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# Significance of Platelet Indices in Patients with Acute Ischemic Stroke

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## Abstract

**Background** Platelets play an important role in the development of intravascular thrombosis. Platelet size has been considered to reflect platelet activity. Platelet indices had been studied as an independent predictor of acute ischemic stroke (IS).

**Objectives** Assessing the relation of acute IS with different platelet indices.

**Methods** Fifty patients were enrolled: 25 of them had first acute IS (mean age 64 years, 12 (48%) were males) [group 1], while the rest 25 patients were those with more than one IS (mean age 68 years, 16 (64%) were males) [group 2] in comparison with the control group (20) subjects (mean age 57 years, 10 (50%) males). Work up included history and clinical examination in addition to brain CT scan and platelet indices which are: mean platelet count (MPC), mean platelet volume (MPV), platelet large cell ratio (P-LCR), and platelet distribution width (PDW) within first 24 hours of patient presentation.

**Results** The mean platelet count (MPC) was found to show significant difference between group 2 versus group 1 and control (P=0.012, P=0.023 respectively), while no statistically significant differences were reported with the other indices (MPV, PDW or P-LCR). Linear negative correlation was demonstrated between MPC and MPV, PDW and P-LCR in group 1, such correlation wasn't found in group 2.

**Conclusion** Mean platelet count (MPC) differs significantly in cases of multiple stokes in comparison with those having first stroke or the control group; therefore, the significance of this finding needs further studies.

**Keywords** Platelet indices, platelet count, mean platelet volume, platelet distribution width, platelet-large cell ratio, ischemic stroke.

## Introduction

Stroke is a sudden loss of neurologic function resulting from focal disturbance of cerebral blood flow due to ischemia or hemorrhage [(1)]. Platelets play an important role in the pathophysiology of ischemic stroke by developing intravascular thrombus after erosion or rupture of atherosclerotic plaques [(2)].

Platelet volume is a marker of platelet function and activation that is readily measured as mean platelet volume (MPV) and positively associated with platelet reactivity [(3-7)]. Larger platelets contain more dense granules and are metabolically more active than small platelets and having higher thrombotic potential [(8-14)]. In steady-state platelet production, there is an inverse but nonlinear relationship between MPV and MPC [(3, 15-19)].

The aim of this study is to investigate whether MPC, MPV, platelet distribution width (PDW) and platelet large cell ratio (P-LCR) have any association with ischemic stroke and possibility of being independent risk factors for stroke among the other conventional risk factors.

## Methods

In cross-sectional study; fifty consecutive patients presented with clinical manifestations

of acute ischemic stroke were enrolled in the period between November, 2010 and March, 2011 as they were received at Al-Kadhimiya Teaching Hospital.

For every patient, medical evaluation conducted including history, clinical examination, evaluation of risk factors, and drug therapy. Venous blood samples were collected within first twenty-four hours of hospitalization and before any medical or therapeutic intervention.

Blood samples were taken and analyzed by a Sysmex KX- 21N auto-analyzer at same hospital laboratory. For all patients; brain computed tomography and neurological opinion were taken. Those patients with infection, inflammatory disease, trauma, underlying hematological disease, autoimmune disease, malignancy and patients with clear source of emboli showering were excluded from the study. In this study (50) Eligible patients were included and distributed into two groups each group include (25) patients:

1. Group 1: subjects with the evidence of first-ever ischemic stroke (IS).
2. Group 2: subjects with more than one stroke.

There were (20) control subjects with similar baseline characteristics and exclusion criteria, who confirmed their stable healthy status by direct interviewing, used for comparison of the same parameters in this study. They had been met during their routine follow up at cardiology clinic.

All patients and control were informed and agreed to participate in this study in addition to local medical ethical committee license.

