health issue [16]. In patients with AECOPD, blood leukocyte counts, acute phase proteins, particularly CRP, and inflammatory cytokines were found to be higher indicators of systemic inflammation [17]. PLTs are important biological mediators of blood clotting and clot formation. PLTs biogenesis is critical in the lung, and PLTs activation and the mediators they release play a role in the progression of COPD[18].

One of the important findings in this study is the significant increase of PLTs count together with TLC count in AECOPD group than the stable group. This result indicates that the PLTs might have a role in COPD exacerbation. Consistent with these findings are those reported by Fawzy et al. [19] and In et al. [ 20] who found an elevated PLTs in patients with COPD exacerbations compared to those in the stable patients. It is now understood that PLTs are involved in a wide variety of pathophysiologic processes, including inflammation, host defense, and tumor biology [21]. TLC counts were shown to be higher in AECOPD patients than in controls, which is consistent with our findings and the findings of Koo et al. [22] who used TLC as an inflammatory biomarker for COPD. Our findings of thrombocytosis and leukocytosis can be explained by the recruitment of leukocytes to the site of inflammation and the initiation of numerous intercellular and extracellular processes that may later contribute to atherogenic and thrombotic events [23].

We examined the smoking index among smokers since tobacco use is a main risk factor for the development and exacerbation of COPD [24]. The smoking index in the AECOPD group was considerably greater than in the stable group.

In the present study we found significant decrease of FVC%, $FEV_1$%, and $FEV_1$/FVC ratio in the AECOPD group compared to the stable group (p= 0.001). These results were in agreement with many other studies as the exacerbation group had significantly lower lung function than the stable group [25][26][27]. Additionally, when comparing the AECOPD group with the stable group, we found a significant increase of $PaCO_2$, $HCO_3$ and a significant decrease of pH, $PaO_2$, and $O_2$ saturation. These results supported those of Eltaweel et al. [28] and Cukic, [29] as they found that AECOPD induces significant decrease of $PaO_2$ and pH with significant increase of $PaCO_2$. PLTs indices MPV, PDW, and P-LCR were significantly decreased in AECOPD group compared to stable group with significant increase of PCT% .As COPD is a systemic inflammatory disease, changes in PLTs-indices (number, structure, shape, and dynamics) may help explain these results. Therefore, PLTs-indices should be considered as an important, simple, and inexpensive parameter for evaluating the inflammatory process in AECOPD. Ulasli et al. [30 reported that patients with AECOPD had significantly lower MPV levels than those in stable phase and healthy controls ]. Moreover, Jia et al. [31] concluded that PCT % were significantly higher in AECOPD patients than healthy controls. This decrease in MPV in AECOPD patients may be due to pro-inflammatory cytokines and acute-phase reactants interfering with megakaryopoiesis, resulting in the release of smaller-sized PLTs from the bone marrow[32]. In addition, systemic inflammation influences PLTs function, which may explain why patients with AECOPD have lower MPV [28]. During exacerbations, widespread PLTs breakdown, and the accumulation of larger PLTs at the site of inflammation during intercellular contacts have all been associated with a decrease in MPV in COPD patients. The PDW rises in situations of PLTs hyperproduction, which results in the release of immature, larger PLTs from bone marrow[23].

Olaee et al. [34] reported that PDW was comparable in the AECOPD, stable, and healthy groups [33]. In a study conducted by Tugba and Ayperi, TLC and PDW were significantly higher in exacerbation group ($p< 0.001$). However, the exacerbation group had significantly lower levels of PCT and MPV. Additionally, in a study done by Ali**,** [35] PLTs indices were higher in AECOPD group compared to stable COPD group and control group, and the AECOPD group had a significant reduction in MPV compared to stable COPD group, which had lower MPV levels than the control group. In addition, there was a significant reduction of MPV in stable COPD group's, follow-up visit during exacerbation. This result can explain why the volume of PLTs changes in COPD as a consequence of the inflammatory process.

We investigate the link between smoking and PLTs indices but there was no significant correlation Mukta et al. [36] observed that smoking status influences PLTs indices, but the authors presented an explanation based on their study's larger sample size and longer time period. There was no significant correlation between PLTs count and other studied laboratory data, pulmonary function tests (PFTs) or smoking index in both studied groups.

We found that in AECOPD group, the MPV was strongly correlated with $HCO_3$, but not with any of the other laboratory examined variables, PFT, or smoking index. These results were in agreement with Ma et al. [37] and Helmy et al. [38] who not found relationships between MPV and TLC or MPV and CRP, and no correlation was found between $FEV_1$% and MPV in COPD exacerbation group. But Eltaweel et al. [28] found a significant positive correlation between MPV and spirometric parameters $FEV_1$%, $FEV_1$/ FVC ratio, and FEF 25-75% in AECOPD patients. Such different results among all studies indicated that we need further researches to detect relation between PLTs indices and PFTs among COPD patients.

Regarding the correlation between (PDW, PCT%, P-LCR%) and other studied laboratory data our results indicated that these three indices were no correlated with ABG and TLC neither in AECOPD nor stable group. However, there was significant negative correlation between (PDW, P-LCR%) and $FEV_1$/FVC ratio among AECOPD group. Also, there were significant positive correlation between PCT% and $FEV_1$/FVC ratio among AECOPD group and significant negative correlation between them in stable group. Unfortunately, we can't compare these findings with previous studies as till now there has been limited data in this area.

Although several factors, such as increased systemic inflammation, hypoxemia, and oxidative stress, have been hypothesized to play a role in PLTs activation in COPD patients, the precise underlying mechanisms remain unknown. In addition, it was found that AECOPD is associated with high grade systemic inflammation, as determined by markers of inflammation such as elevations in blood leukocytes, acute phase proteins like CRP, and inflammatory cytokines[17].