The normal value of the studied platelets parameters were reported as follows:

- MPC: (128-434×$10^9$/L) for females and (134-377×$10^9$/L) for males,
- MPV: (8.5-12.8 fL) for females and (8.1-12.4 fL) for males,
- PDW: (9.4-18.1 fL) for females and (9.8-18.0 fL) for males,
- P-LCR: (14.3-44 %) for females and (10.7-45.0 %) for males.[20]

Statistical Analysis included ANOVA (for demographic differences among the 3 groups), Chi-square (for differences in each parameter between groups), and Pearson correlation coefficient (for correlation analysis), by the programs SPSS 16 and Microsoft office Excel 2007, considering P≤ 0.05 as statistically significant difference.

## Results

The mean age of patients in group 1 was 64.72±8.50 years, ranging from 46 to 80 years. The mean age of patients in group 2 was 68.72±6.10 year, ranging from 60 to 83 years, while the mean age of control subjects was 62.4±9.5 years, ranging from 46 to 73 years and those were matched with no statistical differences with either group 1 (p= 0.1), or group 2 (p=0.09). There was no significant difference in the mean age between patients in group 1 and patients in group 2 (p=0.222) as shown in table 1.

**Table 1. Demographic characteristics of patients and control subjects**

| Feature | Control group | Group 1 | *P* | Group 2 | *P* | *P!* |
|---|---|---|---|---|---|---|
| No | 20 | 25 | | 25 | | |
| Age (years) | 62.4±9.5 | 64.72±8.50 | 0.1 | 68.72±6.10 | 0.09 | 0.222 |
| Male, **No.** (%) | 10 (50) | 12 (48) | 1 | 16 (64) | 0.474 | 0.254 |
| Hypertension, **No.** (%) | 14(70) | 17 (68) | 1 | 18 (72) | 0.606 | 0.758 |
| DM, **No.** (%) | 14(70) | 14 (56) | 0.704 | 12 (48) | 0.212 | 0.571 |
| Current smoking, **No.** (%) | 10 (50) | 11 (44) | 0.519 | 10 (40) | 0.712 | 0.774 |
| IHD, **No.** (%) | 20(100) | 4 (16) | <0.001 | 4 (16%) | <0.001 | 1 |

*!* Comparison between group 1 and group 2, * <0.05, ** <0.001

In group 1 patients, 12 (48%) were males while group 2 patients whom presented with more than one IS, 16 were (64%) males in comparison with the control group in which 10 (50%) were males. The three groups were matched with respect to gender (p=0.493) as noticed in table 1.

The risk factors like smoking, hypertension, diabetes mellitus and ischemic heart disease (IHD) were reviewed also, but with no statistical significance differences reported among the 3 groups except for the history of IHD that presented more in the control group as demonstrated in table 1.

Mean platelet count (MPC) for group 1 was 253.72±76.35×$10^9$/L and in group 2 was 341.04±133.52×$10^9$/L while for control 234.60±60.36×$10^9$/L. There is statistically significant difference in MPC of group 2 in comparison to control group and group 1 (p = 0.023 and 0.012 respectively) but there is no similar statistically significant difference between group 1 and control group (Table 2).

**Table 2. Mean platelet count (MPC) among the 3 groups**

| Parameter | Groups | mean±SD | Range | P value | | |
|---|---|---|---|---|---|---|
| | | | | Control *Vs* group 1 | Control *Vs* group 2 | Group 1 *Vs* group 2 |
| MPC (x$10^9$/L) | Control | 234.60±60.36 | 156-328 | 1.000 | 0.023* | 0.012* |
| | Group 1 | 253.72±76.35 | 125-404 | | | |
| | Group 2 | 341.04±133.52 | 202-759 | | | |

MPC = mean platelet count, * = P<0.05

No statistically significant difference reported in mean platelet volume (MPV) among the 3 groups (p = 1.000, 0.801 and 1.000 respectively) (Table 3) and similar results concerning mean platelet distribution width (PDW) among these 3 groups (p = 1.000, 0.614 and 0.465 respectively) were reported (Table 4) also as well as for platelet large cell ratio (P-LCR) (P values= 1.000, 1.000 and 0.862; respectively) as shown in table 5.

**Table 3. Mean platelet volume (MPV) among the 3 groups**

| Parameter | Groups | mean±SD | Range | P value | | |
|---|---|---|---|---|---|---|
| | | | | Control *Vs* group 1 | Control *Vs* group 2 | Group 1 *Vs* group 2 |
| MP**V** (**f**/L) | Control | 11.10±0.98 | 10.0-12.3 | 1.000 | 0.801 | 1.000 |
| | Group 1 | 10.94±1.31 | 8.6-13.9 | | | |
| | Group 2 | 10.63±0.93 | 9.3-12.7 | | | |

MPV = mean platelet volume

**Table 4. Mean platelet distribution width (PDW) among the 3 groups**

| Parameter | Groups | mean±SD | Range | P value | | |
|---|---|---|---|---|---|---|
| | | | | Control *Vs* group 1 | Control *Vs* group 2 | Group 1 *Vs* group 2 |
| **PDW** (**f**L) | Control | 15.3±1.8 | 12.3-18.0 | 1.000 | 0.614 | 0.465 |
| | Group 1 | 15.12±3.1 | 10.9-23.8 | | | |
| | Group 2 | 14.1±19.3 | 11.6-19.1 | | | |

MPD = mean platelet distribution

**Table 5. Mean platelet large cell ratio (P-LCR) among the 3 groups**

| Parameter | Groups | mean±SD | Range | P value | | |
|---|---|---|---|---|---|---|
| | | | | Control *Vs* group 1 | Control *Vs* group 2 | Group 1 *Vs* group 2 |
| **PLCR (%)** | Control | 33.7±7.89 | 24.1-44.8 | 1.000 | 1.000 | 0.862 |
| | Group 1 | 33.38±9.81 | 17.8-39.4 | | | |
| | Group 2 | 30.78±7.36 | 20.4-46.6 | | | |

PLCR = platelet large cell ratio

Strong negative correlations were found in group 1 patients between MPC and PDW, MPV and P-LCR, ($p<0.001$) (Figures 1a, b and c) respectively whereas these correlations were found non-significant in group 2 patients ($p = 0.3$, 0.4, and 0.4 respectively) (Figures 2a, b and c)