Our results found no significant difference between AECOPD types and (PLT count, MPV and PDW) while there was significant difference between AECOPD types and (PCT% and P-LCR%) in AECOPD group. These results explained that not all types of AECOPD have the same effect on PLTs indices, so we need more studies on larger groups. Studies made by Ma et al. [37] and Ulasli et al. [30] revealed that MPV values were not significantly different between the stages of COPD, therefore; MPV cannot distinguish disease severity among COPD patients. A cross-sectional study was done by Fathy et al. [39] documented that the MPV was significantly increased by increasing the severity of COPD. Also, another study by Moniruzzaman et al**.** [40] detected positive correlation between PLTs count and the severity of COPD. A previous study by Biljak et al. [41] revealed that in spite of changes in the lung function parameters, there was no significant differences in PLTs count and MPV between the COPD stages. But those studies worked on COPD severity not exacerbation severity, so further researches need to be done on AECOPD severity and its relations with PLTs indices.

The main strength of the current study is that it is conducted only on AECOPD patients without comorbidities, therefore it reflects the influence of COPD only as inflammatory process on PLTs indices.

## CONCLUSION

Platelets play an important role in inflammatory process in COPD. In COPD exacerbation, PLTs indices as a marker of platelet activation, are considered a simple inexpensive and minimal invasive inflammatory biomarker for detection of COPD exacerbation.

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# الملخص العربي

## دراسة مؤشرات الصفائح الدموية في مرضى التفاقم الحاد لمرض ضيق الشعب الهوائية المزمن

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**ملخص البحث**

**الخلفية**: يرتبط مرض ضيق الشعب الهوائية المزمن ارتباطا وثيقا بزياده دلالات الإلتهاب المتعددة مثل ارتفاع كريات الدم البيضاء في الدم، والبروتينات الحادة، والسيتوكينات المحفزة لحدوث الالتهاب. تعد مشاركة الصفائح الدموية النشطة ومؤشراتها في الفيزيولوجيا المرضية لمرض ضيق الشعب الهوائية المزمن ليس مفاجئًا نظرًا لدورها الهام في عمليه التجلط والحفاظ على التوازن الطبيعي للدم.

**الهدف :** دراسة مؤشرات الصفائح الدموية في مرضى التفاقم الحاد لمرض ضيق الشعب الهوائية المزمن.

**الطرق:** اشتملت دراسة الحالات والشواهد هذه 100 مريضا بمرض ضيق الشعب الهوائية المزمن المتفاقم، و 100 مريضا بمرض ضيق الشعب الهوائية المزمن المستقر المتوافقين من حيث العمر والجنس.تم تسجيل السن و الجنس و مؤشر التدخين. كما تم قياس وظائف التنفس، غازات الدم الشرياني، وظائف الكبد والكلى ، عدد كريات الدم البيضاء لكلى، عدد الصفائح الدموية، متوسط حجم الصفائح الدموية، عرض توزيع الصفائح الدموية، نسبه الصفائح الدموية ، نسبه الخلايا الكبيرة في الصفائح الدموية.

**النتائج**: بالمقارنة مع المجموعة المستقرة، انخفض متوسط حجم الصفائح الدموية، عرض توزيع الصفائح الدموية، ونسبه الخلايا الكبيرة في الصفائح الدموية، بينما زادت نسبه الصفائح الدموية في مجموعة التفاقم الحاد. ارتفع عدد خلايا الدم البيضاء الكلى، عدد الصفائح الدموية، و سرعة الترسيب فى مجموعه التفاقم الحاد مقارنة بالمجموعة المستقرة. تناسب عرض توزيع الصفائح الدموية تناسبا عكسيا مع حجم الزفير القسري في الثانية الأولى، و نسبة حجم الزفير القسري في الثانية الأولى / السعه الحيوية القسرية في مجموعة التفاقم الحاد، بينما لم يكن هناك ارتباط إحصائي بينهما في المجموعة المستقرة. تناسبت نسبة الصفائح الدموية ايجابيا مع نسبة حجم الزفير القسري في الثانية الأولى / السعه الحيوية القسرية في مجموعة التفاقم الحاد و سلبيا في المجموعة المستقرة، تناسبت نسبة الصفائح الدموية ايجابيا مع مؤشر في مجموعة التفاقم الحاد. تناسبت نسبة الخلايا الكبيرة في الصفائح الدموية تناسبا سلبيا مع حجم الزفير القسري في الثانية الأولى / السعة الحيوية القسريه في مجموعة التفاقم الحاد. بالنسبة لشدة التفاقم الحاد، اختلفت نسبة الصفائح الدموية ونسبة الخلايا الكبيرة في الصفائح الدموية احصائيا في التفاقم الحاد البسيط و المتوسط و الشديد، بينما لا يوجد اختلاف في عدد الصفائح الدموية ، متوسط حجم الصفائح الدموية وعرض توزيع الصفائح الدموية.

**الاستنتاج**: من الممكن اعتبار مؤشرات الصفائح الدموية و التي تقيس نشاط الصفائح الدموية إجراء بسيط واختراقي طفيف للكشف عن تفاقم مرض ضيق الشعب الهوائية المزمن. عدد الصفائح الدموية و متوسط حجم الصفائح الدموية مؤشرات مهمة لتفاقم مرض ضيق الشعب الهوائية المزمن.

**الكلمات المفتاحية**: التفاقم الحاد، مرض ضيق الشعب الهوائية المزمن، مؤشرات الصفائح الدموية.

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