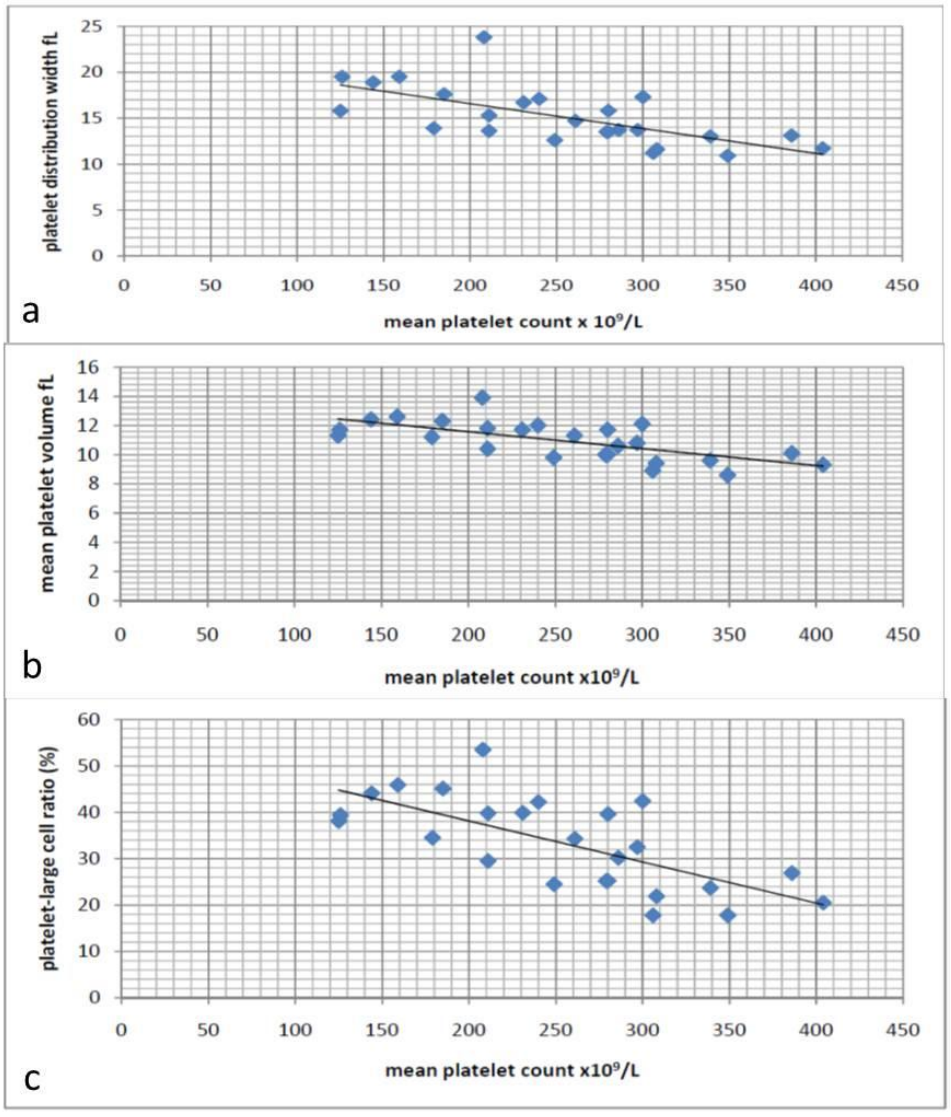


**Figure 1. The correlation between different platelet indices in group 1; (a) mean platelet count and platelet distribution width, (b) mean platelet count and mean platelet volume, (c) mean platelet count and platelet-large cell ratio**

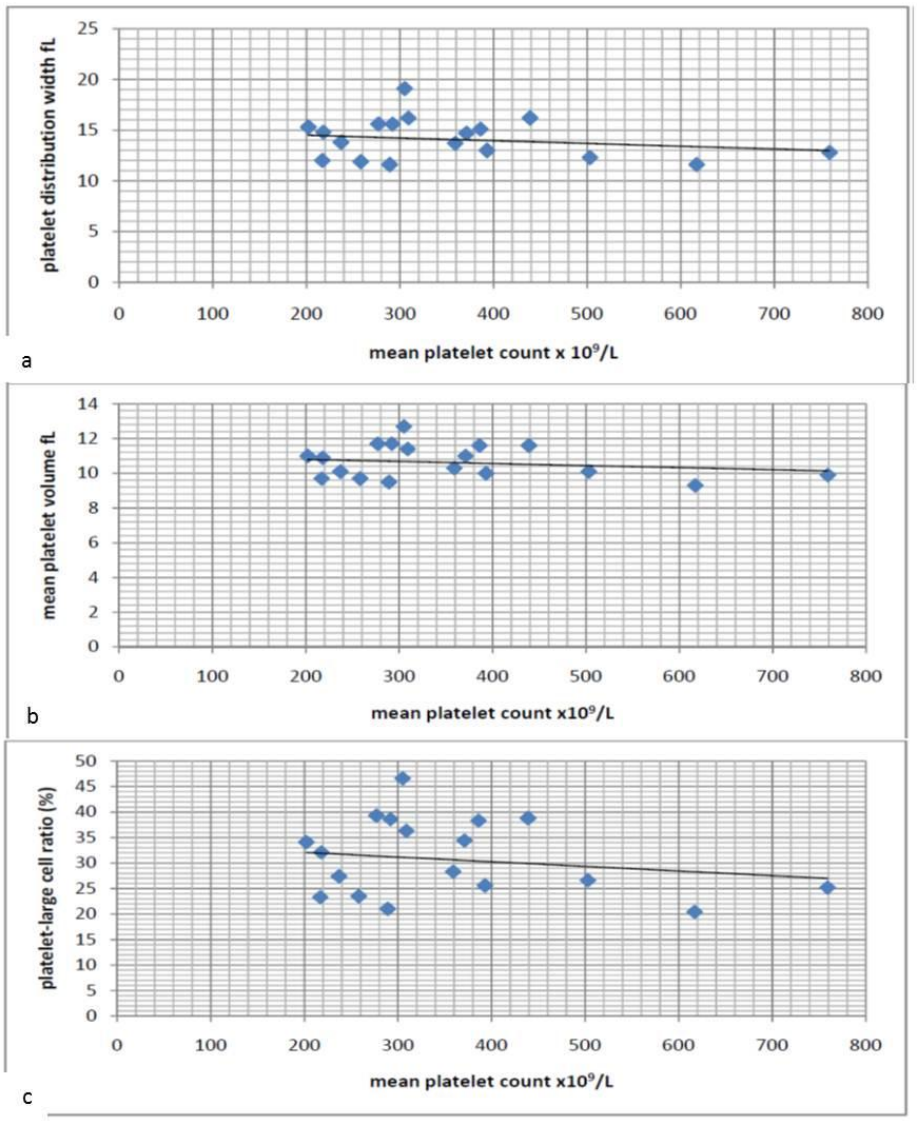


**Figure 2. The correlation between different platelet indices in group 2; (a) mean platelet count and platelet distribution width, (b) mean platelet count and mean platelet volume, (c) mean platelet count and platelet-large cell ratio**

## Discussion

Different platelet indices and especially MPV and MPC are considered as good indices of hemostasis and thrombosis [8,9]. It had been shown that there is association between MPV and ischemic stroke due to greater thrombopoitic reactivity of larger platelet [4,5, 15-19].

In this study, patients with ischemic stroke whether first-ever ischemic stroke or multiple stroke due to presence of similar risk factors (like hypertension, diabetes mellitus, smoking and atherosclerosis) were compared with control group who have similar risk factors but without history of stroke.

Both stroke patients groups were comparable from statistical point of view concerning age and risk factors as well as with control group.

It can be understood that increased MPC will increase the chance of arterial thrombosis and this had been shown also in this study as MPC was higher in group 2 patients when compared with group 1 or control (p= 0.012 ,0.023 respectively) similar to Numminen et al report [21] but in contrast to O'Brien et al [15], Butterworth et al [18] and McCabe et al [22] who

showed no differences in MPC while Nadar et al [23] and Tohgi et al [24] showed a decreased MPC in acute ischemic stroke secondary to platelet consumption. This increase in MPC in group 2 in comparison to control group and group 1 could be explained as part of inflammatory reaction [4,5].

MPV did not show any statistically significant association with development of ischemic stroke among both patients groups and control group in contrast to Greisenegger et al and others [2,13,15,18,19] who suggested that MPV is independent risk factor for development of ischemic stroke secondary to higher platelet thrombopoietic reactivity and this may be due to higher concentration of dense granules with excess release of procoagulant materials [15,18,19] but this couldn't be demonstrated in this study due to alteration in platelets size after storage at room temperature till the time of analysis or delayed presentation of patient to hospital [25]. Platelets may swell in a time dependent fashion after blood sampling in EDTA [25].

Both PDW &P LCR are related to MPV and therefore, they didn't show any difference as the latter didn't confirm any differences among the 3 groups [26].

Reduction of this linear correlation with the use of effective anti-platelet therapy didn't reduce the risk for subsequent stroke in this study which may indicate the existence of other uncontrolled risk factors that potentiate the risk of ischemic stroke.

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